

(19) **DANMARK**

(10) **DK/EP 3555458 T3**



(12) **Oversættelse af
europæisk patentskrift**

Patent- og
Varemærkestyrelsen

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- (51) Int.Cl.: **F 04 D 5/00 (2006.01)** **E 03 B 7/07 (2006.01)** **F 03 B 13/00 (2006.01)**
F 04 D 13/06 (2006.01) **F 04 D 15/02 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2020-09-21**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2020-07-08**
- (86) Europæisk ansøgning nr.: **17818542.7**
- (86) Europæisk indleveringsdag: **2017-12-15**
- (87) Den europæiske ansøgnings publiceringsdag: **2019-10-23**
- (86) International ansøgning nr.: **EP2017083077**
- (87) Internationalt publikationsnr.: **WO2018114698**
- (30) Prioritet: **2016-12-19 EP 16205021**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
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- (54) Benævnelse: **STRØMNINGSSTYREENHED**
- (56) Fremdragne publikationer:
WO-A1-2008/022766
WO-A1-2016/049086
WO-A2-2008/056083
CN-A- 105 041 556

DESCRIPTION

Field of the invention

[0001] The invention relates to a flow controller for controlling flow of a fluid between a first and a second reservoir of fluids.

Background of the invention

[0002] There exist many applications where a fluid is to be transferred from a first reservoir of fluid to a second reservoir of fluid. This transfer may be troublesome, especially in case of changes in differential pressure between the first and second reservoirs.

Summary of the invention

[0003] It is an object of the present invention to solve at least some of the problems mentioned above.

[0004] According to a first aspect, a flow controller configured to selectively act as a pump or a flow regulator for a transport of fluid from a first reservoir to a second reservoir is provided. The flow controller comprising: an inlet connectable to the first reservoir; an outlet connectable to the second reservoir; a pump assembly arranged between the inlet and the outlet and configured to pump fluid through the flow controller from the inlet to the outlet using a pump wheel thereby transporting fluid from the first reservoir to the second reservoir; a flow regulator assembly arranged between the inlet and the outlet, the flow regulator assembly being configured to allow fluid to flow through the flow controller from the inlet to the outlet, thereby transporting fluid from the first reservoir to the second reservoir, and to generate electricity by transforming flow energy of fluid flowing through the flow controller into electricity using a turbine wheel to provide hydro electrical generation; and a mode controller configured to selectively set the flow controller in a pumping mode or in an electricity generating mode; wherein upon being set in the pumping mode, the mode controller is configured to deactivate the flow regulator assembly and to activate the pump assembly; wherein upon being set in the electricity generating mode, the mode controller is configured to deactivate the pump assembly and to activate the flow regulator assembly; wherein the mode controller is configured to set the flow controller in the pumping mode or the electricity generating mode based on a signal indicative on a pressure difference between the fluid at the inlet and the fluid at the outlet; wherein the flow controller further comprises a wheel, wherein the wheel is selectively operable as a pump wheel of the pump assembly to provide pump action upon the flow controller is set in the pumping mode and as a turbine wheel of the flow regulator assembly to provide hydro electrical generation upon the flow controller is set in the electricity generating mode; and

wherein a direction of flow of fluid through the pump wheel and a direction of flow of fluid through the turbine wheel are the same.

[0005] The wording "*selectively act as a pump or a flow regulator*" should be construed as the flow controller is at one point in time acting as a pump and at another point in time acting as a flow regulator. Moreover, the wording "*selectively set the flow controller in a pumping mode or in an electricity generating mode*" should be construed as the flow controller is at one point in time set in the pumping mode and at another point in time set in the electricity generating mode.

[0006] The wording "*pump*" should be construed as a device configured to, in a controlled way, allow fluid to be pumped through the pump when the pump is in an active pumping state. In the expression "in a controlled way" it is comprised that the pump may regulate the flow rate of the fluid being pumped by the pump.

[0007] The wording "*pump assembly*" should be construed as an assembly of units that together are configured to, in a controlled way, allow fluid to be pumped through the flow regulator when the pump assembly is in an active state. Upon the pump assembly being in the pumping mode, the flow through the flow controller may be regulated by driving the wheel (or impeller) at different frequencies. Different predetermined frequencies correspond to different flows through the flow controller.

[0008] The wording "*flow regulator assembly*" should be construed as an assembly of units that together are configured to, in a controlled way, allow fluid to flow through the flow regulator assembly when the flow regulator assembly is in an active state. Moreover, the flow regulator assembly may also be arranged such that the flow rate of fluid through the flow regulator assembly may be controlled. Hence, the flow regulator assembly may be arranged to regulate the flow of fluid theretrough.

[0009] The wording "*fluid*" should be construed as any liquid substance. According to non-limiting embodiments the fluid comprises water. However, according to other embodiments other fluids may be used. Some non-limiting examples are ammonia, oils, alcohols and anti-freezing liquids such as glycol. The fluid may also comprise a mixture of two or more of the fluids mentioned above.

[0010] For some applications the flow regulator assembly may be seen as a hydro electrical generator assembly. The wording "*hydro electrical generator assembly*" should be construed as an assembly of units that together are configured to, in a controlled way, allow fluid to flow through the flow regulator assembly when the flow regulator assembly is in an active state. Moreover, upon the flow regulator assembly is seen as the hydro electrical generator assembly it is configured to generate electricity by transforming flow energy of the fluid flowing through the flow controller into electricity when the flow regulator assembly is in the electricity generating mode.

[0011] For some applications a differential pressure between two reservoirs of fluid changes over time. More precisely, the differential pressure between two reservoirs of fluid may change such that the differential pressure changes from positive to negative or vice versa. Hence, for such applications, upon fluid is to be transferred from a first one of the reservoirs of fluid to a second one of the reservoirs of fluid, sometimes fluid need to be pumped from the first one of the reservoirs of fluid to the second one of the reservoirs of fluid and sometimes fluid need to be allowed to flow from the first one of the reservoirs of fluid to the second one of the reservoirs of fluid. The present flow controller allows for an efficient flow control of fluid between the first and second reservoirs. Moreover, the present flow controller may be made physically compact. Hence, physical space may be saved. Furthermore, the present flow controller allows for transfer of the fluid between the first and second reservoirs in an energy efficient manner.

[0012] The flow controller may be embodied as a centrifugal pump or as an impeller pump. For such pumps the flow of fluid going through the pump assembly may be controlled by controlling the frequency of the rotation of the wheel (or impeller) in the respective pump.

[0013] Using the wheel as both the pump wheel and the turbine wheel allow for construction of a physically compact flow controller.

