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(54) **WATER DISTRIBUTION NETWORK**

(57) In a water distribution network (1) a rapid change in velocity of water produces a transient surge or pressure spike, which travels as a wave along the pipes (3) of the network. Such a change can be provoked by starting or stopping a pump (7). In a water distribution network (1) having at least one pump (7) for distributing water over the network, the pump (7) is driven by an electric motor (8) and a variable speed device (9), and means (10) for operating the pump in phases. On starting the pump in a first starting phase (20) the pump speed rises rapidly from zero to a threshold speed between zero and a maximum pump speed, in a second starting phase (22) the threshold speed is maintained, in a third starting phase (24) the pump speed is increased more slowly to a maximum speed, and in a fourth operating phase (26) the maximum speed is maintained. On stopping the pump (7), in a first stopping phase (28) the pump speed decreases gradually from a maximum speed to an intermediate speed, and in a second stopping phase (30) the pump speed decreases rapidly from the intermediate speed to zero.

imum pump speed, in a second starting phase (22) the threshold speed is maintained, in a third starting phase (24) the pump speed is increased more slowly to a maximum speed, and in a fourth operating phase (26) the maximum speed is maintained. On stopping the pump (7), in a first stopping phase (28) the pump speed decreases gradually from a maximum speed to an intermediate speed, and in a second stopping phase (30) the pump speed decreases rapidly from the intermediate speed to zero.

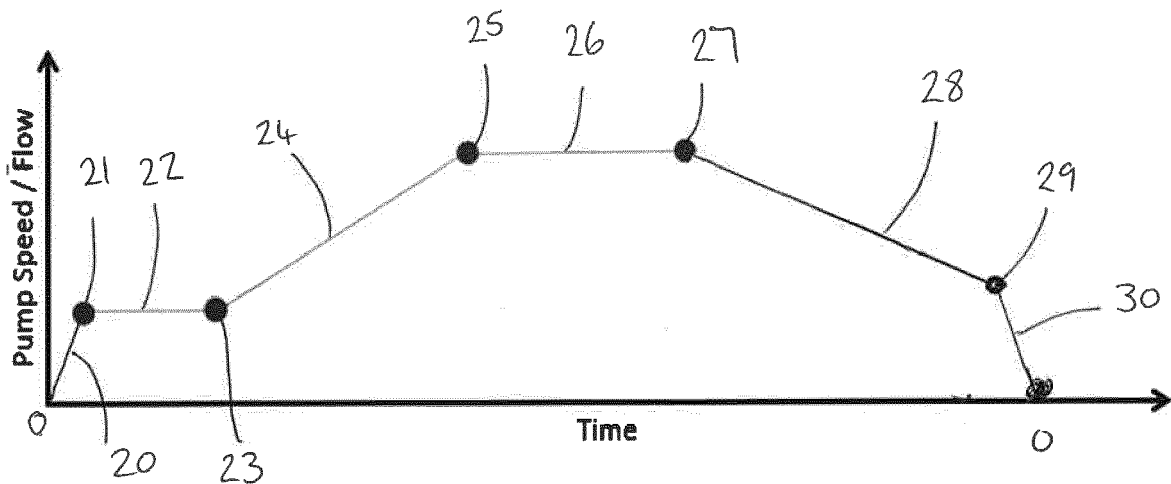


FIG. 4

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## Description

**[0001]** This invention relates to control of pressure in a water distribution network.

**[0002]** Water distribution networks supply water from a treatment works to the eventual consumers, domestic or commercial, through pipes of decreasing diameter. The flow of water across the network is controlled by pumps and valves. Pumps are typically provided at pumping stations and operate at varying pressures and flow rates to move water through the different diameter pipes. There are generally two types of pump; transfer pumps which move large volumes of water, and level of service pumps, which operate to keep a given pressure in a part of the network. Each pump delivers water through a non-return valve which opens at a given pressure differential across it and closes at a given flow through it. It is well known that a rapid change in velocity of water in such a network produces a transient surge or pressure spike, which travels as a wave along the pipes. Such a change can be provoked by starting or stopping a pump, or a rapid change in flow through a pump as it changes speeds, or the opening or closing of a valve. For example, when a pump starts, static water from a supply pipe is drawn quickly into the suction side, causing an initial drop in pressure. The body of water in the supply pipe begins flowing, but the drop in pressure produces a pressure wave which dissipates over a period of time as the flow system equilibrium is achieved. The opposite will happen on the delivery side of the pump, where the body of water adjacent to the pump is static. A sudden input of water at high pressure from the pump will start to move the static body of water. This causes an initial pressure increase, causing a pressure wave which dissipates over a period of time as the flow system equilibrium is achieved. When the pump stops, there is an even bigger effect, because of the energy in the flow. On stopping, the water in the supply pipe is forced to stop, and a region of high pressure builds up behind the pump and a region of low pressure in front of it. The non-return valve closes at a given flow rate. The momentum of the water is transferred to the pump, and a reaction force is generated, forming an oscillating pressure wave travelling along the pipe. The pressure waves are transient, but travel through the network, causing vibration and leading to damage to pipes and pumps. While the existence of these pressure spikes has been known for many years, it is only recently that high speed pressure loggers have become available to measure the pressures involved over a short period of time. It is known to use pressure reduction vessels in the network to dissipate these pressure spikes, but these may not be adequate, as they do not react sufficiently quickly to dissipate the surge or spike fully. They also are extra components, requiring installation and maintenance.

