US 20080206076A1

(19) **United States**

(12) **Patent Application Publication**

Anwer et al.

(10) **Pub. No.: US 2008/0206076 A1**

(43) **Pub. Date: Aug. 28, 2008**

(54) **VERTICAL PUMP ARRANGEMENT**

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(21) Appl. No.: **11/679,682**

(22) Filed: **Feb. 27, 2007**

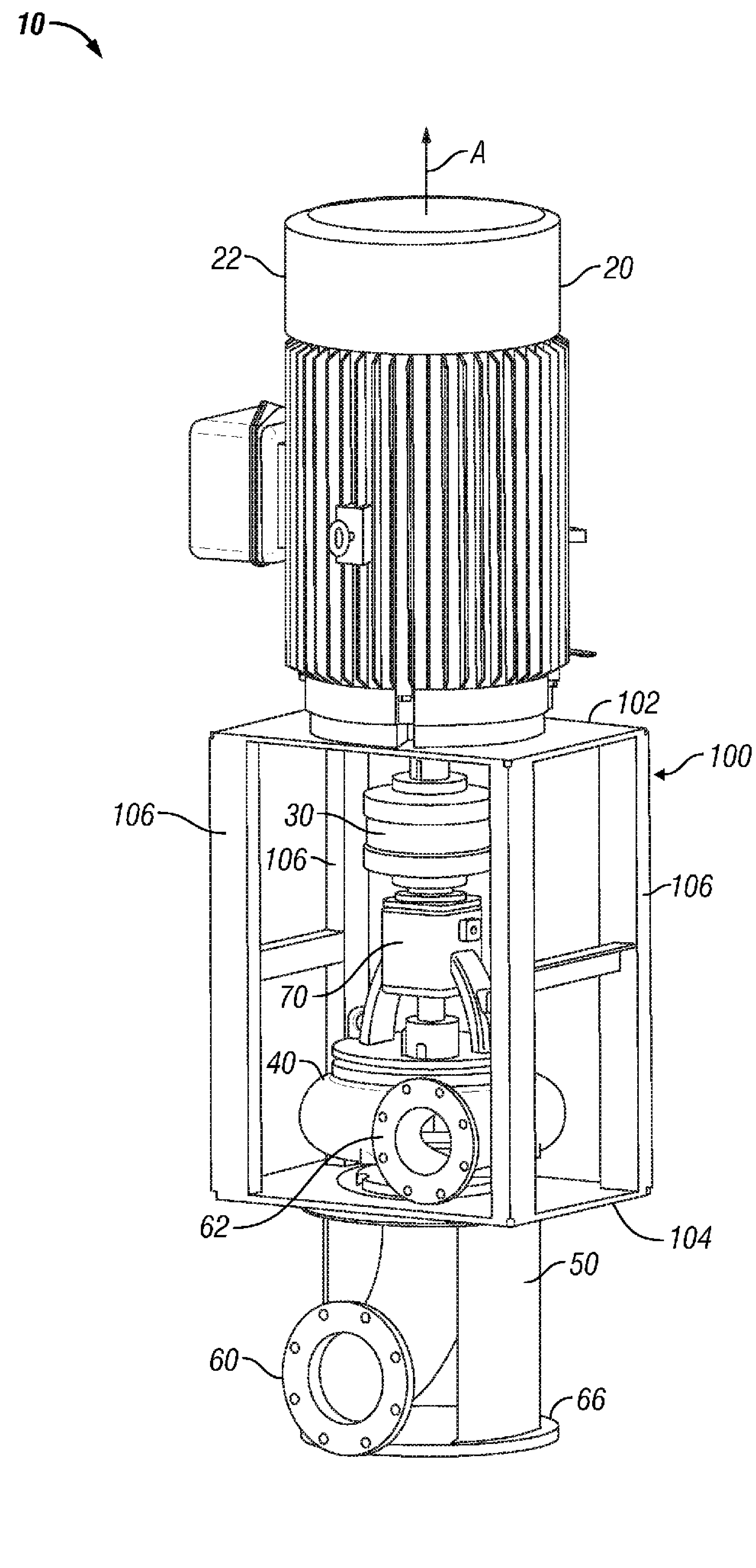
Publication Classification

(51) **Int. Cl.**
F01B 23/08 (2006.01)

(52) **U.S. Cl.** **417/321**; 29/700

(57) **ABSTRACT**

In one aspect, a pump having a pump module and a motor module includes a support member that substantially supports a weight of the motor module and uncouples the pump module from the weight of the motor module.