[0014] The flow regulator assembly may additionally be set in a flow decreasing mode. Upon the flow regulator assembly being set in the flow decreasing mode, the flow through the flow controller may be regulated by driving the wheel (or impeller) so that the wheel (or impeller) is rotating against the flow direction. The wheel may be rotated at a predetermined frequency. By rotating the wheel against the flow direction the flow of fluid through the flow controller may be slowed down. Different predetermined frequencies correspond to different flows through the flow controller. Hence, the flow through flow controller may be deaccelerated by rotating the wheel against the direction of flow through the flow controller.

[0015] The mode controller may be configured to set the flow controller in the pumping mode in case the signal is indicative of that the pressure of the fluid at the inlet is equal or lower than the pressure at the outlet. This protects the flow controller from being damaged.

[0016] The mode controller may be configured to set the flow controller in the electricity generating mode or in the flow decreasing mode in case the signal is indicative of that the pressure of the fluid at the inlet is higher than the pressure at the outlet. This further protects the flow controller from being damaged. The choice of setting the flow controller in the electricity generating mode or in the flow decreasing mode is based on a pressure difference between a pressure of the fluid at the inlet and a pressure of the fluid at the outlet. For relatively low pressure differences the mode controller is configured to set the flow controller in the electricity generating mode and for relatively high pressure differences the mode controller is configured to set the flow controller in the flow decreasing mode. The value at which the flow decreasing mode is to chosen instead of the electricity generating mode depend on the actual flow rate through the flow controller. In case of the flow rate need to be decreased due to the

relatively high pressure difference the mode controller is configured to set the flow controller in the flow decreasing mode.

[0017] The flow controller may further comprise a battery configured to store electricity generated by the hydro electrical generator assembly. Hence, the electricity generated by the hydro electrical generator assembly may be stored for later use.

[0018] The pump assembly may further comprise an electric motor. The electric motor may be configured to at least partly be powered by the electricity stored in the battery. This allows for an energy efficient flow controller since electricity generated by the hydro electrical generator assembly may later be used for pumping of fluid in cases when fluid need to be pumped from the first reservoir to the second reservoir. Further, this allows for an energy efficient flow controller since electricity generated by the hydro electrical generator assembly may later be used for deaccelerating a flow of fluid through the flow controller upon the flow controller being set in the flow decreasing mode.

[0019] The flow controller may further comprise a first flow channel for the fluid and a second flow channel for the fluid, wherein the first flow channel forming part of the pump assembly and the second flow channel forming part of the hydro electrical generator assembly. This allow for a simple construction of the flow controller.

[0020] The flow controller may further comprise a flow director configured to be controlled by the mode controller. The flow director may be configured to direct flow of the fluid through the first flow channel and block flow of the fluid through the second channel upon the flow controller is set in the pumping mode. The flow director may be configured to direct flow of the fluid through the second flow channel and block flow of the fluid through the first channel upon the flow controller is set in the electricity generating mode. This allow for a simple construction of the flow controller.

[0021] The electric motor and the generator may be the same unit configured to act as the electric motor, upon the flow controller being set in the pumping mode, and to act as the generator, upon the flow controller being set in the electricity generating mode.

[0022] According to a second aspect a flow controller is provided. The flow controller is configured to selectively act as a pump or as a flow regulator for a transport of fluid from a first reservoir to a second reservoir. The flow controller comprising: an inlet connectable to the first reservoir; an outlet connectable to the second reservoir; a pump assembly arranged between the inlet and the outlet and configured to pump fluid through the flow controller from the inlet to the outlet using a pump wheel, thereby transporting fluid from the first reservoir to the second reservoir; a flow regulator assembly arranged between the inlet and the outlet, the flow regulator assembly being configured to allow fluid to flow through the flow controller from the inlet to the outlet, thereby transporting fluid from the first reservoir to the second reservoir, the flow regulator assembly being configured to be selectively set in an electricity generating mode and in a flow decreasing mode, wherein upon being set in the electricity generating mode the

flow regulator assembly is configured to generate electricity by transforming flow energy of fluid flowing through the flow controller into electricity using a turbine wheel, and wherein upon being set in the flow decreasing mode the flow regulator assembly is configured to deaccelerate the flow of fluid flowing through the flow controller; and a mode controller configured to selectively set the flow controller in a pumping mode, in the electricity generating mode, or in the flow decreasing mode, wherein the mode controller is configured to set the flow controller in the pumping mode, the electricity generating mode, or the flow decreasing mode based on a signal indicative on a pressure difference between the fluid at the inlet and the fluid at the outlet; and wherein a direction of flow of fluid through the pump wheel and a direction of flow of fluid through the turbine wheel are the same.

[0023] Upon the flow regulator assembly being set in the flow decreasing mode, the flow through the flow controller may be regulated by driving a wheel (or impeller) so that the wheel (or impeller) is rotating against the flow direction. The wheel may be rotated at a predetermined frequency. By rotating the wheel against the flow direction the flow of fluid through the flow controller may be slowed down. Different predetermined frequencies correspond to different flows through the flow controller. Hence, the flow through flow controller may be deaccelerated by rotating the wheel against the direction of flow through the flow controller.

[0024] The mode controller may be configured to set the flow controller in the pumping mode in case the signal is indicative of that the pressure of the fluid at the inlet is equal or lower than the pressure at the outlet.

[0025] The mode controller may be configured to set the flow controller in the electricity generating mode or in the flow decreasing mode in case the signal is indicative of that the pressure of the fluid at the inlet is higher than the pressure at the outlet. The choice of setting the flow controller in the electricity generating mode or in the flow decreasing mode is based on a pressure difference between a pressure of the fluid at the inlet and a pressure of the fluid at the outlet. For relatively low pressure differences the mode controller is configured to set the flow controller in the electricity generating mode and for relatively high pressure differences the mode controller is configured to set the flow controller in the flow decreasing mode. The value at which the flow decreasing mode is to be chosen instead of the electricity generating mode depend on the actual flow rate through the flow controller. In case of the flow rate need to be decreased due to the relatively high pressure difference the mode controller is configured to set the flow controller in the flow decreasing mode. Hence, the flow controller may further comprise a flow meter configured to measure a fluid flow through the flow controller. Upon the measured fluid flow through the flow controller is above a predetermined threshold the mode controller is configured to set the flow controller in the flow decreasing mode.

[0026] The flow controller according to the second aspect comprises a wheel. The wheel may be selectively operable as a pump wheel of the pump assembly to provide pump action upon the flow controller is set in the pumping mode, as a turbine wheel of the flow regulator assembly to provide hydro electrical generation upon the flow controller is set in the electricity

generating mode, or as a flow regulating wheel of the flow regulator assembly to provide a deaccelerating force to the fluid flowing through the flow controller upon the flow controller is set in the flow decreasing mode.

