(19) DANMARK

(10) **DK/EP 3083032 T3**

Patent- og
Varemærkestyrelsen

(12) Oversættelse af
europæisk patentskrift

(51) Int.Cl.: ***B 01 J 19/00 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2020-10-26**

(80) Dato for Den Europæiske Patentmyndigheds
bekendtgørelse om meddelelse af patentet: **2020-08-05**

(86) Europæisk ansøgning nr.: **14821573.4**

(86) Europæisk indleveringsdag: **2014-12-16**

(87) Den europæiske ansøgnings publiceringsdag: **2016-10-26**

(86) International ansøgning nr.: **EP2014077953**

(87) Internationalt publikationsnr.: **WO2015091474**

(30) Prioritet: **2013-12-20 DE 102013114720**

(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**

(73) Patenthaver: **Bayer Aktiengesellschaft, Kaiser-Wilhelm-Allee 1, 51373 Leverkusen, Tyskland**

(72) Opfinder: **KÜPPER, Achim, Paul-Klee Str. 68h, 51375 Leverkusen, Tyskland**
OCHS, Stefan, Böckingstr. 66, 51063 Köln, Tyskland

(74) Fuldmægtig i Danmark: **RWS Group, Europa House, Chiltern Park, Chiltern Hill, Chalfont St Peter, Bucks SL9 9FG, Storbritannien**

(54) Benævnelse: **FREMGANGSMÅDE TIL DRIFT AF ET MODULÆRT OPBYGGET PRODUKTIONSANLÆG**

(56) Fremdragne publikationer:
EP-A2- 1 932 828
WO-A1-2014/072340
DE-A1- 19 917 398
US-A- 4 332 590
US-A1- 2012 107 175

Description

The work which led to this invention was sponsored by grant agreement no. 228867 as part of the European Union's seventh framework programme RP7/2007-2013.

The invention relates to a method for operating a production plant for the production of a chemical and/or pharmaceutical product, having process modules which are connected to one another for production purposes and are autonomous for regulating purposes.

The present invention also relates to a production plant for producing a chemical and/or pharmaceutical product.

In order to produce a particular chemical and/or pharmaceutical product, it is necessary to provide a production plant having an individual plant structure in order to be able to carry out the process steps respectively required in terms of process engineering in individual process sections. If there is no longer a desire to produce this particular product, the production plant is usually dismantled again in order to be able to construct another production plant having an individual plant structure, which can be used to produce another chemical and/or pharmaceutical product, at the same location. This construction and dismantling of production plants is very time-consuming and cost-intensive. There is therefore a constant need to reduce the amount of effort associated with the production of different chemical and/or pharmaceutical products.

The document EP 1 932 828 A2 describes a method for operating a process module within a production plant and the corresponding production plant. The mass inflow into the process module or mass outflow from the process module is increased or decreased if the amount of material that is present in this process module and is to be processed by this process module is less than or greater than a limit value for the amount. The document US 4 332 590 A describes a quite similar method for operating a process

module within a production plant and here too the corresponding production plant.

To avoid this problem, a production plant may be constructed in a modular manner from individual process modules which can be connected to one another for process purposes and are autonomous for regulating purposes. However, such production plants require novel regulating concepts, since regulating concepts that are used in conventional production plants are not readily transferable to production plants that are constructed in a modular manner from process modules which are autonomous for regulating purposes.

The object of the invention is to provide a regulating concept for a production plant for producing a chemical and/or pharmaceutical product having process modules which are connected to one another for production purposes and are autonomous for regulating purposes.

This object is achieved by a method with the features according to Patent Claim 1 and a production plant with the features according to Patent Claim 6. Preferred refinements of the invention are stated in the subclaims which may each constitute an aspect of the invention per se or in any desired combination with one another.

In Patent Claim 1, a method for operating a production plant for the production of a chemical and/or pharmaceutical product having process modules which are connected to one another for production purposes and are autonomous for regulating purposes is proposed, wherein for each process module the amount of material that is respectively present in this process module and is to be processed by this process module is continuously or discretely detected and compared with a prescribed limit value for the amount, wherein

- a mass inflow into the respective process module is increased or decreased if the amount of material that is

respectively present in this process module and is to be processed by this process module is less than or greater than the limit value for the amount, the mass inflow at the same time being a mass outflow of a further process module connected directly upstream of this process module for production purposes, or

- a mass outflow from the respective process module is increased or decreased if the amount of material that is respectively present in this process module and is to be processed by this process module is greater than or less than the limit value for the amount, the mass outflow at the same time being a mass inflow of a further process module connected directly downstream of this process module for production purposes. In the context of the invention, the terms "limit value for the amount" and "target value for the amount" can be used synonymously.