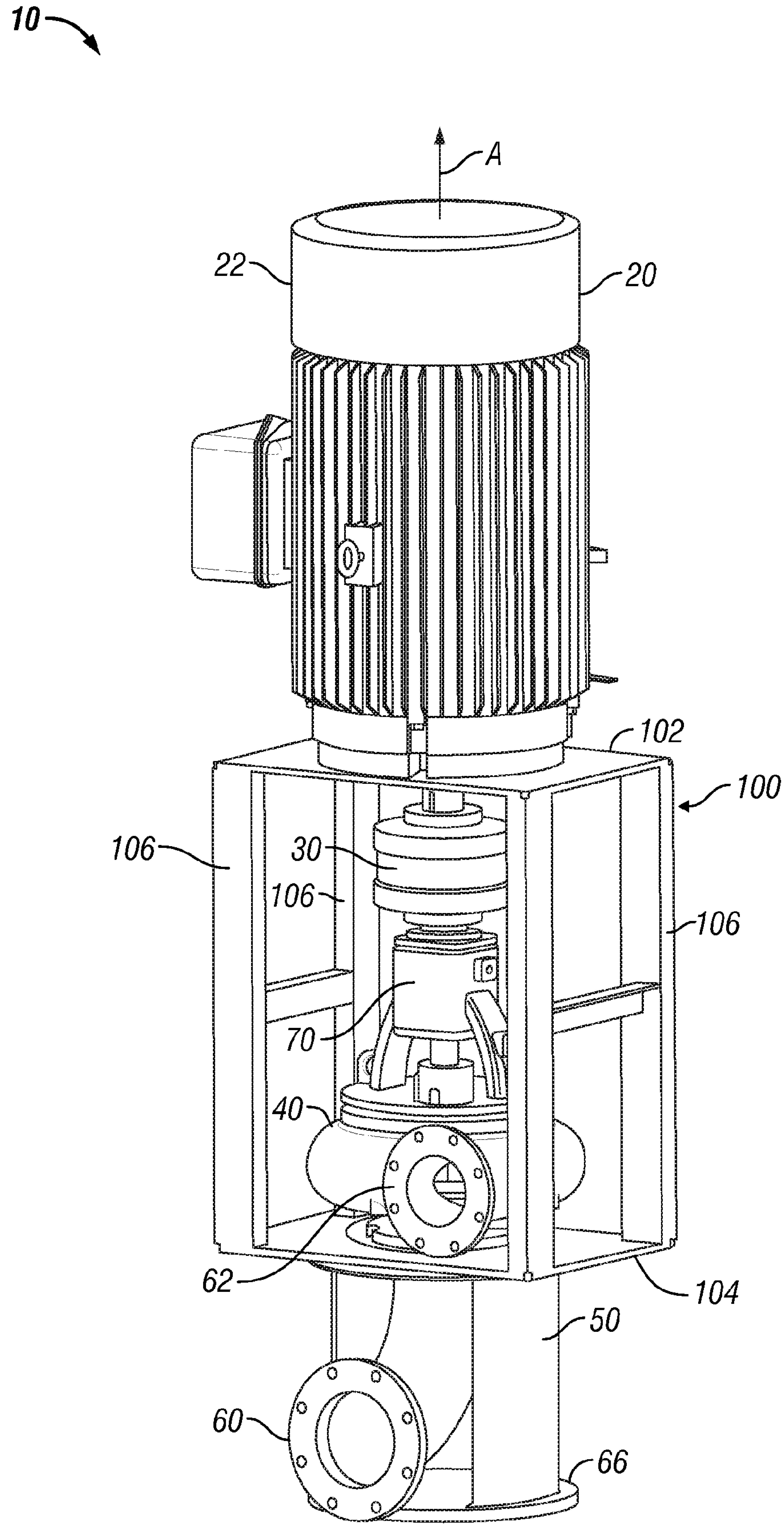


FIG. 1

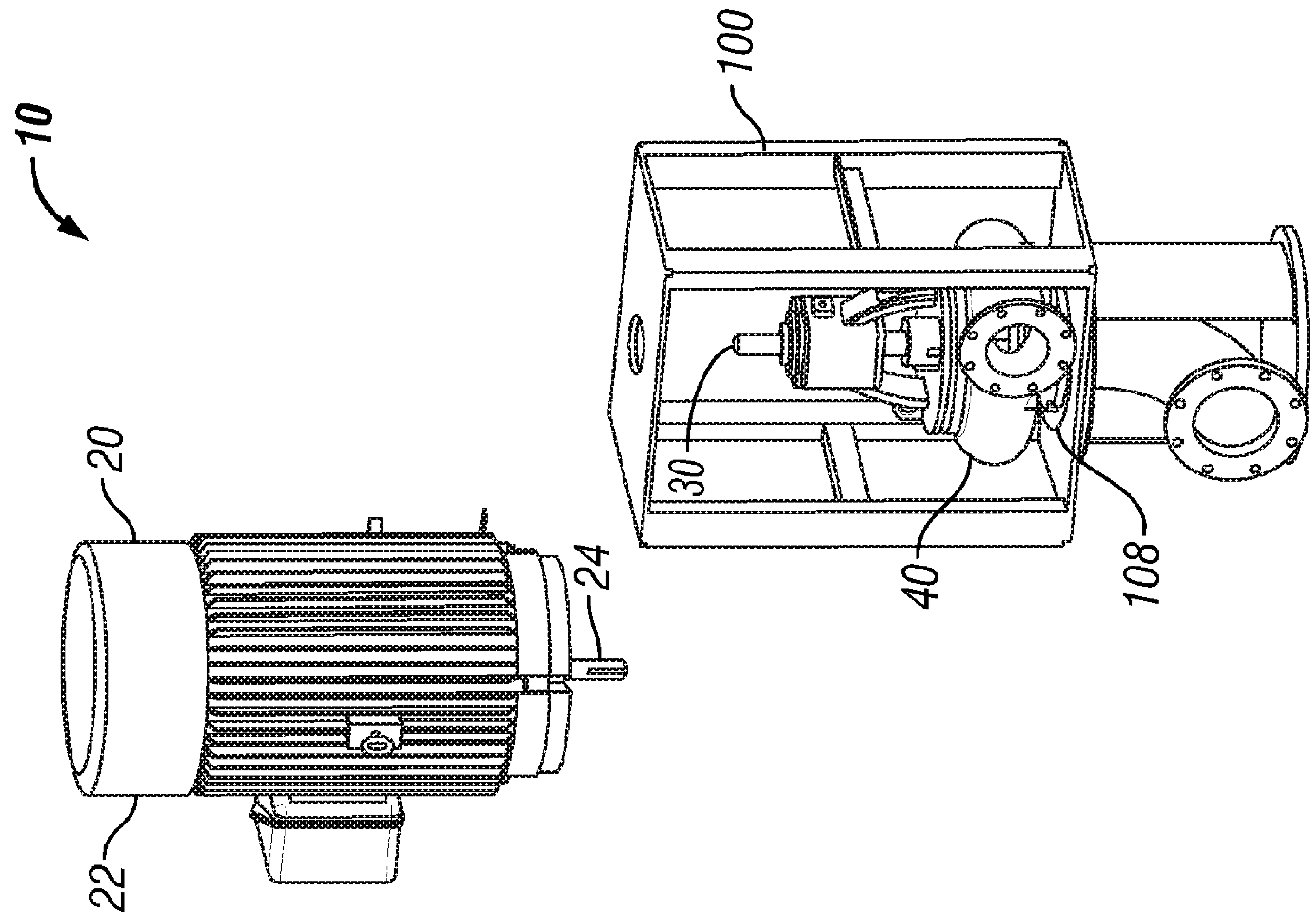


FIG. 2B

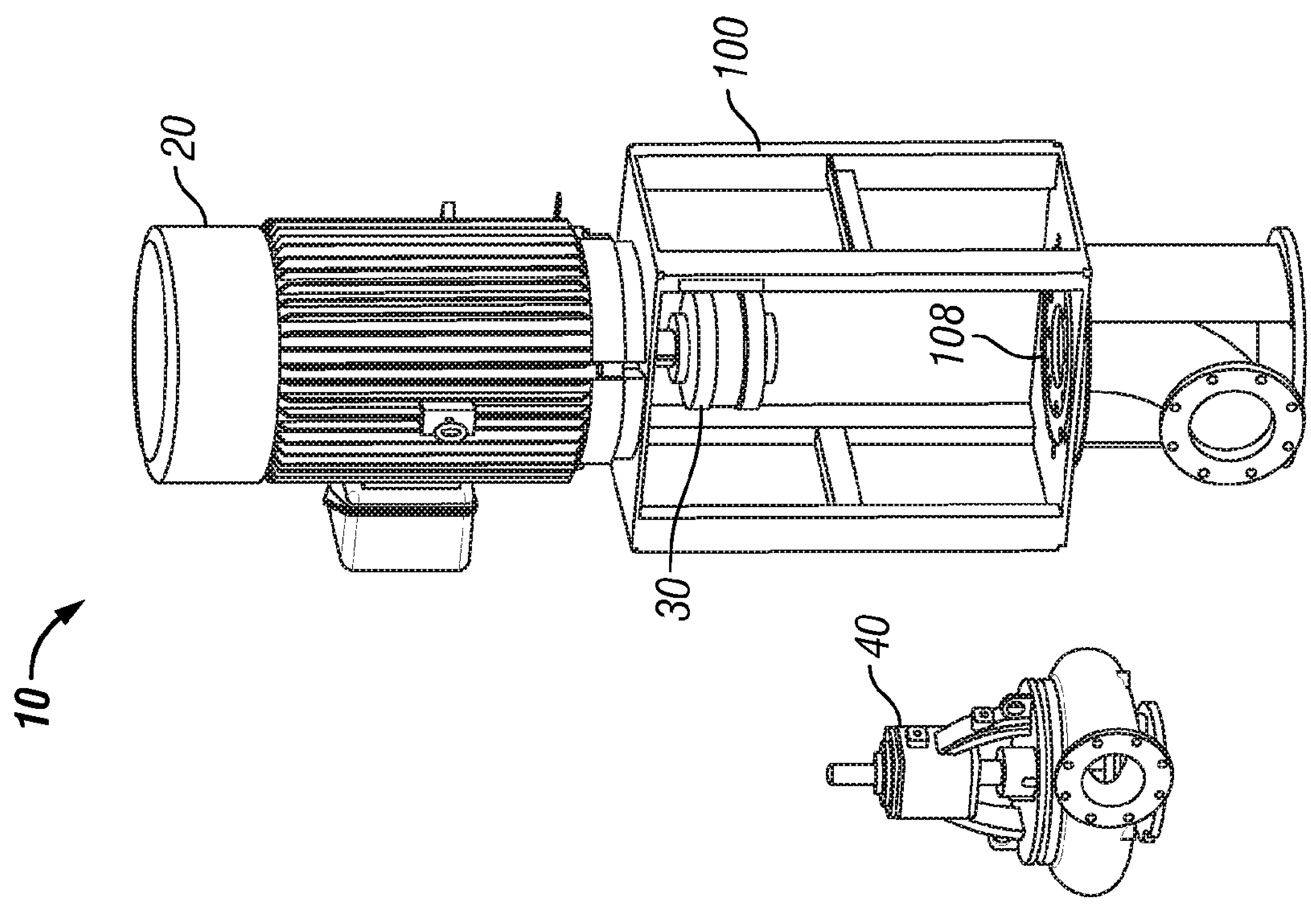


FIG. 2A

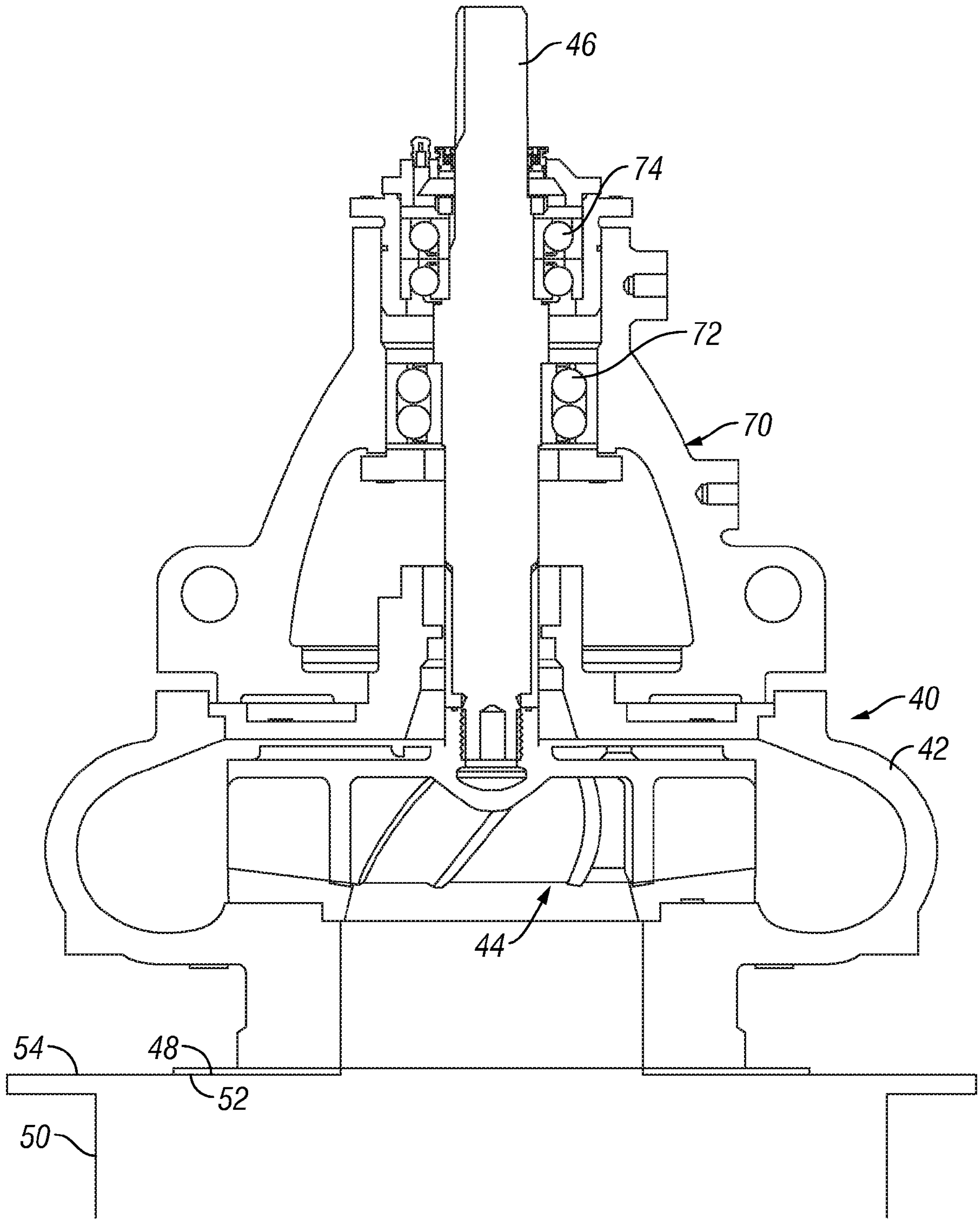


FIG. 3

VERTICAL PUMP ARRANGEMENT

BACKGROUND OF THE DISCLOSURE

[0001] 1. Field of the Disclosure

[0002] The present disclosure relates to devices for configuring vertical pumps and methods for servicing vertical pumps.

[0003] 2. Description of the Related Art

[0004] Vertically aligned pumps are used in many applications because of their relatively small "footprint," i.e., the amount of floor space or area they need for installation and operation. A typical vertical centrifugal pump includes a centrifugal pump, an electric motor module superposed on the pump module, and an intermediate drive train that transmits rotary power from the motor module to the pump module. The small footprint is mostly attributed to the motor module being positioned vertically over the pump module.

[0005] In a conventional vertical pump arrangement, the weight of the motor module is typically supported directly or indirectly by a mechanical connection to the pump module. Such an arrangement can have certain disadvantages. For instance, servicing the drive train or pump module may first require removal of the motor module. In one conventional servicing operation, the motor module is disconnected from the pump module and moved to a separate storage area. Thereafter, one or more components of the drive train or pump module are repaired or replaced, e.g., seals, gaskets, impellers, etc. After servicing is