[0027] Upon the flow controller being set in the electricity generating mode or the flow decreasing mode, the mode controller may be configured to deactivate the pump assembly and to activate the flow regulator assembly.

[0028] Upon the flow controller being set in the pumping mode, the mode controller is configured to deactivate the flow regulator assembly and to activate the pump assembly.

[0029] The above mentioned features of the flow controller according to the first aspect, when applicable, apply to this second aspect as well. In order to avoid undue repetition, reference is made to the above.

[0030] A further scope of applicability of the present invention will become apparent from the detailed description given below. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the scope of the invention will become apparent to those skilled in the art from this detailed description.

[0031] Hence, it is to be understood that this invention is not limited to the particular component parts of the device described or steps of the methods described as such device and method may vary. It is also to be understood that the terminology used herein is for purpose of describing particular embodiments only, and is not intended to be limiting. It must be noted that, as used in the specification and the appended claim, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements unless the context clearly dictates otherwise. Thus, for example, reference to "a unit" or "the unit" may include several devices, and the like. Furthermore, the words "comprising", "including", "containing" and similar wordings does not exclude other elements or steps.

Brief description of the drawings

[0032] These and other aspects of the present invention will now be described in more detail, with reference to the appended drawings showing embodiments of the invention. The figures are provided to illustrate the general structures of embodiments of the present invention. Like reference numerals refer to like elements throughout.

Fig. 1 is a schematic illustration of a flow controller.

Fig. 2A is a schematic illustration of an alternative flow controller set in an electricity generating mode.

Fig. 2B is a schematic illustration of the alternative flow controller of Fig. 2A set in a pumping

mode.

Fig. 3 is an alternative configuration of the flow controller in Fig. 1.

Detailed description

[0033] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which currently preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided for thoroughness and completeness, and to fully convey the scope of the invention to the skilled person.

[0034] In Fig. 1 a flow controller 1 is schematically illustrated. In Figs 2A and 2B an alternative flow controller 1 is schematically illustrated.

[0035] Below first common features of both the flow controller 1 as illustrated in Fig. 1 and the alternative flow controller 1 as illustrated in Figs 2A and 2B will be discussed. Thereafter specific features of the two alternative flow controller 1 will be discussed.

[0036] The flow controller comprises an inlet 2 for a fluid, an outlet 3 for the fluid, a pump assembly 10 arranged between the inlet 2 and the outlet 3, a flow regulator assembly 20 arranged between the inlet 2 and the outlet 3, and a mode controller 30.

[0037] The flow controller 1 is configured to be connected in between a first and a second reservoir (not shown) of fluid. The inlet 2 is configured to be connected to the first reservoir. The outlet 3 is configured to be connected to the second reservoir.

[0038] The pump assembly 10, upon being active, is configured to pump the fluid through the flow controller 1 from the inlet 2 to the outlet 3. Hence, the pump assembly 10, upon being active, is configured to pump fluid from the first reservoir to the second reservoir. The pump assembly 10 comprises a pumping wheel 14 and an electric motor 12. The electric motor 12 is configured to, upon the pump assembly 10 being active, turn the pumping wheel 14 and thereby inducing pumping action to the pump assembly 10. Hence, the pump wheel 14 of the pump assembly 10 is configured to provide pump action. Moreover, the pump assembly 10 may also be arranged such that the flow rate of fluid through the flow controller 1 may be controlled.

[0039] The flow regulator assembly 20, upon being active, is configured to allow the fluid to flow through the flow controller 1 from the inlet 2 to the outlet 3. Moreover, upon being active, the flow regulator assembly 20 is further configured to be selectively set in an electricity

generating mode or in a flow decreasing mode.

[0040] Upon being set in the electricity generating mode the flow regulator assembly 20 is configured to generate electricity by transforming flow energy of the fluid flowing through the flow controller 1 into electricity. The flow regulator assembly 20 comprises a turbine wheel 24 to provide hydro electrical generation and a generator 22 configured to be connected to the turbine wheel 24. The generator 22 is configured to generate electricity upon the turbine wheel 24 being turned. The turbine wheel 24 being turned by a flow of fluid flowing through the flow controller 1 upon the flow regulator assembly 20 being set in the electricity generating mode. Hence, the turbine wheel 24 of the hydro electrical generator assembly 20 is configured to provide hydro electrical generation.

[0041] As mentioned above, the flow regulator assembly 20 may additionally be set in a flow decreasing mode. Upon the flow regulator assembly 20 being set in the flow decreasing mode, the flow through the flow controller 1 may be regulated by driving the turbine wheel 24, now acting as a deaccelerating means, so that the wheel 24 is rotating against the fluid flow direction. The wheel 24 may be rotated at a predetermined frequency. By rotating the wheel 24 against the fluid flow direction the flow of fluid through the flow controller may be slowed down. Different predetermined frequencies correspond to different flows through the flow controller 1. Hence, the flow through flow controller 1 may be deaccelerated by rotating the wheel 24 against the direction of flow through the flow controller 1.

[0042] The mode controller 30 is configured to selectively set the flow controller 1 in a pumping mode, in the electricity generating mode, or in the flow decreasing mode. In the pumping mode the flow regulator 1 is acting as a pump. In the electricity generating mode the flow regulator 1 is acting as a flow regulator and at the same time as a generator for electricity. In the flow decreasing mode the flow regulator 1 is acting as a flow regulator and at the same time slowing down the flow of fluid through the flow controller 1. Hence, the flow controller 1 is configured to selectively act as a pump or as a flow regulator. The flow controller 1 is configured to, upon acting as a pump, pump the fluid from the first reservoir to the second reservoir. The flow controller 1 is configured to, upon acting as a flow regulator, allow the fluid to flow from the first reservoir to the second reservoir. Upon being set in the pumping mode, the mode controller 30 is configured to deactivate the flow regulator assembly 20 and to activate the pump assembly 10. Upon being set in the electricity generating mode or in the flow decreasing mode, the mode controller 30 is configured to deactivate the pump assembly 10 and to activate the flow regulator assembly 20.

