



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
18.02.2009 Bulletin 2009/08

(51) Int Cl.:
F04D 7/04 (2006.01) F04D 15/02 (2006.01)

(21) Application number: **08252693.0**

(22) Date of filing: **14.08.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

- **Wroth, Craig**
Dandenong
Victoria 3175 (AU)
- **Watt, Steve**
Surrey Hills
Victoria 3127 (AU)

(30) Priority: **15.08.2007 GB 0715947**

(74) Representative: **Leeming, John Gerard**
J.A. Kemp & Co.
14 South Square
Gray's Inn
London WC1R 5JJ (GB)

(71) Applicant: **MONO PUMPS LIMITED**
Audenshaw, Manchester M34 5DQ (GB)

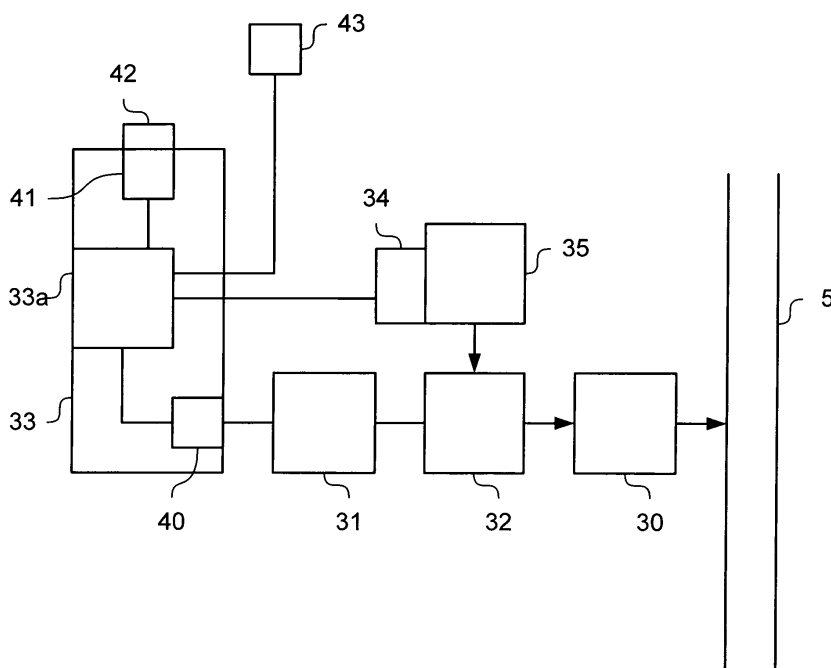
(72) Inventors:
• **Moore, Andrew**
Nunawading
Victoria 3131 (AU)

(54) **Pump system**

(57) A pump system for a pressure sewer system, comprising a pump, a cutter and an electric motor configured to drive the pump and the cutter; the pump system

comprises a current sensor that measures the electric current provided to the motor and the controller stops the operation of the motor if the current drawn by the electric motor exceeds the predetermined threshold.

Fig 2



Description

[0001] The present invention relates to a pump system for use in a pressure sewer system. Pressure sewer systems are an alternative to a traditional gravity feed sewers and are particularly useful in areas where it is difficult and/or expensive to install a traditional gravity sewer mains, such as areas that are hilly, extremely flat, of environmental significance, built up or where minimum disruption is required. In such a system, each home may be provided with a sealed sewage collection tank into which waste from the home is passed. Periodically, the waste is pumped from the sewage collection tank under pressure through relatively small-bore pipes to a processing station. The pipes may follow the natural contour of the ground, resulting in considerable cost savings in installation and maintenance.

[0002] A problem with pressure sewer systems is that it is reliant on the correct functioning of the pumps provided for each sewage collection tank. Accordingly, reliability of the pumps is essential. However, the pumps may become damaged, for example if they attempt to operate when the pressure in the waste pipe leading to the processing station is too high. The pressure in these pipes may vary depending on, for example, the number of pumps operating at a given instant to pump waste into the pipe. Therefore, there have previously been suggested ways of avoiding damage to the pump due to operation against too high a pressure. For example it has been known to monitor the temperature of the pump and to stop the pump if the temperature exceeds a given point because the temperature may damage the pump and may indicate an elevated pressure within the waste pipe. Alternatively, it has been proposed to monitor the pressure of the waste in the pipe leading to the processing station such that the pump may be controlled not to activate if the pressure is too high.