completed, the motor module has to be moved back and reinstalled onto the pump module. Also, reinstallation of the motor module often requires the step of properly aligning the rotational axis of the rotating elements of the pump module and the motor module. As can be appreciated, servicing a vertical centrifugal pump module can be time consuming and expensive. Moreover, in some applications, vertical centrifugal pumps are employed in very harsh operating conditions. Such conditions, which can include high operating speeds, high pressures or contact with abrasive materials, can cause the components of a vertical pump to have relatively short operating lives. Thus, the time consuming and expensive service operation described above must be repeated frequently through the service life of the vertical pump. In some cases, the accumulated cost of these frequent servicing operations can be five to ten times the cost of the pump itself.

[0006] One conventional arrangement for reducing the difficulty for servicing a vertical centrifugal pump is described in U.S. Pat. No. 5,286,612 (the '612 patent). The '612 patent teaches a vertical centrifugal pump that includes a frame separating a motor module casing and a pump casing to provide access to the bearing assembly. However, the frame is connected at one end to the motor module casing and connected at the other end to the pump casing. With this frame arrangement, most, if not all, of the weight of motor module section is applied to the pump section. Thus, access to the pump section will still require a separate operation for removing and separately supporting the motor module section.

[0007] The present disclosure is directed to the ever-present need for more easily serviceable vertical centrifugal pumps.

SUMMARY OF THE DISCLOSURE

[0008] In aspects, the present disclosure provides a pump having a vertically and serially aligned pump module and motor module. In one arrangement, the motor module is positioned substantially vertically above the pump module and serially coupled thereto with a drive train. The pump includes a support member that substantially supports a weight of the motor module. The support member uncouples the pump module from the weight of the motor module by transferring a substantial portion of the weight of the motor module to a location below or adjacent to the pump module. In aspects, the present disclosure also includes methods for servicing vertical pumps. One exemplary method includes supporting a weight of the motor module using a support member, disconnecting the motor module from the pump module without moving the motor module; and servicing a selected component associated with the pump. The selected component can be the motor module, the pump module, the drive train, or any elements used within these devices. Such elements include wear components such as seals, impellers, stuffing box covers, wear pads, casings, gaskets, shaft sleeves, shafts, etc.

[0009] It should be understood that examples of the more important features of the disclosure have been summarized rather broadly in order that detailed description thereof that follows may be better understood, and in order that the contributions to the art may be appreciated. There are, of course, additional features of the disclosure that will be described hereinafter and which will form the subject of the claims appended hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] For detailed understanding of the present disclosure, references should be made to the following detailed description of the described embodiments, taken in conjunction with the accompanying drawings, in which like elements have been given like numerals and wherein:

[0011] FIG. **1** illustrates an isometric view of one embodiment of a pump in accordance with the present disclosure;

[0012] FIG. **2**A illustrates an isometric view of one embodiment of a pump in accordance with the present disclosure with the pump module removed;

[0013] FIG. **2**B illustrates an isometric view of one embodiment of a pump in accordance with the present disclosure with the motor module removed; and

[0014] FIG. **3** schematically illustrates a pump module made in accordance with one embodiment of the present disclosure.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] The present disclosure relates to devices and methods for servicing vertical pumps. The present disclosure is susceptible to embodiments of different forms. There are shown in the drawings, and herein will be described in detail, specific embodiments of the present disclosure with the understanding that the present disclosure is to be considered an exemplification of the principles of the disclosure, and is not intended to limit the disclosure to that illustrated and described herein.