[0043] For some applications a differential pressure between the first and second reservoirs of fluid changes over time. More precisely, the differential pressure between the first and second reservoirs of fluid may change such that the differential pressure changes from positive to negative or vice versa. For such applications, upon fluid is to be transferred from the first reservoir to the second reservoir, sometimes fluid need to be pumped from the first reservoir to the second reservoir and sometimes fluid need to be allowed to flow from the first reservoir to the second reservoir. More precisely, in case the pressure of the fluid is higher in the first

reservoir than in the second reservoir the flow controller 1 is configured to allow a flow of the fluid to flow through the flow controller 1. Hence, the mode controller 30 is configured to set the flow controller 1 in the electricity generating mode or in the flow decreasing mode. Further, in case the pressure of the fluid is lower in the first reservoir than in the second reservoir the flow controller 1 is configured to pump a flow of the fluid from the first reservoir to the second reservoir. Hence, the mode controller 30 is configured to set the flow controller 1 in the pumping mode.

[0044] The mode controller 30 may be configured to receive a signal indicative on a pressure difference between fluid of the first and second reservoirs. Hence, the signal is indicative on a pressure difference between fluid at the inlet 2 and fluid at the outlet 3. The signal indicative on the pressure difference between fluid at the inlet 2 and fluid at the outlet 3 may be derived from pressure gauges arranged at the inlet 2 and at the outlet 3. The flow controller 1 may hence comprise a first pressure gauge arranged at the inlet 2 and a second pressure gauge arranged at the outlet 3. The first and second pressure gauges being configured to determine a respective pressure of the fluid at the inlet 2 and the outlet 3, respectively. The pressures determined by the first and second pressure gauges may be used to derive the signal indicative on the pressure difference between fluid at the inlet 2 and fluid at the outlet 3. The signal indicative on the pressure difference between fluid at the inlet 2 and fluid at the outlet 3 may be derived by the mode controller 30.

[0045] The mode controller 30 may be fully hardware implemented. Alternatively, the mode controller 30 may be fully software implemented. Yet alternatively, the mode controller 30 may be a combined hardware and software implementation. The software portions of the mode controller 30 may be run on a processing unit.

[0046] The mode controller 30 may be configured to set the flow controller 1 in the pumping mode, the electricity generating mode, or the flow decreasing mode based on a signal indicative on the pressure difference between the fluid at the inlet 2 and the fluid at the outlet 3. If so, the mode controller 30 is configured to set the flow controller 1 in the pumping mode in case the signal is indicative of that the pressure of the fluid at the inlet 2 is equal or lower than the pressure at the outlet 3. Moreover, if so, the mode controller 30 is configured to set the flow controller 1 in the electricity generating mode or in the flow decreasing mode in case the signal is indicative of that the pressure of the fluid at the inlet 2 is higher than the pressure at the outlet 3. The choice of setting the flow controller in the electricity generating mode or in the flow decreasing mode is based on a pressure difference between a pressure of the fluid at the inlet 2 and a pressure of the fluid at the outlet 3. For relatively low pressure differences the mode controller 30 is configured to set the flow controller 1 in the electricity generating mode and for relatively low pressure differences the mode controller 30 is configured to set the flow controller in the flow decreasing mode. The value at which the flow decreasing mode is chosen instead of the electricity generating mode depend on the actual flow rate through the flow controller 1. In case of the flow rate need to be decreased due to the relatively high pressure difference the mode controller 30 is configured to set the flow controller 1 in the flow decreasing mode.

[0047] The mode controller 30 may also be configured to control the flow rate of fluid through the flow regulator 1. Accordingly, the mode controller 30 may also be configured to control the pump assembly 10 such that the flow rate of fluid pumped by the pump assembly 10 is controlled. This may be done by regulating a rotation frequency of a pump wheel 14 of the pump assembly 10. Moreover, the mode controller 30 may also be configured to control the flow regulator assembly 20 such that the flow rate of fluid flowing through the hydro electrical generator assembly 20 is controlled. This may be done, as have been discussed above, by regulating the rotation frequency of the wheel 24.

[0048] With reference to Fig. 1 the flow controller 1 may further comprise a wheel 50. The wheel 50 is selectively operable as the pump wheel 14 of the pump assembly 10 and as a turbine wheel 24 of the flow regulator assembly 20. Upon the flow controller 1 is set in the pumping mode the wheel 50 is selectively operable as the pump wheel 14. Upon the flow controller 1 is set in the electricity generating mode the wheel 50 is selectively operable as the turbine wheel 24. Upon the flow controller 1 is set in the flow decreasing mode the wheel 50 is selectively operable as a deaccelerating means. Hence, in the pumping mode the wheel 50 is acting as the pumping wheel 24 and is configured to be connected to the electric motor 12. Moreover, in the electricity generating mode the wheel 50 is acting as the turbine wheel 24 and is configured to be connected to the generator 22. Furthermore, in the flow decreasing mode the wheel 50 is acting as a deaccelerating means and is configured to be connected to the electric motor 12.

[0049] With reference to Figs 2A and 2B the flow controller 1 may comprise a first flow channel 16 for the fluid and a second flow channel 26 for the fluid. The first flow channel 16 forming part of the pump assembly 10. The second flow channel 26 forming part of the flow regulator assembly 20. The flow controller 1 may further comprise a flow director 60. The flow director 60 is configured to be controlled by the mode controller 30. Upon the flow controller 1 is set in the pumping mode, the flow director 60 is configured to direct flow of the fluid through the first flow channel 16 and block flow of the fluid through the second channel 26. This is illustrated in Fig 2B. Upon the flow controller 1 is set in the electricity generating mode or in the flow decreasing mode, the flow director 60 is configured to direct flow of the fluid through the second flow channel 26 and block flow of the fluid through the first channel 16. This is illustrated in Fig 2A. The flow director 60 may be embodied in many different ways. According to a non-limiting example, the flow director 60 may comprise a sliding block configured to selectively block flow of the fluid through the first and second flow channels 16, 26, respectively. Upon the sliding block of the flow director 60 is blocking one of the first and second flow channels 16, 26 the other one is opened allowing fluid to flow there through.

[0050] The person skilled in the art realizes that the present invention by no means is limited to the preferred embodiments described above. On the contrary, many modifications and variations are possible within the scope of the appended claims.

[0051] For example, the flow controller 1 may further comprise a battery 40. The battery may

be configured to store electricity generated by the hydro electrical generator assembly 20. The electric motor 12 may be configured to at least partly be powered by the electricity stored in the battery 40. The mode controller 30 may at least partly be configured to be powered by the electricity stored in the battery 40.

[0052] Moreover, the electric motor 12 may be configured to act as the generator 22 upon the flow controller 1 is set in the electricity generating mode. This is schematically illustrated in Fig. 3. Upon being set in the pumping mode or in the flow decreasing mode, the electric motor 12 is configured to be supplied by electricity. The mode controller 30 may be configured to control the supply of electricity to the electric motor 12. When being applied by electricity the electric motor 12 is configured to turn the wheel 50 now acting as the pumping wheel 14 or the deaccelerating means. Upon being set in the electricity generating mode the electric motor 12 is configured to act as the generator 22. When the electric motor 12 is acting as the generator 22 turning of the wheel 50 now acting as the turbine wheel 14 induce the generator 22 to generate electricity. In accordance with the above, the generated electricity may be stored in the battery 40. The electricity stored in the battery 40 may then later be used for powering the electric motor 12 when being set in the pumping mode or in the flow decreasing mode.