[0003] However, both these proposals have disadvantages. For example, there can be a significant delay between a pump experiencing a high pressure and the temperature of the pump rising significantly at the point at which the temperature is measured. Accordingly, damage may be caused to the pump during such periods of delay. Likewise monitoring the pressure of the waste in the discharge pipe may be unreliable because it involves the provision of pressure switches within the discharge pipe. Such switches may not be reliable because they are in contact with the sewage which can partially or fully block them.

[0004] Accordingly, it is an object of the present invention to provide an improved pump system for use in a pressure sewer system and an improved method of controlling such a pump system.

[0005] The present invention provides a pump system for use in a pressure sewer system, comprising:

- a pump;
- a cutter; and

an electric motor configured to drive the pump and the cutter;

wherein the pump system further comprises:

a current sensor configured to measure the electric current provided to the motor; and

a controller that is configured to monitor the electric current measured by the current sensor during operation of the pump system and, if the measured electric current exceeds a predetermined threshold, stop the operation of the motor.

[0006] The present invention also provides a method of controlling a pump system for use in a pressure sewer system, said pump system comprising a pump, a cutter and an electric motor configured to drive the pump and the cutter; and the method comprising:

measuring the electric current provided to the motor during operation of the pump system and, if the measured electric current exceeds a predetermined threshold, stopping the operation of the motor.

[0007] Systems according to the present invention do not suffer from the drawbacks of the previously proposed arrangements. In particular, controlling the operation of the pump system based on the electric current provided to the electric motor advantageously provides a quick response to any increase in pressure in the discharge pipe. In particular, the electric current drawn by the motor may be directly proportional to the pressure against which the pump is acting. Accordingly, the measurement of the electric current may provide an immediate measurement of the pressure within the discharge pipe. Furthermore, the electric current sensor is not in contact with the sewage and accordingly, may be extremely reliable, requiring little or no routine maintenance.

[0008] Furthermore, if the pump or cutter becomes blocked, the electric current drawn by the motor may increase considerably. Accordingly, the system of the present invention may detect such a blockage by monitoring the electric current. Accordingly, the system may be arranged such that if the electric current exceeds a given level, the motor is reversed by a given amount, such as a quarter turn, in order to unblock the cutter and/or pump.

[0009] The system of the present invention may also be arranged to delay the re-start of the motor for a given period of time after the measured electric current has exceeded the threshold. In the case of the excess current being caused by an elevated pressure in the discharge pipe, for example, one may expect that when the pump system is re-started, other pump systems connected to the discharge pipe may have ceased operation and, accordingly, the pressure in the discharge pipe may have lowered sufficiently that the current drawn by the electric motor in order to pump waste into the discharge pipe will have fallen below the threshold.

[0010] The electric motor may be a single-phase motor

with capacitor-start. In this case the provision of a delay between re-start of the pump system may be beneficial because the capacitors used in a single phase motor with capacitor-start may be damaged if there is not a sufficient time delay between successive starts of the motor and/or if there are too many re-starts in a given period of time.

[0011] The pump system controller may monitor the frequency with which the pump system is stopped due to an excess current being drawn by the electric motor and may be arranged to activate an alarm if the frequency is too high. This may occur, for example, if the cutter or pump becomes blocked and cannot be automatically unblocked by the system according to the present invention. Accordingly, the alarm may be an audible an/or visible alarm arranged to notify the resident of the property at which the pump system is installed and/or the company providing the pressure sewer system of the possible blockage.

[0012] The system may be configured such that if, after the alarm has been activated, the pump system succeeds in removing the blockage, namely the system is successfully re-started, the alarm is deactivated. For example, the system may be configured such that if, after the alarm is activated, the system is re-started and the current drawn by the electric motor does not exceed the threshold for a set period of time, the blockage is deemed to have been removed and the alarm is de-activated.