**[0003]** The pumps are driven by electric motors. Older centrifugal pumps usually operate at a constant speed, but modern pumps are typically centrifugal pumps, con-

trolled by variable speed devices, and which can be set to operate at an optimum or varying speed for the requirement of the installation. Centrifugal pumps on starting are driven by the motor up to the optimum speed quickly, in order to maintain lubrication of the pump to minimise damage. Conversely, on stopping, the pump is controlled to decrease from the optimum speed to zero quickly, also to maintain lubrication to avoid damage. This is the case even though it is possible to control the motor speed in order to protect it and save energy. It has been found that as long as the pump comes up to a threshold speed or decreased from an intermediate speed quickly, damage to the pump is avoided but some control of pump speed, and thus fluid flow and pressure is possible.

**[0004]** According to a first aspect of the invention, in a water distribution network having at least one pump device for distributing water over the network, the pump device comprises a pump driven by an electric motor and a variable speed device, and means for operating the pump in phases, such that on starting the pump in a first starting phase the pump speed rises rapidly from zero to a threshold speed between zero and a maximum pump speed, in a second starting phase the threshold speed is maintained, in a third starting phase the pump speed is increased more slowly to a maximum speed, and in a fourth operating phase the maximum speed is maintained.

**[0005]** This operation means that in the first starting phase the pump is not damaged as it starts rapidly, but only a small surge or pressure spike is generated because of the lower threshold speed. In the second starting phase the flow and pressure from the surge in the first phase can settle, and in the third starting phase the gradual increase in speed does not create a pressure spike. There is no damage to the pump caused by the gradual increase as the water is flowing. In the fourth operating phase the pump operates as normal to supply the water. It has been found that this phased operation substantially eliminates surges and pressure spikes, so it is not necessary to allow for their dissipation by including expansion vessels.

**[0006]** The increase of pump speed in the third phase may include stages of increase and maintained speed until the maximum speed is reached. This assists further in preventing pressure spikes.

**[0007]** According to a second aspect of the invention, in a water distribution network having at least one pump device for distributing water over the network, the pump device comprises a pump driven by an electric motor and a variable speed device, and means for operating the pump in phases such that on stopping the pump, in a first stopping phase the pump speed decreases gradually from a maximum speed to an intermediate speed, and in a second stopping phase the pump speed decreases rapidly from the intermediate speed to zero.

**[0008]** The gradual decrease in the first stopping phase means that pressure spikes are avoided. The rapid de-

crease in the second stopping phase avoids damage to the pump as it maintains the lubrication, but limits the creation of pressure spikes because the reduced flow at the beginning of the second stopping phase means that the energy in the flow is reduced.

**[0009]** Further phases may be included, such that the intermediate speed is maintained in a third stopping phase, before the second stopping phase of rapid decrease to zero. The intermediate speed may be the same as the threshold speed. The third stopping phase may also include stages of maintained speed and decrease.

**[0010]** It will be appreciated that the first and second aspects of the invention may be combined. For each aspect the pump operating means conveniently comprises a microprocessor means, such as a programmable logic circuit, used to control the variable speed device to control the electric motor. The use of a programmable logic circuit has the advantage that the phases and speeds can be changed if requirements alter, or set up easily to accommodate different pumps. The programmable logic circuit may be separate from the pump or provided as a component of the pump.

**[0011]** The variable speed device preferably includes an inverter used to control the frequency and voltage supplied to the electric motor according to the demand in the system. The inverter is connected to the non-return valve for the pump. The non-return valve opens after the pump starts, having an open point at which it cracks open to allow flow. It then opens fully. The non-return valve has a close point at a given flow as the pump stops. The points at which the non-return valve opens and closes may be used to determine the transitions between the starting or stopping phases.

