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(19) **United States**(12) **Patent Application Publication**
BUBLITZ et al.(10) **Pub. No.: US 2017/0184092 A1**(43) **Pub. Date: Jun. 29, 2017**(54) **INTEGRATED DISPLACEMENT
CONTROLLED PUMP***F04C 2/344* (2006.01)*F04C 2/10* (2006.01)*F04B 19/22* (2006.01)(71) Applicant: **Parker-Hannifin Corporation,**
Cleveland, OH (US)*F04B 17/03* (2006.01)*F04C 14/08* (2006.01)(72) Inventors: **Roland BUBLITZ,** Neuss (DE); **Blaise
GOUPY,** Bourges (FR)(52) **U.S. Cl.**CPC *F04B 49/20* (2013.01); *F04B 17/03*(2013.01); *F04B 49/12* (2013.01); *F04C 14/08*(2013.01); *F04C 2/344* (2013.01); *F04C 2/10*(2013.01); *F04B 19/22* (2013.01); *F04C 14/18*(2013.01); *F04C 2240/40* (2013.01)(21) Appl. No.: **15/314,201**(22) PCT Filed: **May 29, 2015**(86) PCT No.: **PCT/US2015/033150**

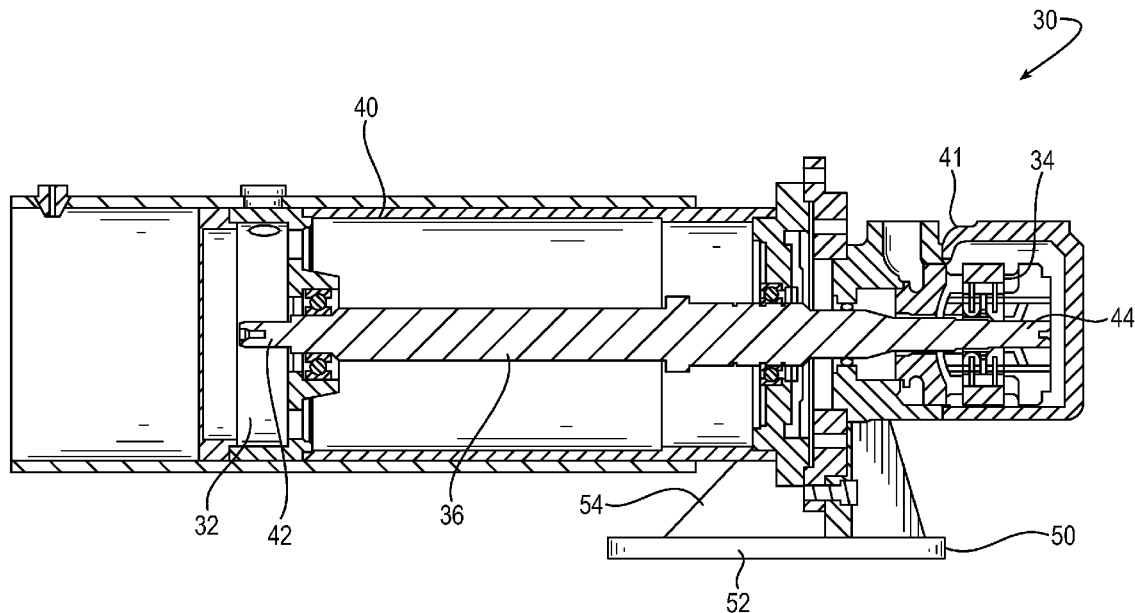
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30, 2014.**Publication Classification**(51) **Int. Cl.***F04B 49/20* (2006.01)*F04B 49/12* (2006.01)*F04C 14/18* (2006.01)

(57)

ABSTRACT

A pump system includes a motor, a pump, and a single shaft extending from the motor into the pump, the single shaft being configured to operate simultaneously as both a motor output shaft and a pump input shaft. A first end of the single shaft interacts with the motor, and a second end of the single shaft interacts with the pump, to configure the shaft to operate as the motor output shaft and the pump input shaft. The pump system further may include a mounting accessory configured to support the motor and the pump. The motor may be an electric motor, and the pump may be a hydraulic pump. A drive controller is configured to generate commands for controlling the electric motor, which in turn drives the pump to achieve a desired flow of hydraulic fluid.