[0013] In addition to stopping the operation of the motor at any point when the electric current drawn by the motor exceeds a given threshold, the pump system may be configured such that the operation of the electric motor is stopped if the current drawn by the electric motor exceeds a second threshold, that is lower than the first threshold, for a given period of time. Accordingly, the first threshold may be set in order to protect the pump system from damage caused by a peak current excess, corresponding to excessively high pressure within the discharge pipe or a significant blockage of the cutter and/or pump and the second threshold may be set at a level such that the pump system is protected from damage that may occur if it operates continuously at that level for a prolonged period, for example corresponding to a moderately elevated pressure within the discharge pipe and/or a relatively minor blockage of the cutter and/or pump.

[0014] The controller of the pump system may be provided with a memory that is configured to store data relating to the electric current provided to the motor. The pump system may further comprise a means for outputting the data for subsequent analysis. For example the output may enable the company providing the pressure sewer system and/or anyone intending to perform maintenance on the pump system, to output the data in order to determine some measure of the past performance of the system. For example, the memory may store the total number of times that the controller has stopped the operation of the motor due to the electric current exceeding one or both of the predetermined thresholds. This may

provide a general guide to the reliability of the system and, if the memory records the date/or time when these stoppages occur, may provide an indication of whether or not the reliability of the system is deteriorating. Likewise the memory may alternatively or additionally store the frequency of the stoppages, providing similar information. The memory may alternatively or additionally store the total time that the current is provided to the motor, providing a history of the total work done by the pump system. Such a measure may be used to schedule maintenance and/or replacement of the pump system, or a component of the pump system, after a given number of hours of operation. Alternatively or additionally, the memory may store a complete record of the current supplied to the motor over time, for example a periodic measurement of the current supplied to the motor during operation. Such a complete record may enable further analysis of the performance of the system, facilitating scheduling of the maintenance and/or replacement of part or all of the pump system and/or fault diagnosis.

[0015] The pump may, in particular, be a positive displacement pump, such as a helical rotor pump with a rotating rotor in a rubber stator. The advantage of using such a pump is that it provides a relative constant flow versus the backpressure on the pump and the current drawn by the motor is directly proportional to the backpressure. Accordingly, monitoring the electric current drawn by the motor provides a measure of the pressure within the discharge pipe. The cutter may, in particular, be a rotating serrated impeller. The impeller may be provided with hammers which pull debris into the cutters.

[0016] The pump system may be installed within a pressure sewer system. In this case, the pump system may be installed between a sewage store tank and a sewage pipe for conveying sewage under pressure to a treatment unit. The pump system may be configured to periodically pump sewage from the sewage store tank into the sewage pipe. In particular, the sewage store tank may include a level sensor system that measures the sewage level in the sewage store tank and the controller of the pump system may commence operation of the motor to pump sewage from the sewage store tank into the sewage pipe when the sewage level in the sewage store tank exceeds a predetermined level.

[0017] The pump system may further be arranged to pump sewage from the sewage store tank into the sewage pipe for a given period of time and/or until the sewage level in the sewage store tank falls below a predetermined level (unless the operation is interrupted due to the level of current drawn by the motor).

[0018] The present invention will now be described by way of non-limiting examples with reference to the accompanying drawings in which:

Figure 1 depicts an arrangement of a pressure sewer system; and

Figure 2 depicts a pump system according to the present invention.

[0019] As shown in Figure 1, a plurality of properties 1,2,3,4, for example residential homes, may be connected to a discharge pipe 5 that passes sewage from each of the properties 1,2,3,4 to a sewage processing station 6. Each of the properties 1,2,3,4 is provided with an associated sewage storage tank 11,12,13,14 into which waste from the properties is passed and that stores the sewage prior to pumping into the discharge pipe 5. A pump system 21,22,23,24 is also associated with each of the properties 1,2,3,4 and is configured to periodically pump the sewage into the discharge pipe 5.

[0020] As shown in Figure 2, each pump system includes a pump 30 for pumping the sewage that is driven by a motor 31. An inline cutter 32 is also provided to macerate the sewage prior to it passing into the pump 30.