**[0012]** For example, on pump starting, the open point of the non-return valve can determine the end of the first starting phase. The open point may be determined empirically for each pump in its particular location, and the programmable logic circuit programmed according to the speed of the pump at the open point, that is, the threshold speed. The length of the second and third starting phases may also be determined empirically. The length of the fourth operating phase will depend on the demand for water in the network.

**[0013]** On pump stopping, the close position of the non-return valve may be used to determine a change in the rate of decrease at the intermediate speed, or to trigger the next phase.

**[0014]** Conveniently, a pressure sensor is provided on each side of the non-return valve. The pressure sensors are connected to the pump operating means to indicate when the non-return valve is about to open, that is, when there is the predetermined pressure differential across the valve. This enables the pump operating means to determine the pump speed at the open position automatically, thus taking differing conditions into account.

**[0015]** The pressure sensors cannot be used to measure the close point of the non-return valve because that depends on flow through the valve rather than pressure

across it. It is then assumed that the close point is at the same pump speed as the open point, and the decrease in pump speed can be determined as described above.

**[0016]** Embodiments of the aspects of the invention are described, by way of example only, in the accompanying drawings, in which:

Figure 1 is a schematic diagram showing the main components of a water distribution network;

Figure 2 is a schematic diagram of a pump device and associated components for use in the network of Figure 1;

Figure 3 is a graph of pump speed against time for a standard mode of operation;

Figure 4 is a graph of pump speed against time illustrating the first and second aspects of the invention; and

Figure 5 is similar to Figure 4, but shows a variation in the second aspect of the invention.

**[0017]** The water distribution network 1 of Figure 1 comprises a source 2 such as a water treatment works, from which potable water is supplied through pipes 3 of decreasing diameter to supply individual domestic or commercial consumers 4. The water is pumped across the network 1, which includes intermediate storage devices 5 between the source 2 and the consumers 4. The storage devices are known as service reservoirs, and may be of different types and sizes, according to the requirements of the network. Pumping stations 6 are located across the network 1 to control the flow of water, by means of pumps and valves. The pumps operate at varying pressures and flow rates to move water through the different diameter pipes. There are generally two types of pump; transfer pumps which move large volumes of water, and level of service pumps, which operate to keep a given pressure in a part of the network. Each pump delivers water through a non-return valve to prevent flow back through the pump. A typical pumping station 6 is shown diagrammatically in Figure 2.

**[0018]** The pumping station 6 shown in Figure 2 includes a pump device 7, operated by an electric motor 8 controlled by a variable speed drive 9 in turn controlled by an operating means 10. The pump device 7 comprises a centrifugal pump. The variable speed drive 9 includes an inverter, and the operating circuit means 10 comprises a programmable microprocessor such as a programmable logic circuit. A non-return valve 11 is provided in the pipe 3 downstream of the pump 7 to prevent flow back through the pump 7. The non-return valve 11 opens at a given pressure differential across it and closes at a given flow through it. As shown, a pressure sensor 12 is provided on each side of the non-return valve 11. The pressure sensors 12 are connected to the microprocessor 10 to provide input signals. As will be explained below, the pressure sensors 12 may be omitted.

**[0019]** Figure 3 shows a standard mode of operation of a pump 7 with the arrangement shown in Figure 2. The

operating means 10 is programmed such that centrifugal pump 7 on starting is driven by the motor 8 from zero speed to its optimum or maximum speed at point 15 quickly, to maintain lubrication of the pump 7 to avoid damage to it. It is then maintained at the optimum or maximum speed for the required time, according to demand, up to point 16. Then the speed is reduced quickly from point 16 to zero, when demand is satisfied. Starting and stopping the pump 7 in this way each creates a pressure spike, as explained above. The figure also shows a different rate of increase and decrease of the pump speed on starting and stopping. On starting the pump speed increases from zero to optimum or maximum speed at point 15' more slowly, and on stopping the pump speed is reduced more slowly from point 16' to zero. This configuration reduces the creation of surges or pressure spikes, but increases the risk of damage to the pump, as it is more difficult to maintain lubrication. It is difficult to find a compromise satisfying both requirements.