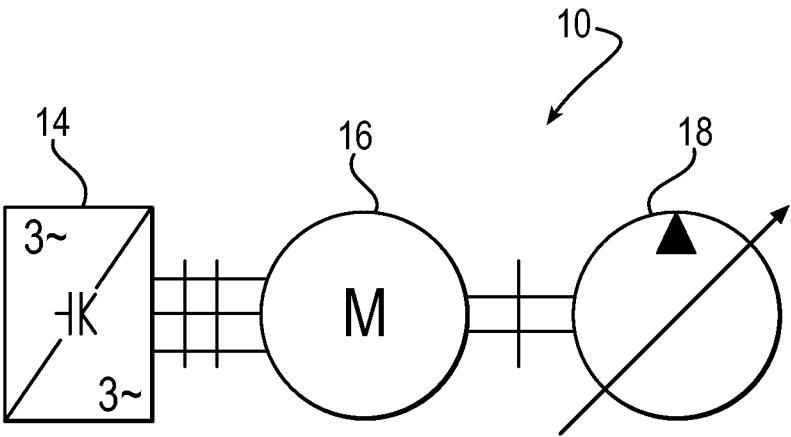


FIG. 1

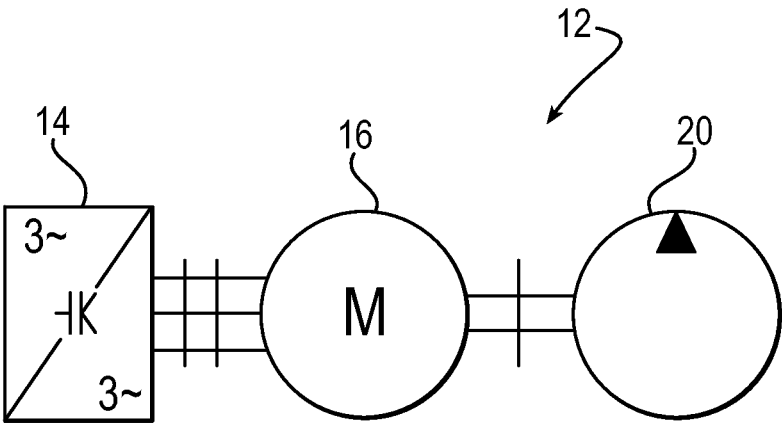


FIG. 2

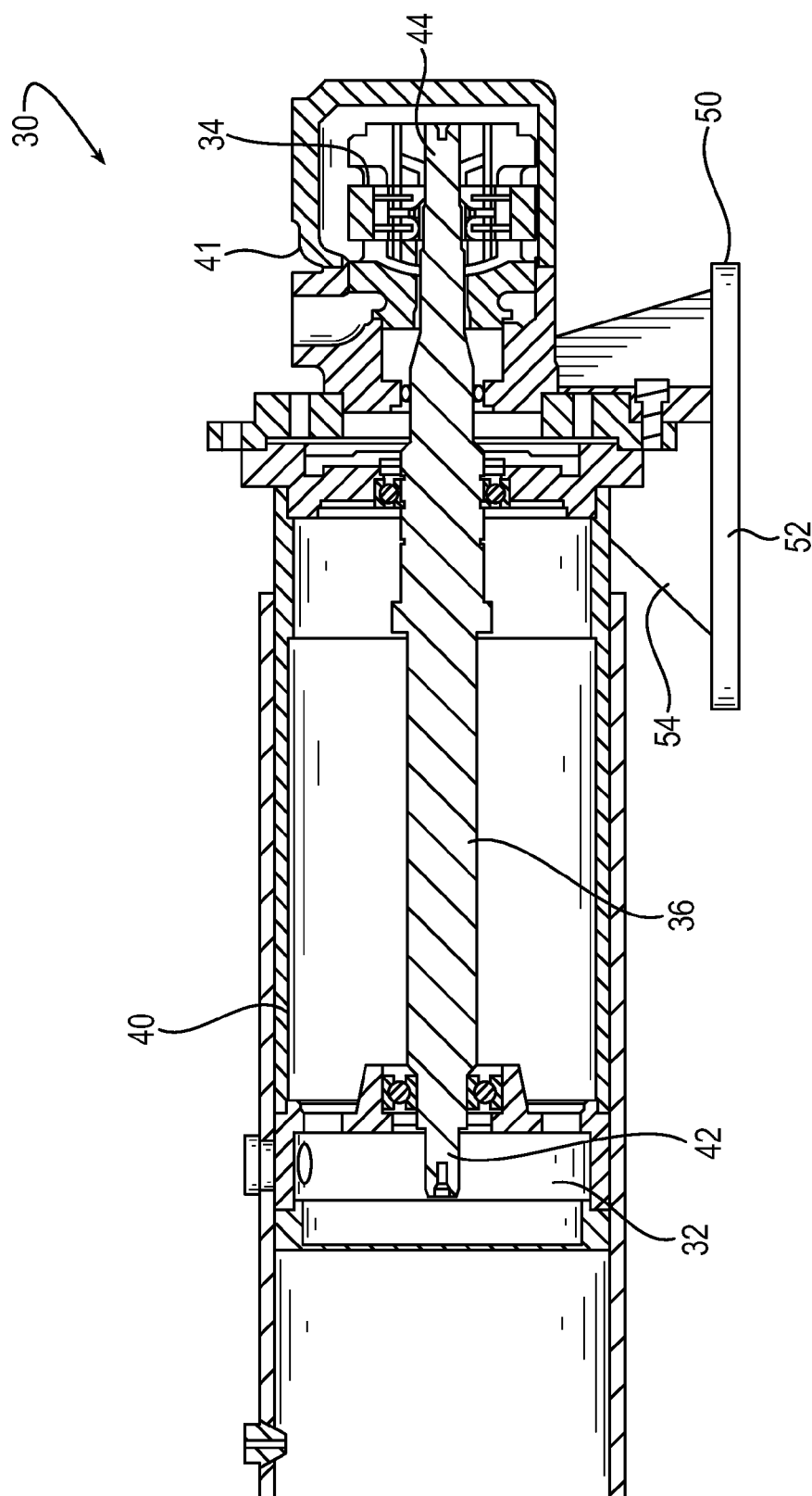


FIG. 3

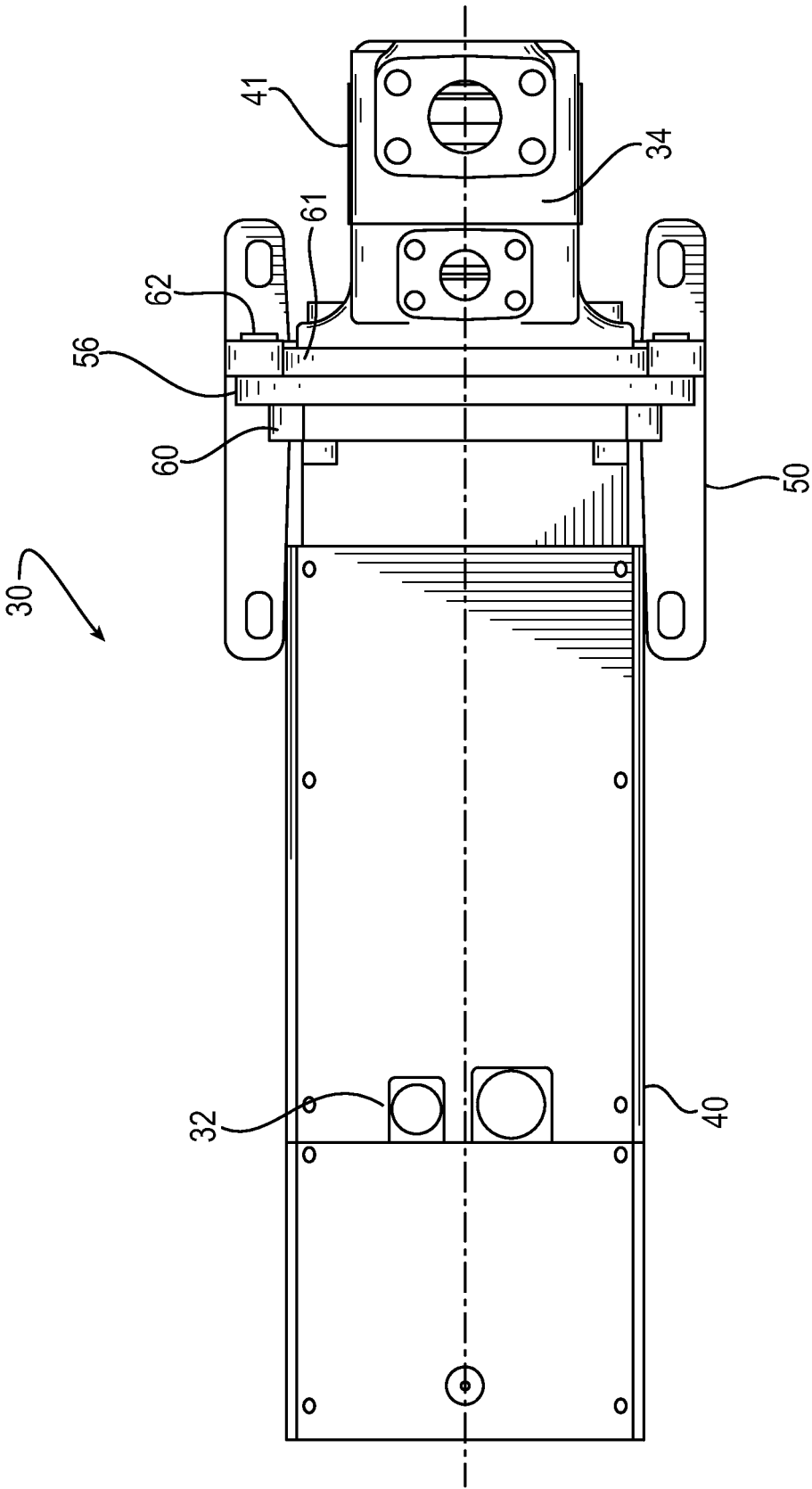


FIG. 4

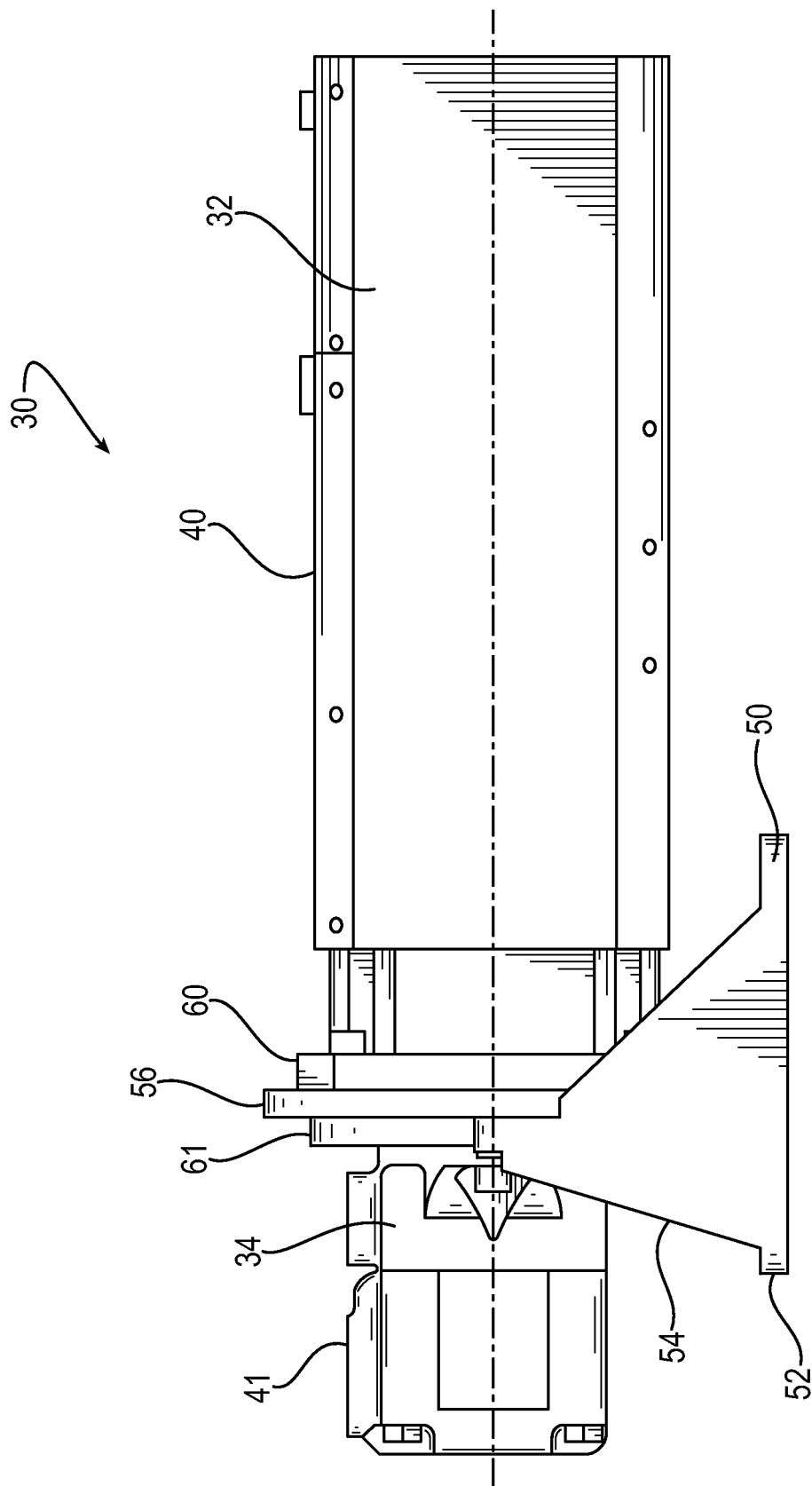


FIG. 5

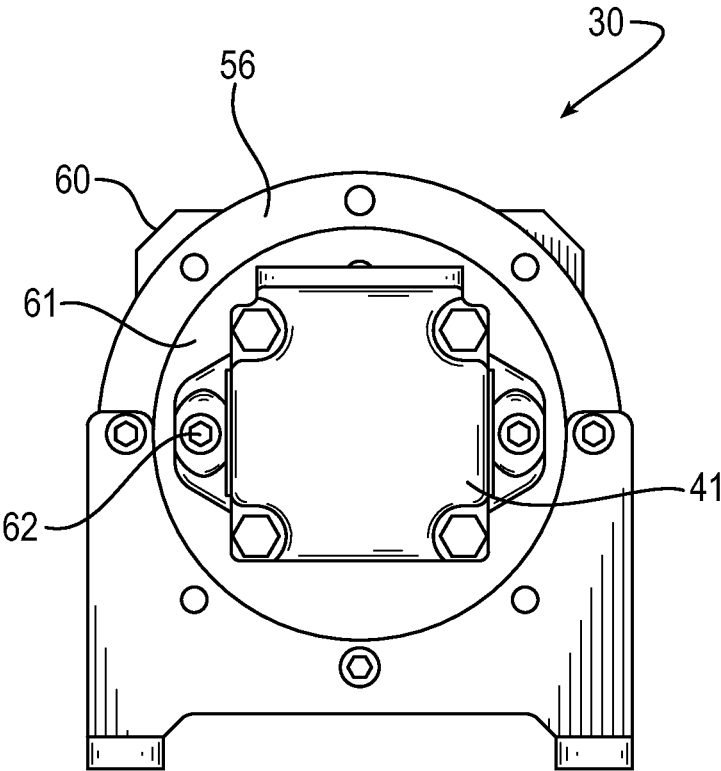
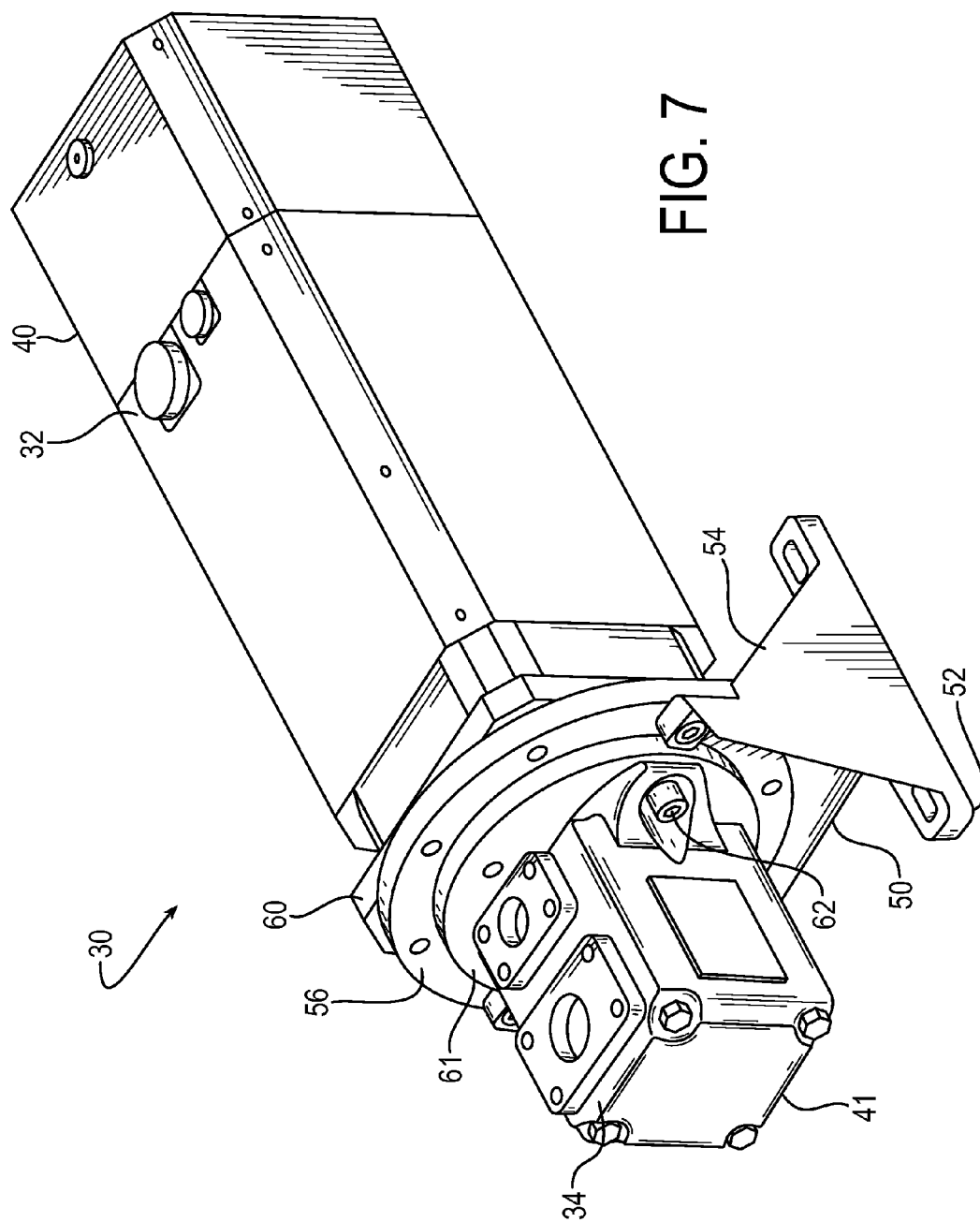


FIG. 6



INTEGRATED DISPLACEMENT CONTROLLED PUMP

FIELD OF INVENTION

[0001] The present invention relates to control of hydraulic fluid systems, and more particularly to electronically controlled hydraulic pumps and motors.

BACKGROUND OF THE INVENTION

[0002] Hydraulic fluid systems are utilized to generate power in a variety of industries. Mining and drilling equipment, construction equipment, motor vehicle transmission systems, and various other industrial applications employ such hydraulic systems.