[0053] Additionally, variations to the disclosed embodiments can be understood and effected by the skilled person in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims.

P A T E N T K R A V

1. Strømningsstyreenhed (1) som er konfigureret til selektivt at fungere som en pumpe eller som en strømningsregulator for en transport af fluid fra et første reservoir til et andet reservoir, hvor strømningsstyreenheden omfatter:

5 et indløb (2) som kan forbindes til det første reservoir;

et udløb (3) som kan forbindes til det andet reservoir;

en pumpeanordning (10) som er arrangeret mellem indløbet (2) og udløbet (3) og konfigureret til at pumpe fluid gennem strømningsstyreenheden (1) fra indløbet (2) til udløbet (3) ved at anvende et pumpehjul (14) og derved transportere fluid fra det første re-
10 servoir til det andet reservoir;

en strømningsregulatoranordning (20) som er arrangeret mellem indløbet (2) og udløbet (3), hvor strømningsregulatoranordningen (20) er konfigureret til at tillade fluid at strømme gennem strømningsstyreenheden (1) fra indløbet (2) til udløbet (3) og derved transportere fluid fra det første reservoir til det andet reservoir, hvor strømningsregulator-
15 anordningen (20) er konfigureret til selektivt at blive indstillet i en elektricitetsgenererende tilstand og i en strømningsreducerende tilstand, hvor når den indstilles i den elektricitetsgenererende tilstand, er strømningsregulatoranordningen (20) konfigureret til at generere elektricitet ved at transformere strømningsenergi af fluid som strømmer gennem strømningsstyreenheden (1), til elektricitet ved at anvende et turbinehjul (24) til at tilvejebringe
20 hydroelektrisk generering og hvor når den indstilles i den strømningsreducerende tilstand, er strømningsregulatoranordningen (20) konfigureret til at deaccelerere strømningen af fluid som strømmer gennem strømningsstyreenheden (1); og

en tilstandsstyreenhed (30) som er konfigureret til selektivt at indstille strømningsstyreenheden (1) i en pumpetilstand, i den elektricitetsgenererende tilstand eller i
25 den strømningsreducerende tilstand, hvor tilstandsstyreenheden er konfigureret til at indstille strømningsstyreenheden (1) i pumpetilstanden, den elektricitetsgenererende tilstand eller den strømningsreducerende tilstand baseret på et signal som indikerer en trykfor-
skel mellem fluidet ved indløbet (2) og fluidet ved udløbet (3); og hvor en retning af strømning af fluid gennem pumpehjulet (14) og en retning af strømning af fluid gennem
30 turbinehjulet (24) er den samme.

2. Strømningsstyreenhed (1) ifølge krav 1, hvor tilstandsstyreenheden (30) er konfigureret til at indstille strømningsstyreenheden (1) i pumpetilstanden i tilfælde af at signalet indikerer at trykket af fluidet ved indløbet (2) er lig med eller lavere end trykket ved udløbet (3).

35 3. Strømningsstyreenhed (1) ifølge krav 1 eller 2, hvor tilstandsstyreenheden (30) er konfigureret til at indstille strømningsstyreenheden (1) i den elektricitetsgenererende tilstand eller i den strømningsreducerende tilstand i tilfælde af at signalet indikerer at tryk-
ket af fluidet ved indløbet (2) er højere end trykket ved udløbet (3).

4. Strømningsstyreenhed (1) ifølge krav 3, yderligere omfattende en fluidstrøm-

ningsmåler som er konfigureret til at måle en fluidstrømning gennem strømningstyreenheden (1), hvor tilstandstyreenheden (30) er konfigureret til at indstille strømningstyreenheden (1) i den strømningssreducerende tilstand når den målte fluidstrømning gennem strømningstyreenheden (1) er over en forudbestemt tærskel.

5 5. Strømningstyreenhed (1) ifølge et hvilket som helst af kravene 1-4, yderligere omfattende et hjul (50), hvor hjulet (50) er selektivt anvendeligt som pumpehjul (14) af pumpeanordningen (10) for at tilvejebringe pumpevirkning når strømningstyreenheden (1) indstilles i pumpetilstanden, som turbinehjul (24) af strømningssregulatoranordningen (20) for at tilvejebringe hydroelektrisk generering når strømningstyreenheden (1) indstilles i den elektricitetsgenererende tilstand, eller som et strømningssdeaccelerationsmiddel af strømningssregulatoranordningen (20) for at tilvejebringe en deaccelererende kraft til fluidet som strømmer gennem strømningstyreenheden (1) når strømningstyreenheden (1) indstilles i den strømningssreducerende tilstand.

15 6. Strømningstyreenhed (1) ifølge et hvilket som helst af kravene 1-5, hvor når strømningstyreenheden indstilles i den elektricitetsgenererende tilstand eller den strømningssreducerende tilstand, er tilstandstyreenheden (30) konfigureret til at deaktivere pumpeanordningen (10) og til at aktivere strømningssregulatoranordningen (20).

20 7. Strømningstyreenhed (1) ifølge et hvilket som helst af kravene 1-6, hvor når strømningstyreenheden (1) indstilles i pumpetilstanden, er tilstandstyreenheden (30) konfigureret til at deaktivere strømningssregulatoranordningen (20) og til at aktivere pumpeanordningen (10).

25 8. Strømningstyreenhed ifølge et hvilket som helst af kravene 1-7, hvor strømningssregulatoranordningen (20) yderligere omfatter en generator (22), hvor pumpeanordningen (10) yderligere omfatter en elektrisk motor (12), hvor den elektriske motor (12) og generatoren (22) er den samme enhed som er konfigureret til at fungere som den elektriske motor (12) når strømningstyreenheden indstilles i pumpetilstanden eller i den strømningssreducerende tilstand, og til at fungere som generatoren (22) når strømningstyreenheden indstilles i den elektricitetsgenererende tilstand.

30 9. Strømningstyreenhed ifølge krav 8, yderligere omfattende et batteri (40) som er konfigureret til at lagre elektricitet som er genereret af generatoren (22), hvor den elektriske motor (12) er konfigureret til mindst delvist at være drevet af elektriciteten som er lagret i batteriet (40).