[0016] Referring initially to FIG. **1**, there is shown one embodiment of a pump **10** made in accordance with the present disclosure. The pump **10** may include a motor module **20**, a drive train **30**, and a pump module **40**. The elements of the motor module **20**, the drive train **30**, and the pump module **40** that transmit the rotary power are serially aligned along a common rotational axis A. During operation, the motor module **20** generates rotary power that is transferred to pump module **40** via the drive train **30**. The drive train **30** selectively couples the rotating elements of the motor module **20** to the rotating elements of the pump module **40** using known devices such as spider couplings. In a conventional manner, the pump module **40** receives fluid from an inlet **60** and expels fluid from an outlet **62**. As used herein, the term "vertical pump" may be used to refer to a pump wherein the motor module **20** is positioned substantially vertically over the pump module **40** and wherein their rotating components share a common axis of rotation.

[0017] While it is not necessarily the case, the motor module **20** may be an electrically driven motor and the pump module **40** may be a centrifugal-type pump. Hydraulically actuated pumps, for example, may also be utilized in certain applications. The pump **10** can be used to flow nearly any type of fluid, mixture or slurries, gases, and multiple phase liquids, i.e. liquids having entrained gas and liquids having both entrained gas and solids.

[0018] Referring now to FIGS. **1** and **3**, there is shown a support member **100** that supports the weight of the motor module **20** without transferring any of that weight onto the pump module **40**. In one arrangement, the support member **100** transfers most or all of the weight of the motor module **20** to an underlying support structure or pedestal **50**. Thus, the support member **100** functions to isolate or uncouple the pump module **40** from the majority of the weight of the motor module **20**. In one embodiment, the pedestal **50** is generally symmetric with the support member **100**. For instance, the pedestal **50** and the support member **100** are arranged such the loadings imposed by the motor module **20** and the pump module **40** are generally distributed to reduce the occurrence of moment arms or other destabilizing forces. This symmetry increases the likelihood that the pump **10** is stable and will not require additional restraining devices to remain upright.

[0019] In one embodiment, the support member **100** is formed as a relatively rigid frame that includes a first base plate **102** that supports the motor module **20** and a second base plate **104** that seats on the pedestal **50**. One or more stands or legs **106** connect the first base plate **102** to the second base plate **104**. The second base plate **104** has an opening **108** best seen in FIG. 2A that permits the pump module **40** to seat on the pedestal **50**. The legs **106** and base plates **102** and **104** are spaced apart to allow personnel to access the drive train **30** and the pump module **40**. Thus, the support member **100** provides a cavity or space having suitable dimensions to receive, house, and service the drive train **30** and the pump module **40**. In this embodiment, the support member **100** supports the weight of the motor module **20** and the pedestal **50** supports the combined weight of the motor module **20** and the pump module **40**. In a variant not shown, the support member **100** supports the weight of the motor module **20** and the pedestal **50** supports the weight of the pump module **40**. In either case, it should be appreciated that the support member **100** enables the pedestal **50** to be separately loaded with the weight of the pump module **40** and the motor module **20** because the support member **100** is not connected to the pump module **40** via a load transferring connection.

[0020] Referring now to FIG. **3**, there is shown the seating arrangement for the pump module **40**. The pump module **40** includes a flange **48**, which may be a separate element, that seats on a surface section **52** of the pedestal **50**. However, the base plate **104** seats on a separate section **54** of the pedestal **50**. Thus, the motor module **20** and pump module **40** apply their respective weight to the pedestal **50** in a parallel fashion. Because the pump module **40** is not used to transfer the weight of the motor module **20** to the pedestal **50**, the pump module **40** may be considered as substantially isolated or uncoupled from the weight of the motor module **20**. Thus, advantageously, the pump module **40** can be manipulated, e.g., moved, serviced, tested, etc., while the motor module **20** remains in place.