[0003] A hydraulic fluid system may be employed to drive an external device, such as a wheel shaft, a fan, or other like external device. In hydraulic control, a hydraulic motor receives control signals, and based on such control signals a motor output shaft drives a hydraulic pump. The hydraulic pump in turn pumps hydraulic fluid for driving an external device. The driving of the external device is regulated through the control of hydraulic fluid flow through the system. Control of hydraulic fluid flow typically is performed in part by motor control of the hydraulic pump, and additionally by the operation of valve systems that are operative between the pump and the external device being driven, and as between any external sources or drains for the hydraulic fluid.

[0004] In many applications, compact size is of significant importance for the configuration of the hydraulic fluid system. Reducing size has often proven difficult. In conventional configurations, a motor, such as an electric motor, as referenced above controls the hydraulic pump. The motor output torque drives an output shaft. A spacer device typically is employed to space the pump apart from the motor, and the motor and the pump commonly are linked by an additional coupling shaft. Such conventional configuration, including a motor with an output shaft, spacer, coupling shaft, and hydraulic pump with a shaft has resulted in a bulky and costly configuration that may be unsuitable for certain applications in which a more compact design is desirable. Accordingly, hydraulic fluid systems have not been employed to their full potential.

SUMMARY OF THE INVENTION

[0005] The present invention provides an enhanced motor-controlled hydraulic pump system that improves over the deficiencies of conventional pump system configurations. In exemplary embodiments, the pump system includes a motor, a pump, and a single shaft extending from the motor into the pump. The single shaft operates as the motor output shaft and the pump input shaft, and a mounting accessory supports the pump and the motor. By employing a single shaft for operating as the motor output shaft and the pump input shaft, the present invention thus permits a more compact configuration as compared to conventional configurations with comparable performance, thereby being suitable for a broader range of applications.