**[0020]** Figure 4 shows operation of the pump 7 according to the invention. The microprocessor 10 is programmed such that on starting the pump 7 there is a first starting phase 20 of operation in which the pump 7 is driven quickly from zero to a threshold speed at point 21. The threshold speed is less than the optimum or maximum speed but is chosen to ensure that lubrication of the pump 7 is maintained to avoid damage. In practice it has been found that a threshold speed of about 40% of the maximum is appropriate, but it will be appreciated that this will depend on the pump. In a second starting phase 22 the pump 7 is maintained at the threshold speed to point 23, and then in a third starting phase 24 the pump speed rises slowly up to the optimum or maximum speed at point 25. In an operating phase 26 the pump 7 is then maintained at the optimum or maximum speed for the required time. This illustrates the first aspect of the invention. It has been found that this operation substantially reduces and even eliminates the pressure spike, as the initial rapid rise in pump speed in the first phase 20 is smaller and the pressure is then allowed to settle at the threshold speed in the second phase 22.

**[0021]** In the third phase 24 the slower rise in speed to the optimum or maximum speed does not create a pressure spike. There is no risk of damage to the pump 7 as the water is flowing and maintaining lubrication of the pump. This method of operation does not affect the volume of water pumped to any significant extent.

**[0022]** Figure 4 also shows the second aspect of the invention, on stopping the pump 7 at the end of the operating phase 26. Instead of stopping quickly, the microprocessor 10 is programmed to reduce the pump speed slowly in first and second stopping phases 28 and 30 from the optimum or maximum speed at point 27 down to zero. In the first stopping phase 28 the pump speed decreases slowly from the optimum or maximum speed at point 27 to an intermediate speed at point 29. In a second stopping phase 30 the pump speed is decreased rapidly to zero. It has been found that this operation sub-

stantially reduces and even eliminates the pressure spike, as the initial gradual decrease in pump speed in the first phase 28 decreases the flow slowly, avoiding a surge or spike. The rapid decrease in the second phase 30 means that the lubrication of the pump is maintained so that it is not susceptible to damage.

**[0023]** Figure 5 shows a modification of the second aspect of the invention. The first aspect is the same as in Figure 4, and corresponding reference numerals have been applied to corresponding parts. Thus, on stopping the pump 7 at the end of phase 26, the microprocessor 10 is programmed to provide three stopping phases. A first stopping phase 31 decreases the pump speed from the optimum or maximum speed at point 27 to an intermediate speed at point 32. The decrease in the first stopping phase 31 is relatively slow. In a second stopping phase 33 the intermediate speed is maintained to point 34, and in a third stopping phase 35 the pump speed is reduced to zero. The point 34 is the same as the point 29 of Figure 4, and the third stopping phase 35 is the same as the second stopping phase 30 of Figure 4. The slow decrease in the first stopping phase 31 ensures that there is only a small risk of a pressure spike being generated, and the constant speed second stopping phase 32 allows the pressure to settle. Although the third stopping phase 34 provides a rapid decrease in speed, the reduced flow through the pump 7 means that the risk of a pressure spike is substantially reduced.

**[0024]** In Figures 4 and 5 it will be noted that the intermediate speed at points 29 and 31 is slightly higher than the threshold speed of the second starting phase 22. The intermediate speed will be chosen according to the needs of the pump, and may be higher than, lower than or equal to the threshold speed. The rates of increase and decrease will also be chosen according to the characteristics of the pump 7.

**[0025]** It will be appreciated that the use of a programmable logic circuit as the operating means 10 has the advantage that the speeds and phase lengths can be changed if requirements alter. A programmable logic circuit can also be set up easily to accommodate different pumps 7.

**[0026]** The non-return valve 11 may be used in the setting up of the operating means 10. The non-return valve 11 cracks open to allow flow at a predetermined pressure differential across the valve, determined by the force in a spring (not shown), and then opens fully. The non-return valve 11 closes when the flow through it falls to a given level, equivalent to a pump speed. The point at which the non-return valve 11 cracks open (the open point) and closes (the close point) may be used to determine the transitions between the starting phases and/or the stopping phases.

**[0027]** Thus, on pump starting, the open point of the non-return valve 11 can determine the end of the first phase 20. The open point may be determined empirically for each pump 7 in its particular location in the network 1, and the programmable logic circuit programmed for

the threshold speed according to the pump speed at the open point.

**[0028]** On pump stopping, the close position of the non-return valve 11 may determine the intermediate speed for the transition between the first and second stopping phases.

**[0029]** The length of the various phases will also be determined empirically.

**[0030]** Figure 2 shows a pressure sensor 12 on each side of the non-return valve 11, each sensor 12 being connected to the operating means 10 to provide input signals. The pressure sensors 12 indicate when the non-return valve 11 is about to open, that is, when the predetermined pressure differential is reached. The operating means 10 can then be programmed to use the signals to determine automatically the pump speed at the open point of the non-return valve 11, and to use this as the threshold speed. Differing conditions can then be taken into account, and any changes in the pump characteristics.