[0021] The pump 30 may, in particular, be a helical rotor pump, with a rotating rotor in a rubber stator. This is a type of positive displacement pump which, advantageously, provides a relatively constant flow versus the backpressure on the pump. This is beneficial because the pressure within the discharge pipe 5 in a pressure sewer system may vary depending on the number of pumps operating at any one time and the consequent pipe friction. By maintaining a relatively constant flow, the positive displacement pump may ensure that a relatively consistent amount of sewage, such as the contents of a sewage storage tank 11,12,13,14, is pumped in a given time.

[0022] It should be appreciated that it is important that the pumps are highly reliable. This is because the pump systems may be installed on every property in a residential area, resulting in a high number of pumps, and the function of the pumps is essential to the habitability of the property. Accordingly, high reliability of the pumps avoids the need of expensive service calls and customer dissatisfaction. Helical rotor pumps may provide the necessary level of reliability.

[0023] The cutter 32 is connected inline with the pump and driven by the same motor, for example may be connected on a common drive shaft with the pump. The cutter may, in particular, be formed from a rotating serrated impeller, rotating in a stationary ring. The cutter may, in particular, have two hammers, which are configured to pull debris into the cutters.

[0024] The motor 31 driving the cutter 32 and pump 30, may, for example, be a single-phase 240 volt split phase motor with capacitor-start. The operation of the motor is controlled by a controller 33.

[0025] The controller 33 may, in particular, include a micro-controller 33a with appropriate dedicated software and hardware. The controller 33 may be connected to a level sensor 34 that is arranged to monitor the level of sewage in the sewage storage tank 35 associated with the pump system. Accordingly, the controller may commence operation of the pump system when the sewage level in the storage tank 35 exceeds a given level. Accordingly, given that the supply of waste from a typical domestic residence is infrequent, it is not necessary to

pump waste continuously from the storage tank, reducing the use of the pump, which may increase its useful life and reduce energy consumption.

[0026] The controller 33 may be configured to continue operation of the pump system once activated until the sewage level in the storage tank falls below a second given level as detected by the level sensor 34. Alternatively, the controller 33 may operate the pump system for a given period of time, preventing damage that may be caused to the motor, for example, by excessive heating generated during use.

[0027] In accordance with the present invention, the controller 33 also includes a current sensor 40 that measures the electric current drawn by the motor 31. The controller 33 may, accordingly, monitor the current drawn by the motor 31 in order to prevent damage to the pump system. For example, the controller may be set to stop the operation of the motor if the electric current measured by the current sensor 40 exceeds a given level. This may correspond to the pressure in the discharge pipe 5, which corresponds to the backpressure exerted on the pump 30, exceeding a given level. Preventing operation of the motor in these circumstances may prevent damage to the pump caused by excessive backpressure and/or damage to the motor caused by excessive loading.

[0028] Excessive current drawn by the electric motor 31 may also be indicative of a blockage in the cutter 32 and/or the pump 30. Accordingly, the controller 33 may also be configured to reverse the direction of the motor if an excessive current is detected by the current sensor 40. For example, the controller may reverse the motor by a predetermined amount such as a quarter turn of the motor. This may be sufficient to unblock the cutter 32 and/or the pump 30 without causing significant pumping in the reverse direction, which would be undesirable. Prior to reversing the motor, the controller may briefly pause the operation of the motor, for example for approximately 1 second. Once the motor has been reversed, the controller 33 may resume normal operation of the pump system. If the excessive current is still detected, the process may be repeated.

[0029] By detecting, for example, blockages of the cutter 32 and/or the pump 30, from the electrical current drawn by the motor 31, it is possible to take remedial action, namely stopping the operation of the motor and/or reversing it to unblock the blockage, very quickly. Accordingly, the motor may be protected from burning out.

[0030] In an advantageous arrangement, the controller 33 may be configured to provide a time delay after the operation of the motor has been stopped and/or after the motor has been reversed before normal operation of the pump system is resumed. This may be particularly beneficial if the motor has capacitor-start because repeated starting of the motor in a short period of time may result in damage of the capacitors. Furthermore, by delaying the resumption of normal operation of the pump system, the conditions of the discharge pipe 5 may have changed. For example, the number of other pump systems con-

nected to the discharge pipe 5 that are in operation may have changed. In particular, if the number of pumps systems connected to the discharge pipe 5 that are in operation reduces, the pressure within the discharge pipe 5 may decrease such that when the pump system in question resumes normal operation, the current drawn by the electric motor is below the threshold.