[0006] The present invention provides an integrated, electronically controlled pump system by which a motor, such as an electric motor, drives the hydraulic pump operation. The pump system configuration permits the use of a single shaft extending from the electric motor into the pump so as to

allow for an integrated design and assembly configuration. In this configuration, a mounting accessory is attached to the motor over the shaft, and the shaft protrudes out from the mounting accessory and allows for the pump and motor to be attached to the shaft ends via the use of a splined, keyed, or bolted ends. The pump may then be bolted to the motor through the mounting accessory to allow for a simplified construction, assembly, and alignment. The electric motor may be any suitable motor type, such as for example an induction, permanent magnet, switched reluctance, or other electric motor type, and the motor may be an alternating current (AC) or direct current (DC) motor. The pump may be any suitable hydraulic pump, and including a pump/motor assembly configuration, such as for example a vane, external gear, internal gear, bent axis piston, or axial piston pump/motor type of pump.

[0007] An aspect of invention, therefore, is a pump system. In exemplary embodiments, the pump system includes a motor, a pump, and a single shaft extending from the motor into the pump, the single shaft being configured to operate simultaneously as both a motor output shaft and a pump input shaft. A first end of the single shaft interacts with the motor, and a second end of the single shaft interacts with the pump, to configure the shaft to operate as the motor output shaft and the pump input shaft. The pump system further may include a mounting accessory configured to support the motor and the pump. The motor may be an electric motor, and the pump may be a hydraulic pump. A drive controller is configured to generate commands for controlling the electric motor, which in turn drives the pump to achieved a desired flow of hydraulic fluid.

[0008] These and further features of the present invention will be apparent with reference to the following description and attached drawings. In the description and drawings, particular embodiments of the invention have been disclosed in detail as being indicative of some of the ways in which the principles of the invention may be employed, but it is understood that the invention is not limited correspondingly in scope. Rather, the invention includes all changes, modifications and equivalents coming within the spirit and terms of the claims appended hereto. Features that are described and/or illustrated with respect to one embodiment may be used in the same way or in a similar way in one or more other embodiments and/or in combination with or instead of the features of the other embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a schematic drawing depicting an exemplary pump system, utilizing a variable displacement pump and a drive controller.

[0010] FIG. 2 is a schematic drawing depicting another exemplary pump system, utilizing a fixed displacement pump and a drive controller.

[0011] FIG. 3 is a drawing depicting a longitudinal axial cross-sectional view of an exemplary pump system in accordance with embodiments of the present invention.

[0012] FIG. 4 is a drawing depicting a top view of the exemplary pump system of FIG. 3.

[0013] FIG. 5 is a drawing depicting a back view of the exemplary pump system of FIG. 3.

[0014] FIG. 6 is a drawing depicting an end view of the exemplary pump system of FIG. 3.

[0015] FIG. 7 is a drawing depicting an isometric view of the exemplary pump system of FIG. 3.

DETAILED DESCRIPTION

[0016] Embodiments of the present invention will now be described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. It will be understood that the drawings are not necessarily to scale.

[0017] FIGS. 1 and 2 provide generalized schematic representations of exemplary hydraulic pump systems. FIGS. 1 and 2 are schematic drawings respectively depicting exemplary pump systems 10 and 12. In the embodiments of FIGS. 1 and 2, each of the pump systems 10 and 12 is a drive controlled pump system that includes a drive controller 14 that electronically controls a motor 16. The motor 16 may be an electric motor and may be any suitable electric motor type. For example, the electric motor may be an induction, permanent magnet, switched reluctance, or other electric motor type, and the motor may be an alternating current (AC) or direct current (DC) motor.

[0018] A user controls operation of the motor 16 by actuating the drive controller 14, which is configured to generate appropriate electronic commands for controlling the motor. The drive controller 14 may be configured as an AC drive unit that includes a frequency controller and related control electronics as are known in the art. The drive controller 14 enables the system to provide the exact power that is required in the control cycle at all times. The drive controller 14 is configured to continuously record target values for the volume flow and/or pressure of a machine control system for the particular application, and compares the target values to actual pressure or flow values of the machine control system. The drive speed of the electric motor 16 is thus regulated so that the pump provides the exact amount of a working fluid, such as hydraulic fluid, required to achieve the target values.

[0019] In the exemplary embodiment of the pump system 10 of FIG. 1, as indicated by the schematic representation the hydraulic pump may be configured as a variable displacement type pump 18. In the exemplary embodiment of the pump system 12 of FIG. 2, as indicated by the schematic representation the hydraulic pump may be configured as a fixed displacement type pump 20. The pump may be any suitable hydraulic pump, including a pump/motor assembly configuration, such as for example a vane, external gear, internal gear, bent axis piston, or axial piston pump/motor type of pump.

[0020] Additional details of the pump system of the present invention are depicted in the additional figures. In particular, FIG. 1 is a drawing depicting a longitudinal axial cross-sectional view of an exemplary pump system 30 in accordance with embodiments of the present invention. FIG. 4 is a drawing depicting a top view of the pump system 30 of FIG. 3. FIG. 5 is a drawing depicting a back view of the pump system 30 of FIG. 3. FIG. 6 is a drawing depicting a pump end view of the pump system 30 of FIG. 3. FIG. 7 is a drawing depicting an isometric view of the pump system 30 of FIG. 3. Accordingly, like components of the pump system 30 are identified with like reference numerals in the depictions of FIGS. 3-7.