**[0031]** As explained above, the pressure sensors 12 cannot indicate the close point of the non-return valve 11. The operating means 10 may then be programmed to take the threshold speed of the second starting phases 22 as the intermediate speed for the second stopping phase 32, or a given amount above or below that speed.

### Claims

1. A water distribution network (1) having at least one pump device for distributing water over the network, the pump device comprising a pump (7) driven by an electric motor (8) and a variable speed device (9), and means (10) for operating the pump in phases, such that on starting the pump (7) in a first starting phase (20) the pump speed rises rapidly from zero to a threshold speed between zero and a maximum pump speed, in a second starting phase (22) the threshold speed is maintained, in a third starting phase (24) the pump speed is increased more slowly to a maximum speed, and in a fourth operating phase (26) the maximum speed is maintained.
2. A water distribution network as claimed in claim 1, in which the increase of pump speed in the third starting phase (24) includes stages of increase and maintained speed until the maximum speed is reached.
3. A water distribution network (1) having at least one pump device for distributing water over the network, the pump device comprising a pump (7) driven by an electric motor (8) and a variable speed device (9), and means (10) for operating the pump in phases such that on stopping the pump (7), in a first stopping phase (28) the pump speed decreases gradually from a maximum speed to an intermediate speed, and in a second stopping phase (30) the pump speed decreases rapidly from the intermediate speed to zero.
4. A water distribution network as claimed in claim 3, in which at least one further phase is included, such that the intermediate speed is maintained in a third stopping phase (33), before the second stopping phase (30) of rapid decrease to zero.
5. A water distribution network as claimed in claim 4, in which the third stopping phase (33) includes stages of maintained speed and decrease.
6. A water distribution network as claimed in claim 1 and claim 3, in which the intermediate speed is the same as the threshold speed.
7. A water distribution network as claimed in any preceding claim, in which the pump operating means (10) comprises a microprocessor means, such as a programmable logic circuit, used to control the variable speed device (9) to control the electric motor (8).
8. A water distribution network as claimed in claim 7, in which the programmable logic circuit is separate from the pump (7) or provided as a component of the pump (7).
9. A water distribution network as claimed in any preceding claim, in which the variable speed device (9) includes an inverter used to control the frequency and voltage supplied to the electric motor (9) according to the demand in the system.
10. A water distribution network as claimed in claim 9, in which the inverter is connected to a non-return valve (11) for the pump (7).
11. A water distribution network as claimed in claim 10, in which the points at which the non-return valve (11) opens and closes are used to determine the transitions between the starting or stopping phases.
12. A water distribution network as claimed in claim 11, in which on pump starting, the open point of the non-return valve (11) determines the end of the first starting phase (20).
13. A water distribution network as claimed in claim 11, in which on pump stopping, the close position of the non-return valve (11) determines a change in the rate of decrease at the intermediate speed.
14. A water distribution network as claimed in any of claims 10 to 13, in which a pressure sensor (12) is provided on each side of the non-return valve (11).

15. A water distribution network as claimed in claim 14, in which the pressure sensors (12) are connected to the pump operating means (10) to indicate when the non-return valve (11) is about to open.