If a mass inflow into the respective process module is increased when the amount of material that is respectively present in this process module and is to be processed by this process module is less than the limit value for the amount, the mass inflow at the same time being a mass outflow of a further process module connected directly upstream of this process module for production purposes, the production plant or the process modules thereof operate(s) on the basis of a regulating concept known from production engineering, known as the pulling principle. If, on the other hand, a mass outflow from the respective process module is increased when the amount of material that is respectively present in this process module and is to be processed by this process module is greater than the limit value for the amount, the mass outflow at the same time being a mass inflow of a further process module connected directly downstream of this process module for production purposes, the production plant or the process modules thereof operate(s) on the basis of a regulating concept that is likewise known from production engineering, known as the pushing principle. Consequently, in the case of the pulling principle, the impulse for activity

originates from a process module respectively connected downstream of a process module, whereas, in the case of the pushing principle, the impulse for activity originates from a process module respectively connected upstream of a process module. It is essential to the invention that all of the process modules of a production plant operate uniformly on the basis of the pulling principle or the pushing principle. If not all of the process modules of a production plant were to operate uniformly on the basis of the pulling principle or the pushing principle, these process modules would work against one another. It is also not advisable to regulate an outflow of an upstream process module independently of an inflow of a process module connected downstream of the upstream process module.

The process modules which can be connected to one another for production purposes and are autonomous for regulating purposes may be designed as units which can be transported as a whole, can be transported to a desired production site at which a correspondingly equipped production plant of a modular construction is intended to be erected, and can be transported away from this site after the desired production has been concluded. This makes it possible to easily reuse individual process modules at different production sites in a manner that reduces production costs. For this purpose, a process module may have a housing which allows easy transport of the process module and in which at least one process assembly for carrying out the desired process section is arranged and the dimensioning thereof can be standardized.

At a production site, the process modules can be connected, preferably via standardized couplings, to a permanently installed communication network and to a supply network which can be used to supply the process modules with material and/or energy and/or into which materials can be delivered, with the result that at least one chemical batch reaction and/or continuous production can be carried out in a substantially autonomous manner using the process modules. The supply network can be used to transport, in particular, solid, liquid and/or

gaseous materials or mixtures of materials which may be present in single-phase or multi-phase form, for example as a suspension or emulsion. For example, the supply network may have a compressed air line for supplying compressed air, a feed water line for supplying water, an electrical line for supplying electrical energy, a materials line for supplying starting materials and/or auxiliary materials and/or for discharging products, by-products and/or waste materials, a cooling line for supplying cold or for dissipating heat and/or a heating line for supplying heat or for removing cold. Various wired or wireless communication networks come into consideration as the communication network. Standardized information interchange between the process modules connected to the communication network can be carried out via the communication network.

Additionally or alternatively, a material and/or energy store which can be connected to the supply network and/or a storage container for liquid, solid and/or gaseous materials may be provided inside the housing of a process module, with the result that chemical reactions can take place autonomously and independently of an external supply. The process modules may have, for example, functionalities for heating, cooling, mixing, separating, controlling the pressure, ventilating and/or venting which make it possible to carry out a chemical reaction and control reaction conditions.

According to an advantageous refinement, for detecting the amount of material that is respectively present in at least one of the process modules and is to be processed by this process module, a filling level in this process module is detected. This represents an easy possible way of detecting the amount of material that is respectively present in a process module and is to be processed by the process module by means of suitable filling level sensors. It is also possible to perform in each process module a detection of the amount of material that is present in the process module and is to be processed by this process module by means of detecting the filling level in the process module.

According to a further advantageous refinement, for detecting the amount of material that is respectively present in at least one of the process modules and is to be processed by this process module, a pressure in this process module is detected. This may be provided as an alternative to the last-mentioned refinement, or in addition to it to obtain redundant information. This refinement also represents an easy possible way of detecting the amount of material that is respectively present in a process module and is to be processed by the process module by means of suitable pressure sensors. It is also possible to perform in each process module a detection of the amount of material that is present in the process module and is to be processed by this process module by means of detecting the pressure in the process module.

Patent Claim 6 proposes a production plant for producing a chemical and/or pharmaceutical product, having at least two process modules which can be connected to one another for production purposes and are autonomous for regulating purposes, wherein each process module has an electronic device of its own, in particular a control and/or regulating device, which is set up to detect continuously or discretely an amount of material that is respectively present in the respective process module and is to be processed by this process module and compare it with a prescribed limit value for the amount, wherein each electronic device is also set up

- to actuate an inflow of the respective process module to increase or decrease a mass inflow into this process module if the amount of material that is respectively present in this process module and is to be processed by this process module is less than or greater than the limit value for the amount, the inflow at the same time being an outflow of a further process module connected directly upstream of this process module for production purposes, or

- to actuate an outflow of the respective process module to

increase or decrease a mass outflow from this process module if the amount of material that is respectively present in this process module and is to be processed by this process module is greater than or less than the limit value for the amount, the outflow at the same time being an inflow of a further process module connected directly downstream of this process module for production purposes.