[0021] Principal components of the pump system 30 include a motor 32, a pump 34, and a single shaft 36. The single shaft 36 extends from the motor 32 into the pump 34, and the single shaft 36 extending from the motor into the pump is configured to operate simultaneously as both a motor output shaft and a pump input shaft. The pump system

30 further includes a mounting accessory 50 configured to support the motor 32 and pump 34. The use of a single shaft 36 extending from the electric motor 32 allows for an integrated design and assembly configuration. With such configuration, the mounting accessory 50 is attached to the motor 32 over the shaft 36, and the shaft 36 protrudes outward from the motor and allows for the pump 34 to be attached to the shaft 36. The pump 34 is then bolted to the motor 32 through the mounting accessory 50 to allow for simplified construction, assembly, and alignment.

[0022] The pump system 30 further includes a motor housing 40 that houses the motor 32. The motor may include any suitable connection features that may extend through the motor housing, so as to electrically connect the motor to any suitable drive controller as referenced above. Referring particularly to the cross-sectional view of FIG. 3, the shaft 36 has a first end 42 and a second end 44. The first end 42 of the shaft 36 is received within the motor 32 such that the motor 32 interacts with the shaft 36 to drive the shaft 36. The interaction may be provided by splined, keyed, or bolt elements integrally formed in the first end 42 of the shaft 36, which interact with analogous opposing elements of the motor portion that receives the shaft 36. The shaft 36 extends outward from the motor 32 and through the motor housing 40 into the pump 34.

[0023] The pump system 30 further includes a pump housing 41 that houses the pump 34. The pump housing may include any suitable fluid porting for receiving and pumping a working fluid, such as hydraulic fluid, to and from the pump for the driving or operation of any suitable external device. On the pump side, the second end 44 of the shaft 36 is received within the pump 34 such that the second shaft end 44 interacts with the pump 34 to drive the pump 34. Similarly as with the motor, the interaction of the shaft with the pump may be provided by splined, keyed, or bolt elements integrally formed in the second 44 of the shaft 36, which interact with analogous opposing elements of the pump portion that receives the shaft. In this manner, the shaft 36 is configured as a single shaft to operate simultaneously as both the motor output shaft and the pump input shaft. Such configuration of a single shaft results in the advantages referenced above, by which the pump system 30 is easier to construct, assemble, and align, and further provides a more compact configuration, as compared to conventional configurations with comparable performance, thereby being suitable for a broader range of applications.

[0024] The pump system 30 additionally has enhanced mounting features as compared to conventional configurations. As referenced above, the pump system 30 includes a mounting accessory 50. In exemplary embodiments, the motor housing and the pump housing may be attached to the mounting accessory 50. The mounting accessory 50 may be configured as an integral bracket that provides for efficient mounting of the motor to the pump, while permitting the single shaft configuration by which the shaft 36 is configured to operate as both the motor output shaft and the pump input shaft.

[0025] The mounting accessory 50 may include an external mounting plate 52, which may be employed to mount the pump system 30 to any suitable external device. The mounting accessory further may include at least one support bracket, such as a plurality support brackets 54, that extend from the external mounting plate 52. In exemplary embodiments, the support brackets 54 may be triangularly shaped

and extend generally perpendicularly from the external mounting plate 52. The at least one support bracket may support a central mounting plate 56 that is employed for mounting the motor to the pump as further described below. The central mounting plate 56 extends at least over the shaft 36 to permit the shaft to extend fully from the motor into the pump, and permitting free rotation of the shaft 36 relative to the mounting accessory 50. In exemplary embodiments, the central mounting plate 56 may include a circular bore that extends fully around the shaft 36 through which the shaft 36 extends.

[0026] The motor 32 and pump 34 may be mounted to each other via the mounting accessory 50 as follows. The motor housing 40 may include a motor mounting plate 60, and the pump housing 41 may include a pump mounting plate 61. Such features particularly are viewable in FIGS. 4-7. The motor may be mounted to the mounting accessory 50 by attaching the motor mounting plate 60 to a first side of the central mounting plate 56. Similarly, the pump may be mounted to the mounting accessory 50 by attaching the pump mounting plate 61 to a second side of the central mounting plate 56 opposite to the first side. The mounting plates may be mounted to each other by any suitable fastening elements 62, such as bolts, screws, or other suitable fastening elements. In this manner, the mounting accessory 50 is configured as an integral mounting bracket that provides for efficient mounting of the motor to the pump.

[0027] An aspect of the invention, therefore, is a pump system. In exemplary embodiments, the pump system includes a motor, a pump, and a shaft extending from the motor into the pump, the shaft being configured to operate as a motor output shaft and a pump input shaft. The pump system may include one or more of the following features, either individually or in combination.

[0028] In an exemplary embodiment of the pump system, the pump system includes a mounting accessory configured to support the motor and the pump.

[0029] In an exemplary embodiment of the pump system, the mounting accessory is attached to the motor over the shaft and the shaft protrudes outward from the motor.

[0030] In an exemplary embodiment of the pump system, the mounting accessory includes an external mounting plate, at least one support bracket that extends from the external mounting plate, and a central mounting plate that is supported by the at least one support bracket.

[0031] In an exemplary embodiment of the pump system, the at least one support bracket comprises a plurality of support brackets that are triangularly shaped and extend perpendicularly from the external mounting plate.