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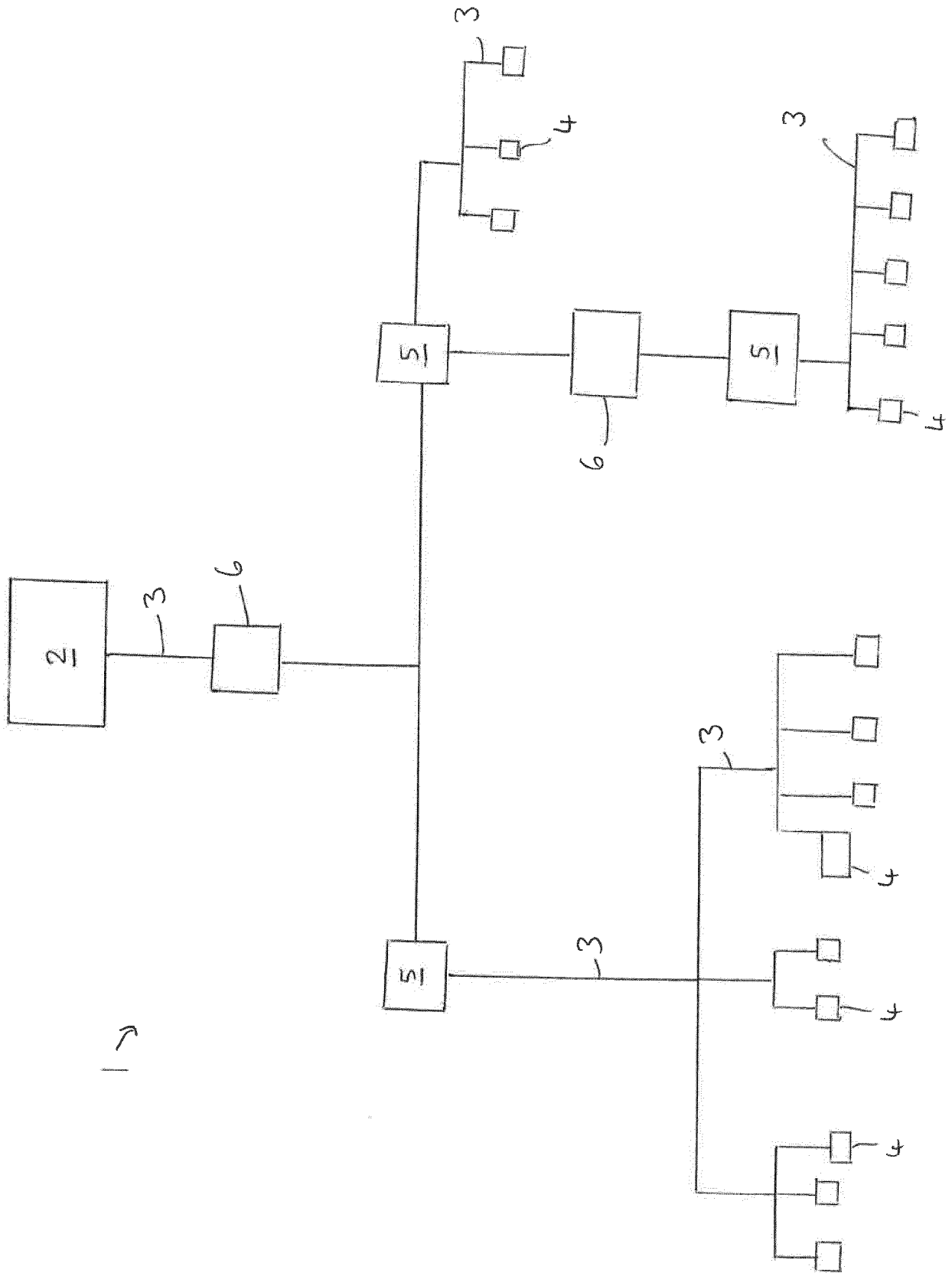
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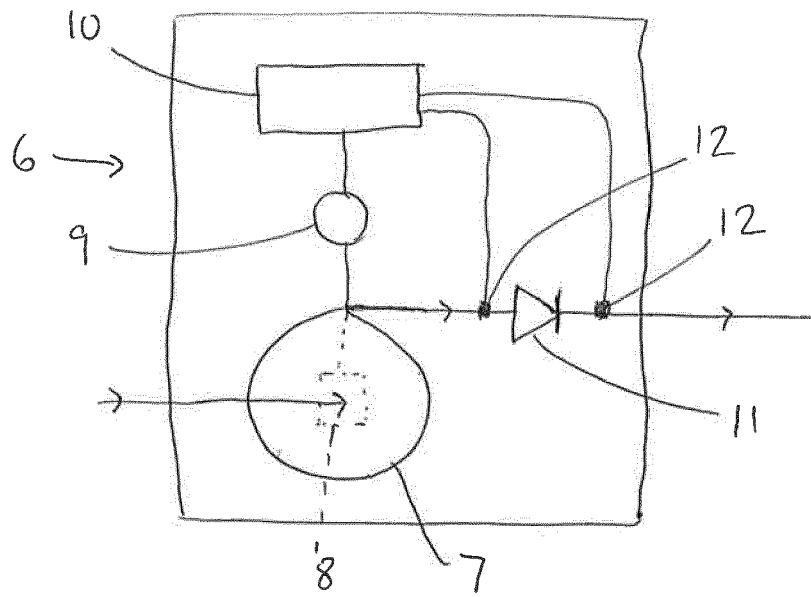