[0021] It will be appreciated that the support member **100** is susceptible to numerous variations. For example, while four legs **106** are shown, greater or fewer legs **106** can be used. Moreover, in some embodiments, one or both of the base plates **102** and **104** can be omitted. For instance, one or more legs can directly connect the motor module **20** to the pedestal **50**. Moreover, in the shown embodiment, the support member **100** transfers the weight of the motor module **20** to the pedestal **50**. In other embodiments, the support member **100** can transfer the weight of the motor module **20** to a different or additional location. For instance, one or more of the legs **106** could extend to a floor **66**. Additionally, while the constituent members of the support member **100** can be fixed using techniques such as welding. The support member **100** can also be configured to be selectively disassembled. For instance, the upper base plate **102** and the legs **106** can be formed as one unit that disconnects from the lower base plate **104**. Such a unit can remain with the motor module **20** after the motor module **20** is removed from the rest of the pump **10** and function as a temporary support or stand. Furthermore, while the support member **100** can be constructed as an as-installed component of the pump **10**, in some embodiments, the support member **100** can be constructed to be connected to the pump **10** prior to performing service and removed after service is completed.

[0022] In embodiments, the support member **100** is configured to support both the weight of the motor module **20** and the torsional loading imposed by the motor module **20** during operation. Furthermore, in some embodiments, the motor module **20** is configured to operate at two or more speeds. Each such speed can induce a resonant vibration. Thus, the support member **100** can be configured to have resonant frequency different from each such speed induced resonance vibration. The interfaces between the support member **100** and the motor module **20** can utilize flanges, quick disconnect couplings, fastening members and other devices that permit repeated connections and disconnections. Thus, the support member **100** is configured to permit the motor module **20** to be readily connected and disconnected from the pump **10**.

[0023] As will be discussed in further detail below, because the pump module **40** does not support the motor module **20**, numerous servicing operations can be performed on the pump **10** without moving the motor module **20**. By servicing, it is meant the repair or replacement of any of the constituent components of the pump **10**, any tasks needed to maintain the pump **10** in proper working order, e.g., lubrication, tightening bolts, aligning components, and performing diagnostics on the pump **10**.

[0024] Referring now to FIG. **2**A, there is shown a partially disassembled pump **10**. In the state shown, the pump module **40** has been disconnected from the drive train **30**. The lifting and handling devices for moving the pump module **40** are not shown. One skilled in the art will appreciate that the support member **100** provides a number of functional advantages. One advantage is that the support member **100** provides direct access to the drive train **30** and its associated coupling. Thus, the pump module **40** can be disconnected from the drive train **30** without disturbing the motor module **20**. That is, for example, no flanges or fastening devices for the motor module **20** have to be disassembled and a crane or other lifting device is not required to move the motor module **20**. Indeed, even the drive train **30** is mostly left in place. Another advantage is that a replacement pump module (not shown) can be immediately installed into the pump **10**, which then enables the pump **10** to quickly reenter service. Yet another advantage is that because the motor module **20** and drive train **30** has not been moved, the amount of work needed to align the rotating elements of the drive train **30** and the reinstalled pump module **40** may be reduced.

[0025] Referring now to FIG. 2B, there is shown another partially disassembled pump **10**. In the state shown, the motor module **40** has been disconnected from the drive train **30**. As described previously, the support member **100** provides direct and immediate access to the drive train **30**, which allows the motor module **20** to be disconnected from the drive train **30** without disturbing the pump module **40**. Another advantage is that a replacement motor module (not shown) can be immediately installed into the pump **10**, which then enables the pump **10** to quickly reenter service. In this regard, the motor module **20** may be modular in that the motor is not customized to a specific pump module **40**. Rather, an appropriate "off the shelf" motor can be utilized.

[0026] In addition to facilitating service of the pump **10** and its constituent components, the support frame **100** also enables a configuration that is more robust that conventional vertical pumps. For example, because the support frame **100** allows personnel to access the components between the motor module **20** and the pump module **40**, components for improving service life and operating efficiencies can be added to the pump **10**.

[0027] Referring now to FIGS. **1** and **3**, the motor module **20** includes a casing or housing **22**. Within the housing **22**, but not shown, are known components such as windings, bearings and a rotor. A shaft **24** (FIG. 2B) transfers the rotary power to the drive assembly **30**. The pump module **40** includes a housing or casing **42**, which contains known components such as the impeller **44** and associated drive shaft **46**. The pump module **40** also includes a bearing section **70**. In one embodiment, the bearing section **70** includes one or more bearing elements **72**, **74** that support the drive shaft **46**. For example, the bearing elements **72**, **74** reduce the amount of radial or lateral vibration in the drive shaft **46**. In addition to providing greater overall performance or efficiency, the bearing elements **72**, **74** can reduce the degrading effects of impeller vibrations, which then reduces the wear and tear on the pump module **40**. Thus, service life of the pump module **40** may also be improved. It should be understood that while two bearing elements **72** and **74** are shown, greater or fewer can also be utilized. Moreover, while radial vibrations have been discussed, axial vibrations or axial loadings may also be borne by suitable bearing elements in the bearing module **70**.