[0032] In an exemplary embodiment of the pump system, the pump system further includes a motor housing that houses the motor, and a pump housing that houses the pump, wherein the motor housing and the pump housing are attached to the mounting accessory.

[0033] In an exemplary embodiment of the pump system, the pump system further includes a motor housing that houses the motor, and a pump housing that houses the pump. The motor housing has a motor mounting plate that is attached to a first side of the central plate of the mounting accessory, and the pump housing has a pump mounting plate that is attached to a second side of the central plate of the mounting accessory opposite the first side.

[0034] In an exemplary embodiment of the pump system, a first end of the shaft interacts with the motor, and a second

end of the shaft interacts with the pump, to configure the shaft to operate as the motor output shaft and the pump input shaft.

[0035] In an exemplary embodiment of the pump system, the motor is an electric motor.

[0036] In an exemplary embodiment of the pump system, the electric motor is one of an induction, permanent magnet, or switched reluctance electric motor type.

[0037] In an exemplary embodiment of the pump system, the electric motor is an alternating current (AC) motor.

[0038] In an exemplary embodiment of the pump system, the electric motor is a direct current (DC) motor.

[0039] In an exemplary embodiment of the pump system, the pump is a hydraulic pump.

[0040] In an exemplary embodiment of the pump system, the hydraulic pump is one of a vane, external gear, internal gear, bent axis piston, or axial piston pump/motor type hydraulic pump.

[0041] In an exemplary embodiment of the pump system, the hydraulic pump is a variable displacement type pump.

[0042] In an exemplary embodiment of the pump system, the hydraulic pump is a fixed displacement type pump.

[0043] In an exemplary embodiment of the pump system, the pump system further includes a drive controller configured to generate commands for controlling the motor.

[0044] In an exemplary embodiment of the pump system, the drive controller is configured to continuously record target values for a volume flow and/or pressure of a machine control system and compares the target values to actual values of the machine control system.

[0045] In an exemplary embodiment of the pump system, a drive speed of the motor is regulated so that the pump provides an amount of a working fluid required to achieve the target values.

[0046] Although the invention has been shown and described with respect to a certain embodiment or embodiments, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification and the annexed drawings. In particular regard to the various functions performed by the above described elements (components, assemblies, devices, compositions, etc.), the terms (including a reference to a “means”) used to describe such elements are intended to correspond, unless otherwise indicated, to any element which performs the specified function of the described element (i.e., that is functionally equivalent), even though not structurally equivalent to the disclosed structure which performs the function in the herein illustrated exemplary embodiment or embodiments of the invention. In addition, while a particular feature of the invention may have been described above with respect to only one or more of several illustrated embodiments, such feature may be combined with one or more other features of the other embodiments, as may be desired and advantageous for any given or particular application.

1. A pump system comprising:

a motor;

a pump;

a shaft extending from the motor into the pump, the shaft being configured to operate as a motor output shaft and a pump input shaft; and

a mounting accessory configured to support the motor and the pump, the mounting accessory comprising an external mounting plate, at least one support bracket that

extends from the external mounting plate, and a central mounting plate that is supported by the at least one support bracket, wherein the pump and the motor are mounted to the central mounting plate.

2. The pump system of claim 1, wherein the mounting accessory is attached to the motor over the shaft and the shaft protrudes outward from the motor.

3. The pump system of claim 1, wherein the at least one support bracket comprises a plurality of support brackets that are triangularly shaped and extend perpendicularly from the external mounting plate.

4. The pump system of claim 1, further comprising a motor housing that houses the motor, and a pump housing that houses the pump, wherein the motor housing and the pump housing are attached to the mounting accessory.

5. The pump system of claim 1, further comprising:

a motor housing that houses the motor; and

a pump housing that houses the pump;

wherein the motor housing has a motor mounting plate that is attached to a first side of the central plate of the mounting accessory, and the pump housing has a pump mounting plate that is attached to a second side of the central plate of the mounting accessory opposite the first side.

6. The pump system of claim 1, wherein a first end of the shaft interacts with the motor, and a second end of the shaft interacts with the pump, to configure the shaft to operate as the motor output shaft and the pump input shaft.

7. The pump system of claim 1, wherein the motor is an electric motor.

8. The pump system of claim 7, wherein the electric motor is one of an induction, permanent magnet, or switched reluctance electric motor type.

9. The pump system of claim 7, wherein the electric motor is an alternating current (AC) motor.

10. The pump system of claim 7, wherein the electric motor is a direct current (DC) motor.

11. The pump system of claim 1, wherein the pump is a hydraulic pump.

12. The pump system of claim 11, wherein the hydraulic pump is one of a vane, external gear, internal gear, bent axis piston, or axial piston pump/motor type hydraulic pump.

13. The pump system of claim 11, wherein the hydraulic pump is a variable displacement type pump.

14. The pump system of claim 11, wherein the hydraulic pump is a fixed displacement type pump.

15. The pump system of claim 1, further comprising a drive controller configured to generate commands for controlling the motor.

16. The pump system of claim 15, wherein the drive controller is configured to continuously record target values for a volume flow and/or pressure of a machine control system and compares the target values to actual values of the machine control system.

17. The pump system of claim 16, wherein a drive speed of the motor is regulated so that the pump provides an amount of a working fluid required to achieve the target values.

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