FIG 2

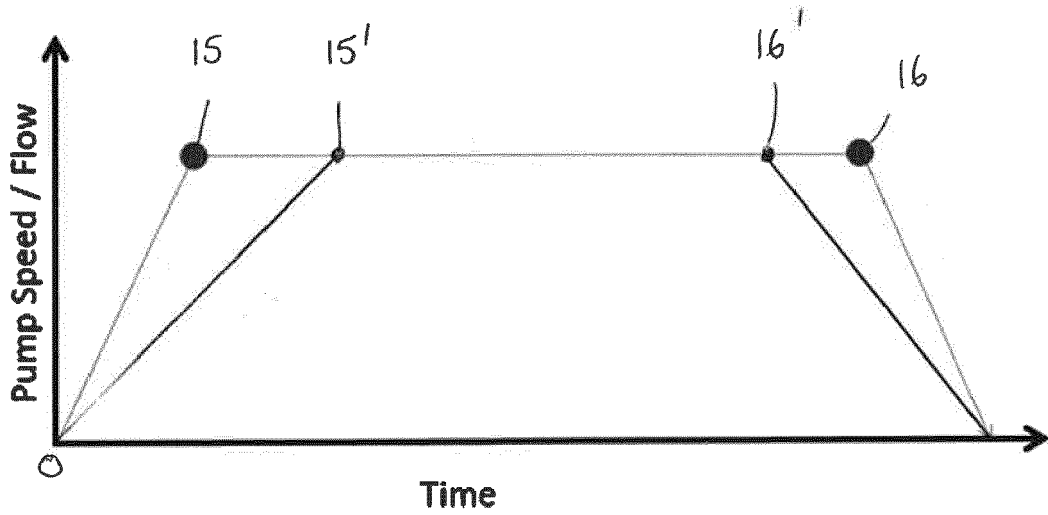


FIG 3

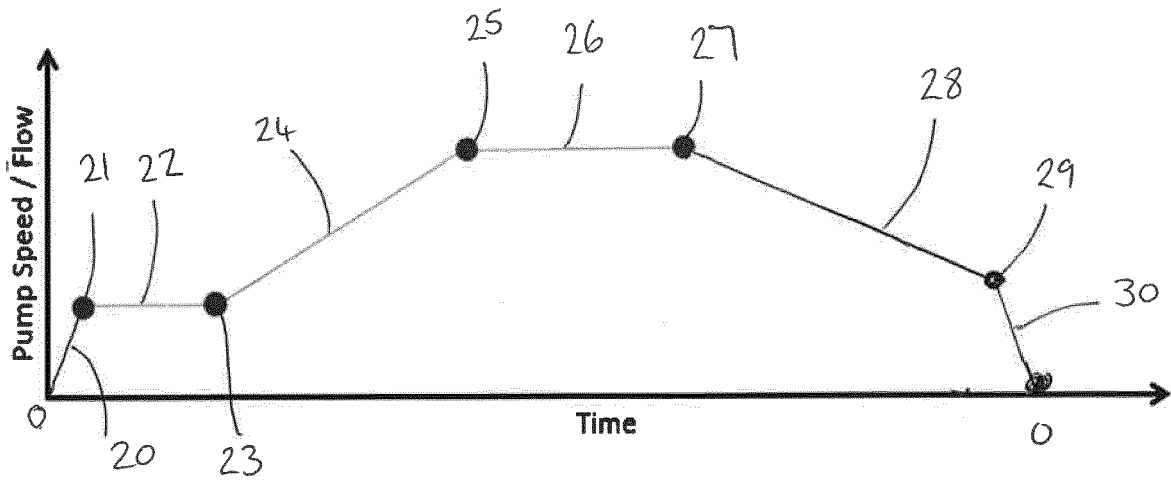


FIG. 4

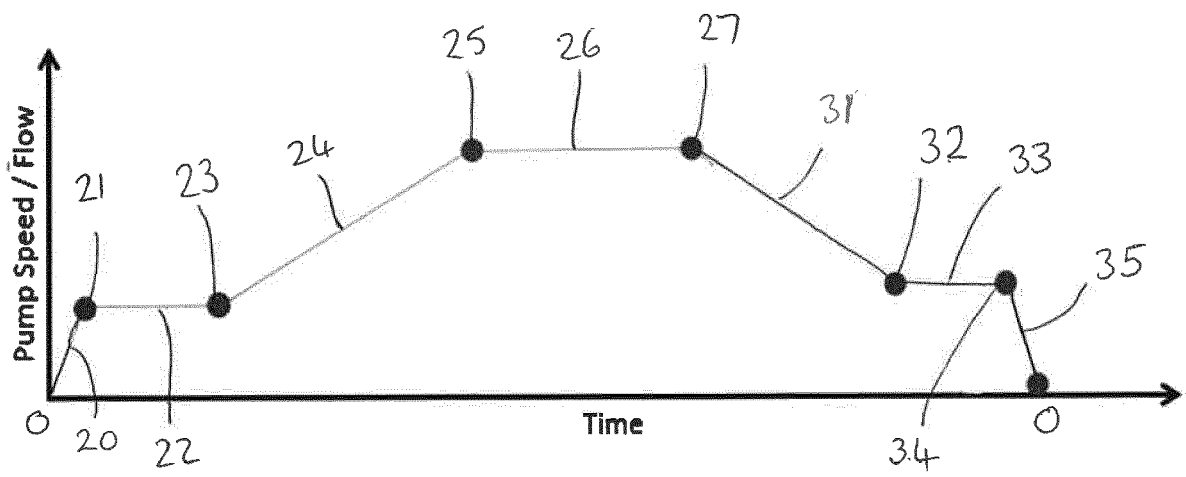


FIG. 5



EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2007/248468 A1 (HOLMBERG MIKAEL [FI]) 25 October 2007 (2007-10-25) * figures 3,4 * * paragraph [0002] * * paragraph [0047] - paragraph [0048] * * paragraph [0056] *	1-15	INV. E03B5/00 E03B7/07 F04B49/06 F04D15/00
X	US 2017/138363 A1 (LARSSON MARTIN [SE] ET AL) 18 May 2017 (2017-05-18) * figures 1,2 * * paragraph [0002] - paragraph [0005] * * paragraph [0021] - paragraph [0024] * * paragraph [0034] *	1-15	
X	JP S56 69486 A (EBARA MFG) 10 June 1981 (1981-06-10) * the whole document *	1-15	
X	US 2005/123408 A1 (KOEHL ROBERT M [US]) 9 June 2005 (2005-06-09) * figure 1 * * paragraph [0026] - paragraph [0030] * * paragraph [0062] - paragraph [0075] *	1-15	TECHNICAL FIELDS SEARCHED (IPC) E03B F04D F04B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 10 December 2018	Examiner Châtellier, Xavier
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.

EP 18 20 1170

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The members are as contained in the European Patent Office EDP file on  
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10-12-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007248468 A1	25-10-2007	EP 1847714 A1 US 2007248468 A1	24-10-2007 25-10-2007
-----			