[0028] Embodiments of the present disclosure can be advantageously employed in a variety of environments. One environment of particular note is an offshore platform used in connection with recovering hydrocarbons such as oil and gas from subterranean formations. As is known, personnel on offshore platforms utilize a number of fluids while drilling, completing, and servicing subsea wellbores. For example, the pumps used on offshore platforms can be used to pump drilling fluids, drill cutting slurries, potable water, seawater, chemicals and additives, etc. Indeed, the pumps can be used in a variety of devices from ballast control units, rig cooling systems, and washdown systems to emergency fire control systems. As is also known, deck space on offshore platforms can be very limited. Thus, there can be a pronounced emphasis on pumps that take up as little deck space as possible. Moreover, because rig rental costs can easily reach tens of thousands of dollars a day, there is also a pronounced emphasis on performing as many tasks concurrently as possible. The resources, however, which include personnel, tooling, lifting and handling devices such as cranes, and even storage space, are limited.

[0029] It should therefore be appreciated that embodiments of the present disclosure can present advantages in such an environment. For instance, the vertical pumps of the present disclosure have a relatively small footprint, which can free deck space for other uses. Also, because service of the pump does not necessarily require a full disassembly, many servicing operations can be performed with fewer lifting and handling devices and personnel. Additionally, because embodiments of the present disclosure permit the use of devices for enhancing operating life and performance, the time between servicing operations may be increased, which further reduces the time and burden on rig personnel.

[0030] The foregoing description is directed to particular embodiments of the present disclosure for the purpose of illustration and explanation. It will be apparent, however, to one skilled in the art that many modifications and changes to the embodiment set forth above are possible without departing from the scope of the disclosure. It is intended that the following claims be interpreted to embrace all such modifications and changes.

1. An apparatus for flowing a fluid, comprising:
(a) a pump module;
(b) a motor module serially coupled to the pump module and positioned substantially vertically above the pump module; and
(c) a support member substantially supporting a weight of the motor module, the pump module being substantially uncoupled from the weight of the motor module.

2. The apparatus of claim **1** wherein the support member transfers a substantial portion of the weight of the motor module to a location below the pump module.

3. The apparatus of claim **1** further comprising a pedestal, wherein the support member applies a substantial portion of the weight of the motor module to a first section on the pedestal and a weight of the pump module is applied to a second section on the pedestal that is different from the first section.

4. The apparatus of claim **1** wherein the support member comprises a frame having a first section substantially loaded by a weight of the motor module and a second section positioned parallel and spaced apart from the pump module, the first section and second section being substantially not loaded by a weight of the pump module.

5. The apparatus of claim **1** further comprising: a drive train transferring rotational power from the motor module to the pump module; a first bearing assembly associated with the motor module and a second bearing assembly associated with the drive train.

6. The apparatus of claim **1** wherein the pump module includes a pump casing and the motor module includes a motor casing axially spaced apart from the pump casing.

7. The apparatus of claim **1** wherein the support member is formed such that the motor module can be moved without moving the pump module.

8. The apparatus of claim **1** wherein the support member is formed such that the pump module can be moved without moving the motor module.

9. A method for servicing a pump, wherein the pump includes a pump module and a motor module positioned substantially above the pump module, comprising:

(a) supporting a weight of the motor module using a support member;

(b) disconnecting the motor module from the pump module without moving the motor module; and

(c) servicing a selected component associated with the pump.

10. The method of claim **9** wherein the selected component is a wear component; and further comprising replacing the wear component without moving one of the motor module and the pump module.

11. The method of claim **10** wherein the wear component is one of: (i) a seal, (ii) an impeller; (iii) a stuffing box cover, (iv) a wear pad, (v) a casing, (vi) a gasket, (vii) a shaft sleeve, and (viii) a shaft.

12. The method of claim **9** further comprising servicing the motor module without moving the pump module.

13. The method of claim **9** further comprising servicing the pump module without moving the motor module.

14. The method of claim **9** further comprising aligning the motor module with the pump module by adjusting the support member.

15. The method of claim **9** further comprising: positioning the support member parallel to the pump module.

16. An apparatus for servicing of a vertical pump having a pump section positioned vertically below a motor section and a drive train transmitting rotational power from the motor section to the pump section, the apparatus comprising:

a weight transfer member connected to the motor section, the weight transfer member extending in substantially downward direction parallel to the pump section to a selected location adjacent a lower portion of the pump module, the load transfer member transferring a majority of the weight of the motor section from above the pump module section to the selected location without substantially exposing the pump module to the weight of the motor module.

17. The apparatus of claim **16** further comprising a base connected to the load transfer member, the base being at the selected location.

18. The apparatus of claim **17** wherein the base is symmetrically loaded by a weight of the motor module and the pump module.

19. The apparatus of claim **17** wherein the weight transfer member supports the weight of the motor module but not the weight of the pump module and the base supports the weight of the motor module and the weight of the pump module.

20. The apparatus of claim **19** wherein the load transfer member is removable from the base.

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