35 10. Strømningstyreenhed (1) som er konfigureret til selektivt at fungere som en pumpe eller som en strømningssregulator for en transport af fluid fra et første reservoir til et andet reservoir, hvor strømningstyreenheden omfatter:

et indløb (2) som kan forbindes til det første reservoir;

et udløb (3) som kan forbindes til det andet reservoir;

en pumpeanordning (10) som er arrangeret mellem indløbet (2) og udløbet (3) og konfigureret til at pumpe fluid gennem strømningstyreenheden (1) fra indløbet (2) til ud-

- løbet (3) og derved transportere fluid fra det første reservoir til det andet reservoir;
en hydroelektrisk generatoranordning (20) som er arrangeret mellem indløbet (2) og udløbet (3), hvor den hydroelektrisk generatoranordning (20) er konfigureret til at tillade fluid at strømme gennem strømningsstyreenheden (1) fra indløbet (2) til udløbet (3) og
- 5 derved transportere fluid fra det første reservoir til det andet reservoir, og til at generere elektricitet ved at transformere strømningsenergi af fluid som strømmer gennem strømningsstyreenheden (1), til elektricitet; og
- en tilstandsstyreenhed (30) som er konfigureret til selektivt at indstille strømningsstyreenheden (1) i en pumpe tilstand eller i en elektricitetsgenererende tilstand;
- 10 hvor når den indstilles i pumpe tilstanden, er tilstandsstyreenheden (30) konfigureret til at deaktivere den hydroelektriske generatoranordning (20) og til at aktivere pumpeanordningen (10); og
- hvor når den indstilles i den elektricitetsgenererende tilstand, er tilstandsstyreenheden (30) konfigureret til at deaktivere pumpeanordningen (10) og til at aktivere den
- 15 hydroelektriske generatoranordning (20);
- hvor tilstandsstyreenheden (30) er konfigureret til at indstille strømningsstyreenheden (1) i pumpe tilstanden eller den elektricitetsgenererende tilstand baseret på et signal som indikerer en trykforskel mellem fluidet ved indløbet (2) og fluidet ved udløbet (3);
- hvor strømningsstyreenheden yderligere omfatter et hjul (50), hvor hjulet (50) er
- 20 selektivt anvendeligt som et pumpehjul (14) af pumpeanordningen (10) for at tilvejebringe pumpevirkning når strømningsstyreenheden indstilles i pumpe tilstanden, og som et turbinehjul (24) af den hydroelektriske generatoranordning (20) for at tilvejebringe hydroelektrisk generering når strømningsstyreenheden indstilles i den elektricitetsgenererende tilstand; og
- 25 hvor en retning af strømning af fluid gennem pumpehjulet (14) og en retning af strømning af fluid gennem turbinehjulet (24) er den samme.
11. Strømningsstyreenhed ifølge krav 10, hvor tilstandsstyreenheden (30) er konfigureret til at indstille strømningsstyreenheden (1) i pumpe tilstanden i tilfælde af at signalet indikerer at trykket af fluidet ved indløbet (2) er lig med eller lavere end trykket ved
- 30 udløbet (3).
12. Strømningsstyreenhed ifølge krav 10 eller 11, hvor tilstandsstyreenheden (30) er konfigureret til at indstille strømningsstyreenheden (1) i den elektricitetsgenererende tilstand i tilfælde af at signalet indikerer at trykket af fluidet ved indløbet (2) er højere end trykket ved udløbet (3).
- 35 13. Strømningsstyreenhed ifølge et hvilket som helst af kravene 10-12, yderligere omfattende et batteri (40) som er konfigureret til at lagre elektricitet som er genereret af strømingsregulatoranordningen (20).
14. Strømningsstyreenhed ifølge krav 13, hvor pumpeanordningen (10) yderligere omfatter en elektrisk motor (12), hvor den elektriske motor (12) er konfigureret til mindst

delvist at være drevet af elektriciteten som er lagret i batteriet (40).

15. Strømningsstyreenhed ifølge krav 10-14, hvor strømningsregulatoranordningen (20) yderligere omfatter en generator (22) som er konfigureret til at blive forbundet til turbinehjulet (24), hvor pumpeanordningen (10) yderligere omfatter en elektrisk motor (12), hvor den elektriske motor (12) og generatoren (22) er den samme enhed som er konfigureret til at fungere som den elektriske motor (12) når strømningsstyreenheden indstilles i pumpetilstanden, og til at fungere som generatoren (22) når strømningsstyreenheden indstilles i den elektricitetsgenererende tilstand.