[0031] The controller 33 may monitor the number of times that the operation of the pump system is interrupted and/or the frequency of occurrence of such interruption. This may indicate a problem with the system. For example, if the frequency of the stoppages exceeds a certain level, it may indicate a blockage in the cutter 32 and/or the pump 30 that cannot be automatically unblocked. Accordingly, the pump system may be provided with an audible and/or visible alarm 43 that may be activated by the controller in such circumstances. The alarm 43 may be arranged to notify the residence of the house associated with the pump system of the problem in order that they may take remedial action. Alternatively or additionally, the alarm 43 may notify the provider of the pressure sewer system in order that they may take remedial action.

[0032] In the event that the pump system is subsequently able to unblock the cutter 32 and/or pump 30, for example such that the current drawn by the electric motor in operation falls to within acceptable limits and/or stoppages of the pump system cease, the alarm may be deactivated.

[0033] In addition to the controller 33 responding to a peak electric current, namely the current drawn by the motor 31 exceeding a given level, the controller may stop the operation of the motor and/or reverse it briefly, in response to other conditions. For example, if the current drawn by the electric motor remains above a second threshold, that is lower than the previously described threshold, for a significant period of time, the controller 33 may respond as above. The drawing of such a moderately increased current level by the motor may be indicative of a condition that may not result in damage to the pump system if it occurs relatively briefly but may damage the pump system if it occurs for a prolonged period of time. For example, prolonged usage at a moderately high current level may result in over-heating of the motor 31. Likewise, it may be indicative of a moderately high pressure within the discharge pipe 5. In the latter case it may be beneficial to suspend pumping of the sewage into the discharge pipe 5 until a later time, as discussed above, by which time the pressure in the discharge pipe 5 may have lowered. Such an arrangement may reduce the power consumption of the pump system. Furthermore, if each pump system connected to the discharge pipe 5 is arranged in this fashion, the overall pressure in the discharge pipe may be reduced, reducing the likelihood of leaks.

[0034] The controller 33 may also have a data store 41 that stores data relating to the current drawn by the motor 31. An output 42 may be provided for outputting the data. The output may be any suitable data output

means, for example a connection to the data store 41, providing a physical connection to be made between the data store 41 and a data reading device, enabling the data to be downloaded to the device. Alternatively, the output 42 may, for example, provide a wireless connection to such a data collection device which may be beneficial if access to the pump system is restricted. As a further example, the output 42 may provide a connection to a network, for example the internet, over which the data from the data store 41 may periodically be supplied.

[0035] The data stored may be any data that is useful. For example, the data may simply be the total number of times that the controller 33 has suspended the operation of the pump system due to the motor current exceeding one or both of the predetermined thresholds. It is to be appreciated that the stoppage counts may be separate for stoppages caused by the current exceeding the two different thresholds and/or a combined count. Likewise, it should be appreciated that the data store 41 may store the date and/or time of each of the stoppages and/or the time separation between the stoppages. Alternatively or additionally, the data store 41 may store the frequency with which the operation of the motor is stopped due to the current drawn by the motor exceeding one or both of the thresholds. Alternatively or additionally, the data store 41 may store a record of the current drawn by the motor. For example, the data may include a measurement of the current drawn by the motor at periodic intervals. It should be appreciated that the data may only record the current during the operation of the pump system. Alternatively or additionally, the data may relate to the total time that current has been drawn by the motor, namely the total time that the pumping system has been in operation.

[0036] The data recorded by the controller 33 may be used for a variety of reasons. For example, the data may be used to schedule maintenance of the pump system. Alternatively or additionally, the data may be used to schedule replacement of part or all of the pump system, for example the pump and/or the motor may be replaced after a given number of hours of operation in order to ensure reliability. Alternatively or additionally, the data may be used to monitor the overall use of the pressure sewage system. Alternatively or additionally, the data may be used for faultfinding.