US 2017138363 A1	18-05-2017	AU 2015275758 A1 BR 112016029430 A2 CA 2952827 A1 CN 106460854 A EP 3158201 A1 JP 6389532 B2 JP 2017518462 A KR 20170019434 A MA 39567 A1 PH 12016502425 A1 SE 1450756 A1 SG 11201610485V A US 2017138363 A1 WO 2015193784 A1	02-02-2017 22-08-2017 23-12-2015 22-02-2017 26-04-2017 12-09-2018 06-07-2017 21-02-2017 29-06-2018 27-02-2017 18-12-2015 27-01-2017 18-05-2017 23-12-2015
-----			
JP S5669486 A	10-06-1981	JP S5669486 A JP S6253717 B2	10-06-1981 11-11-1987
-----			
US 2005123408 A1	09-06-2005	CA 2548437 A1 CA 2731482 A1 US 2005123408 A1 US 2008063535 A1 US 2008131286 A1 US 2008131289 A1 US 2008131291 A1 US 2008131294 A1 US 2008131295 A1 US 2008131296 A1 US 2008140353 A1 US 2008181785 A1 US 2008181787 A1 US 2008181789 A1 US 2008260540 A1 US 2009104044 A1 US 2010141194 A1 US 2011181431 A1 US 2014334942 A1 US 2014334943 A1 US 2014334944 A1 US 2014334945 A1 US 2015005957 A1 US 2015211511 A1 US 2016334810 A1	23-06-2005 23-06-2005 09-06-2005 13-03-2008 05-06-2008 05-06-2008 05-06-2008 05-06-2008 05-06-2008 05-06-2008 05-06-2008 12-06-2008 31-07-2008 31-07-2008 31-07-2008 23-10-2008 23-04-2009 10-06-2010 28-07-2011 13-11-2014 13-11-2014 13-11-2014 13-11-2014 01-01-2015 30-07-2015 17-11-2016

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ON EUROPEAN PATENT APPLICATION NO.**

EP 18 20 1170

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		WO 2005055694 A2	23-06-2005

15

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25

30

35

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45

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