DRAWINGS

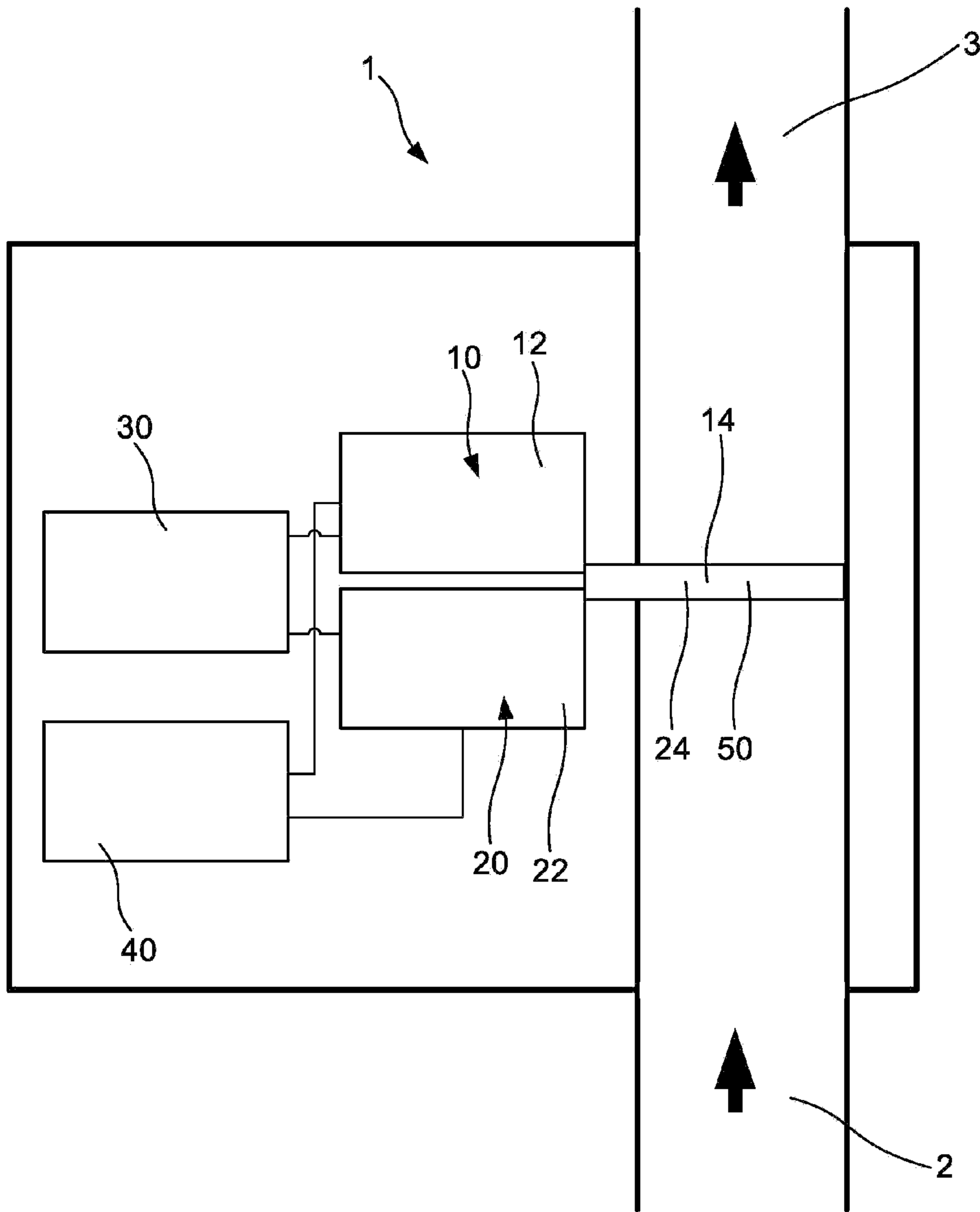


FIG. 1

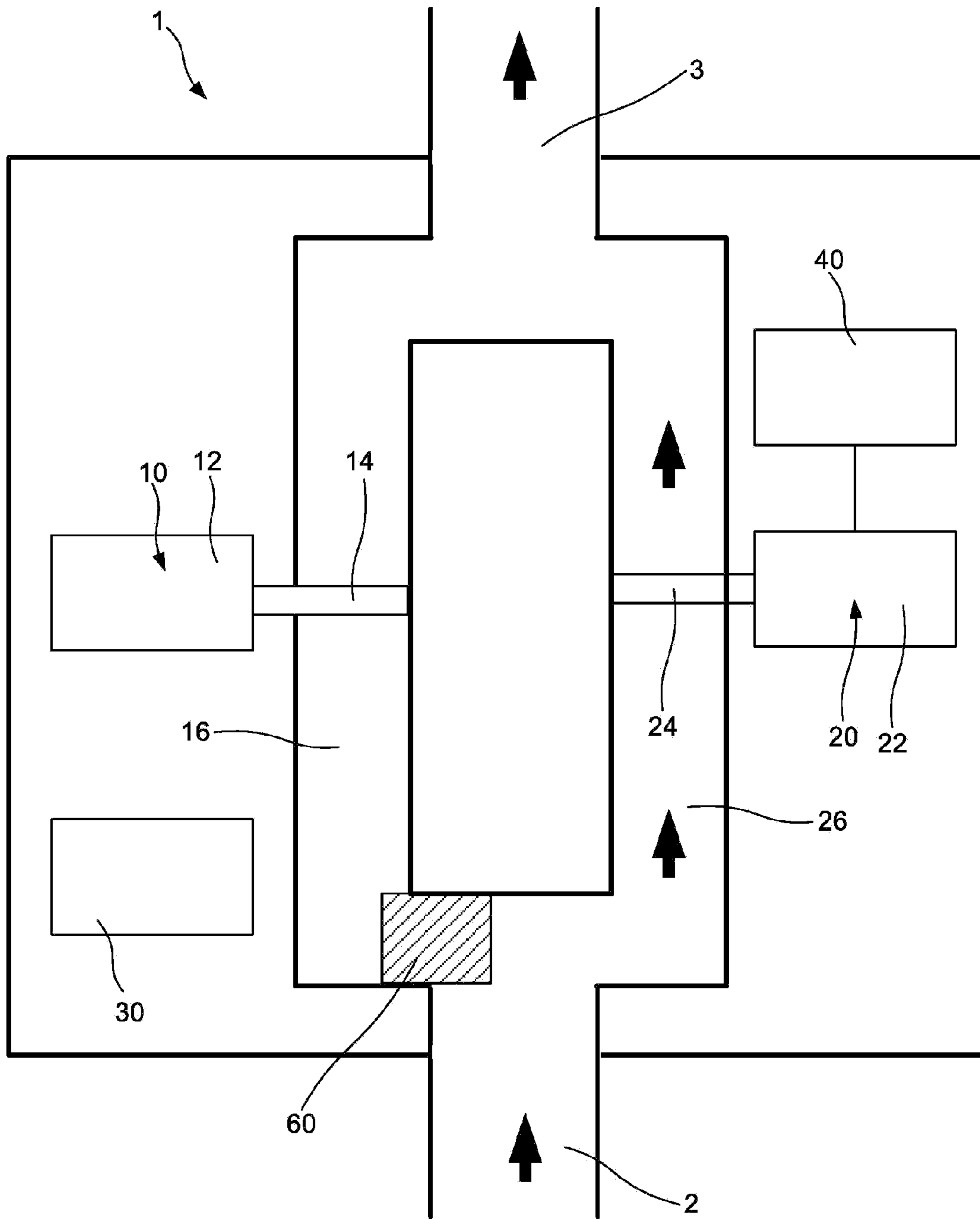