Claims

1. A pump system for use in a pressure sewer system, comprising:
 - a pump;
 - a cutter; and
 - an electric motor configured to drive the pump and the cutter;
 - wherein the pump system further comprises:
 - a current sensor configured to measure the elec-

- tric current provided to the motor; and a controller that is configured to monitor the electric current measured by the current sensor during operation of the pump system and, if the measured electric current exceeds a predetermined threshold, stop the operation of the motor.
2. A pump system according to claim 1, wherein the controller is further configured to at least one of reverse the motor by a predetermined amount after stopping the motor due to the electric current exceeding said predetermined threshold, and re-start the motor after a predetermined delay.
 3. A pump system according to claim 1 or 2, wherein the pump system further comprises an audible and/or visible alarm; the controller is further configured to monitor the frequency with which it stops the operation of the motor due to the electric current exceeding said predetermined threshold; if the controller stops the operation of the motor more than a predetermined number of times in a given time period, the controller activates said alarm; and the controller is optionally configured such that, if after the alarm has been activated, the motor is re-started and the current provided to the electric motor does not exceed said predetermined level, the alarm is deactivated.
 4. A pump system according to any one of the preceding claims, wherein the controller is configured such that; if the measured electric current exceeds a second predetermined threshold, lower than the first predetermined threshold, for a predetermined period of time, the controller stops the operation of the motor for a second predetermined period of time.
 5. A pump system according to any one of the preceding claims, wherein the controller further comprises a memory configured to store data relating to the electric current provided to the motor; the pump system further comprises a data output for outputting the data stored in the memory; and, optionally, the memory stores at least one of the total number of times the controller has stopped the operation of the motor due to the electric current exceeding at least one of said predetermined threshold and said second predetermined threshold; the frequency with which the controller has stopped the operation of the motor due to the electric current exceeding at least one of said predetermined threshold and said second predetermined threshold; the total time that current is provided to the motor; and a record of the current supplied to the motor over time.
 6. A pump system according to any one of the preceding claims, wherein at least one of the pump is a positive displacement pump, the cutter comprises a rotating serrated impeller, and the motor is a single-phase motor with capacitor-start.
 7. A pressure sewer system, comprising:
 - a sewage pipe for conveying sewage under pressure;
 - at least one sewage store tank; and
 - a pump system according to any one of the preceding claims, configured to pump sewage from said sewage store tank into said sewage pipe.
 8. A pump system according to claim 7, further comprising a level sensor system, configured to determine the sewage level in the sewage store tank; wherein the controller of the pump system is further configured to start operation of the motor when the sewage level in the sewage store tank exceeds a predetermined level.
 9. A pump system according to claim 7 or 8, wherein the controller of the pump system is configured to stop the operation of the motor if at least one of the sewage level in the sewage store tank drops below a second predetermined level, and a predetermined time has elapsed.
 10. A method of controlling a pump system for use in a pressure sewer system, said pump system comprising a pump, a cutter and an electric motor configured to drive the pump and the cutter; and the method comprising:
 - measuring the electric current provided to the motor during operation of the pump system and, if the measured electric current exceeds a predetermined threshold, stopping the operation of the motor.
 11. A method according to claim 10, further comprising at least one of reversing the motor by a predetermined amount after stopping the motor due to the electric current exceeding said predetermined threshold, and re-starting the motor after a predetermined delay.
 12. A method according to claim 10 or 11, further comprising monitoring the frequency with which the operation of the motor is stopped due to the electric current exceeding said predetermined threshold; and if the operation of the motor is stopped more than a predetermined number of times in a given time period, activating an audible and/or visible alarm.
 13. A method according to claim 12, wherein, if after the alarm has been activated, the motor is re-started and

the current provided to the electric motor does not exceed said predetermined level, the alarm is deactivated.