FIG. 2A

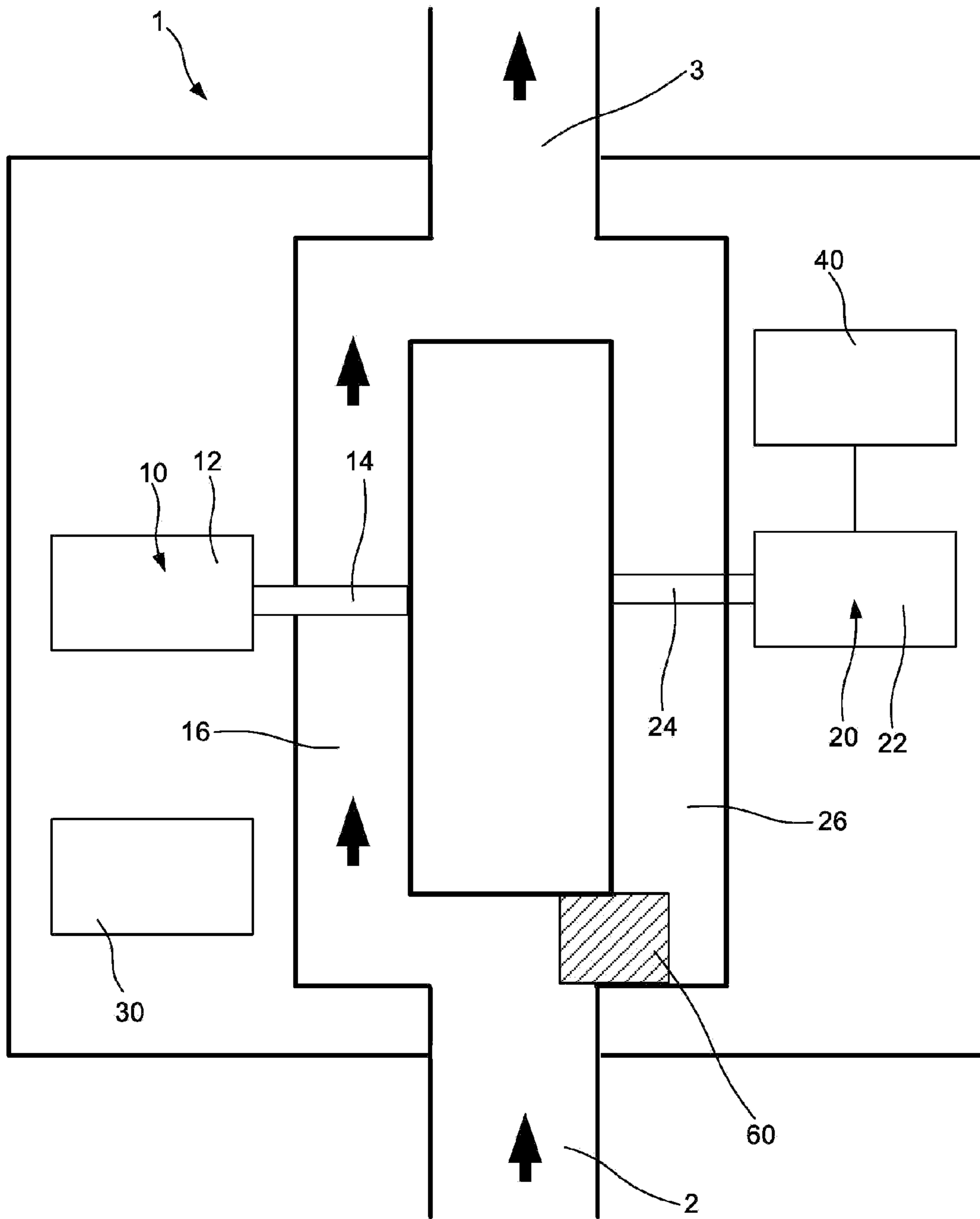


FIG. 2B

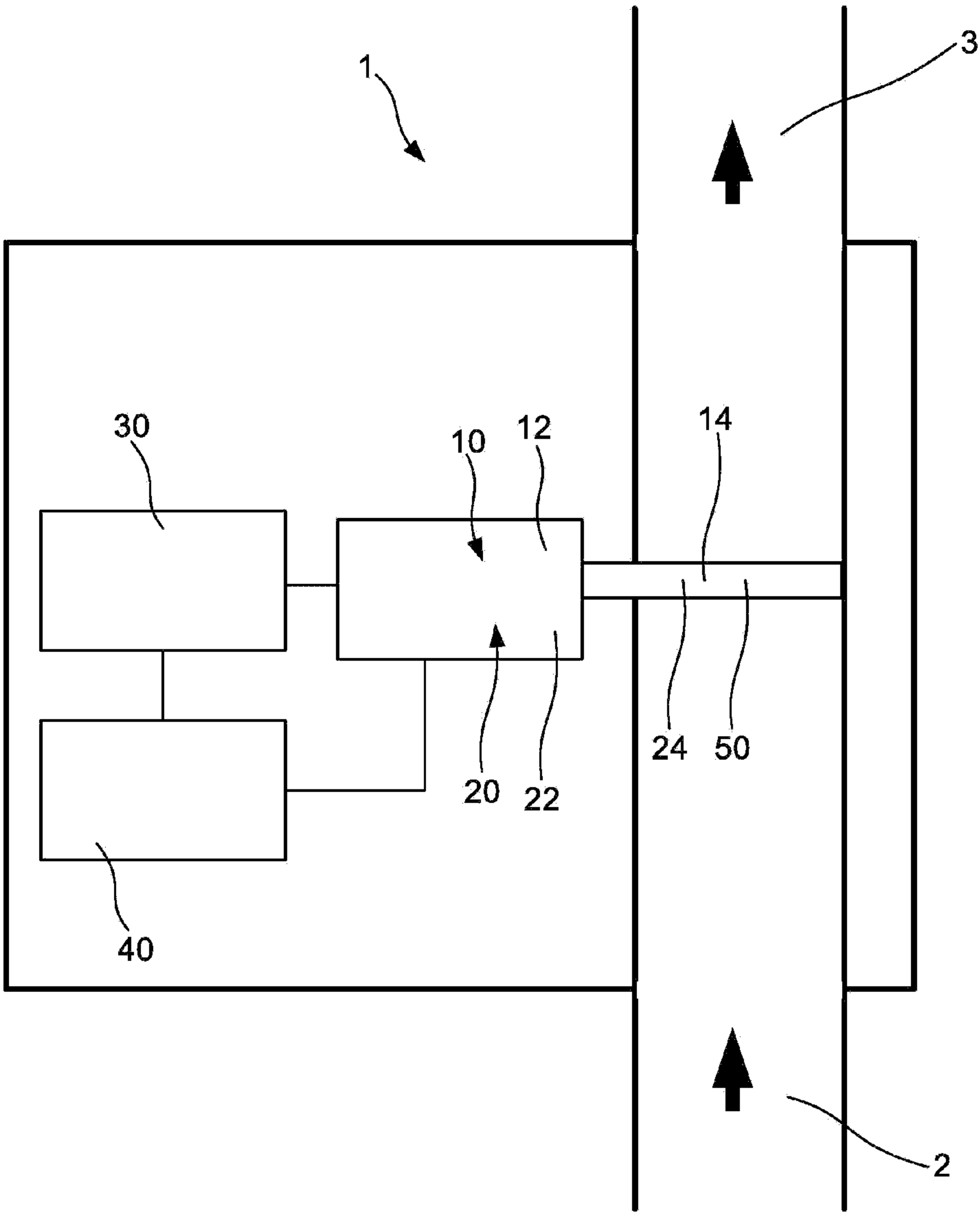


FIG. 3