14. A method according to any one of claims 10 to 13, wherein, if the measured electric current exceeds a second predetermined threshold, lower than first predetermined threshold, for a predetermined period of time, operation of the motor is stopped for a second predetermined period of time. 5 10
15. A method according to any one of claims 10 to 14, further comprising storing data, relating to the electric current provided to the motor, in memory and, optionally, the memory stores at least one of the total number of times the controller has stopped the operation of the motor due to the electric current exceeding at least one of said predetermined threshold and said second predetermined threshold; the frequency with which the controller has stopped the operation of the motor due to the electric current exceeding at least one of said predetermined threshold and said second predetermined threshold; the total time that current is provided to the motor; and a record of the current supplied to the motor over time. 15 20 25

30

35

40

45

50

55

Fig 1

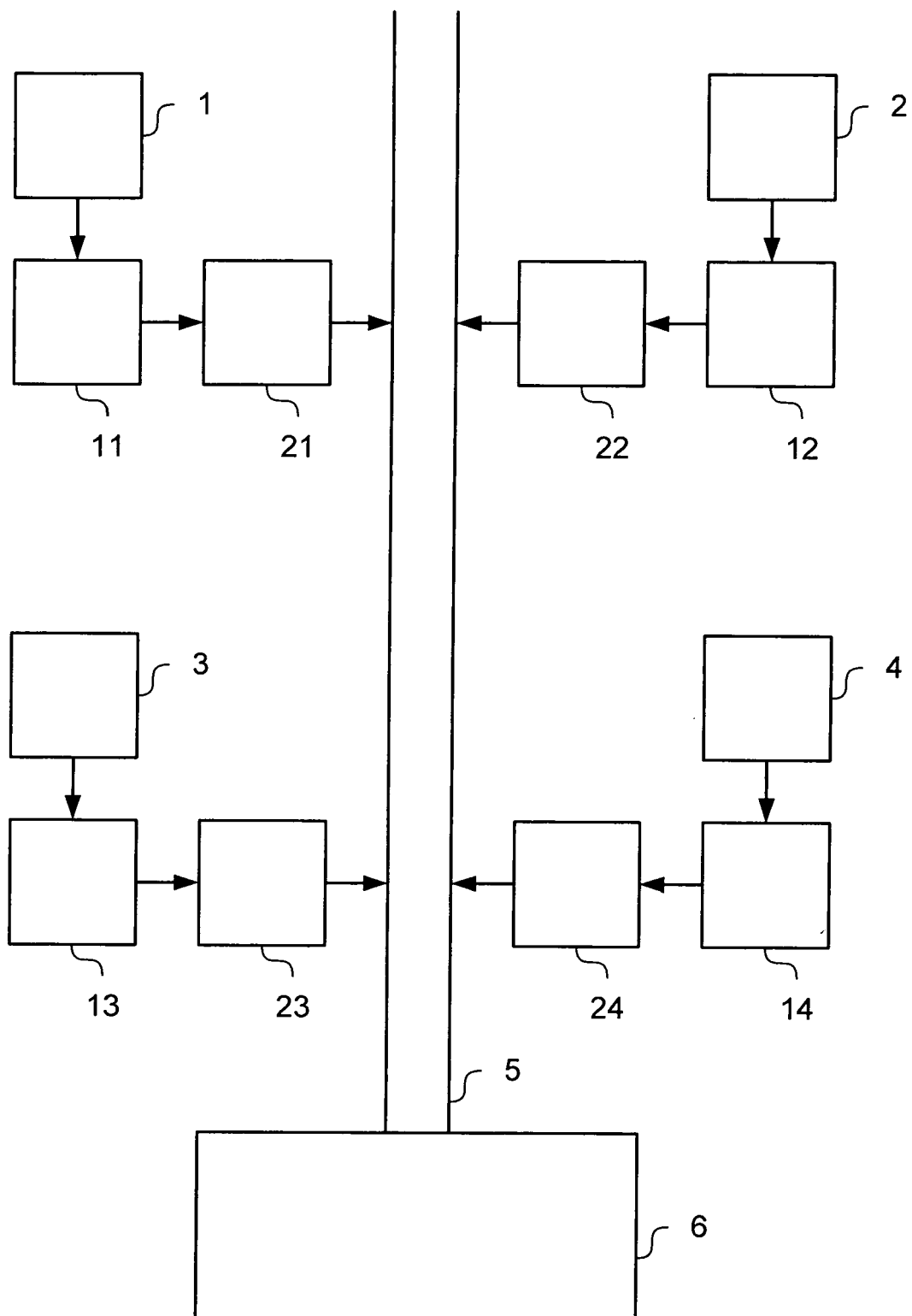


Fig 2