The advantages and embodiments mentioned above with respect to the method are correspondingly associated with this production plant.

Individual process modules may be changed over from the pulling principle to the pushing principle, or vice versa. It is alternatively possible that individual process modules integrated in a corresponding production plant change over automatically and of their own accord. This may additionally necessitate a redesign of the way in which a process module is otherwise regulated, such as for example the way in which internal buffer networks of a process module are regulated.

Each electronic device of a process module may be able to be connected for communication purposes to the aforementioned communication network. The electronic device preferably detects when the respective process module is connected to the communication network, after which the electronic device automatically feeds an identification signal into the communication network, from which signal the generic type of the process module is clear, for example.

Each electronic device may be set up to control and/or regulate the respective process module to independently carry out a particular process section of production. In this case, independently means that the process section is carried out using the process module without the process section or a part of the latter having to be controlled and/or regulated for this purpose by a device remote from the process module. The process module can accordingly thus operate autonomously.

The electronic devices may also be set up in such a manner that process modules connected to the communication network for communication purposes can automatically communicate with one another, for example in such a manner that at least one process module automatically requests information from at least one further process module. This automatic communication between the process modules is possible, in particular, if process modules which are connected to the communication network use their respective electronic device to output an identification signal to the communication network, which signal is received by process modules which are already connected to the communication network. As a result, the receiving process modules can be informed of the address of the process module newly connected to the communication network. In the case of the process modules which are already connected to the communication network or their electronic devices for example, this may be a trigger for these process modules to also emit a corresponding identification signal to the communication network, which signal is in turn received by the process module newly connected to the communication network. The production plant may in this respect have a plug and play functionality.

The information which can be requested from the further process modules may comprise information in the form of given and/or expected process parameters with regard to the process section carried out or to be carried out by the process module providing this information. These process parameters can then be used to control and/or regulate a requesting process module. This is advantageous, in particular, for a subsequent process module which is intended to further process an intermediate product produced by a preceding process module in a temporally preceding process section. For this further processing by the subsequent process module, it is considerably important to know what properties the intermediate product produced by the preceding process module has in order to be able to determine which boundary conditions for producing the desired end product from the intermediate product exist and must be complied with by the

subsequent process module.

According to an advantageous refinement, at least one process module has at least one filling level sensor detecting the filling level of the material in this process module and connected for communication purposes to the electronic device of this process module, the electronic device being set up to determine from the filling level of material respectively detected by means of the filling level sensor the amount of material that is respectively present in the process module and is to be processed by the process module. The advantages and embodiments mentioned with respect to the corresponding refinement of the method are correspondingly associated with this.

According to a further advantageous refinement, at least one process module has at least one pressure sensor detecting the pressure in this process module and connected for communication purposes to the electronic device of this process module, the electronic device being set up to determine from the pressure respectively detected by means of the pressure sensor the amount of material that is respectively present in the process module and is to be processed by the process module. The advantages and embodiments mentioned with respect to the corresponding refinement of the method are also correspondingly associated with this.

A further advantageous refinement provides that on each line forming an outflow for an upstream process module and at the same time an inflow for a process module connected downstream of this process module there is arranged at least one electrically activatable valve connected for communication purposes to the electronic device of the upstream process module or of the downstream process module. This allows a material outflow or a material inflow out of or into a process module to be regulated in an easy way.

The invention is explained below by way of example with reference

to the accompanying figures with the aid of preferred exemplary embodiments and the features specified below may constitute an aspect of the invention either on their own or in combination with one another. In the figures

Figure 1 shows a schematic illustration of an exemplary embodiment of a production plant according to the invention and

Figure 2 shows a schematic illustration of a further exemplary embodiment of a production plant according to the invention.

In Figure 1 is an exemplary embodiment of a production plant 1 according to the invention for producing a chemical and/or pharmaceutical product. The material flow is indicated by the arrow 7. The production plant 1 comprises n process modules 2 which are connected to one another for production purposes and are autonomous for regulating purposes. Each process module 2 has an electronic device 3, in particular a control and/or regulating device, which is set up to detect continuously or discretely an amount of material that is respectively present in the respective process module 2 and is to be processed by this process module 2 and compare it with a prescribed limit value for the amount. Each electronic device 3 is also set up to actuate an inflow of the respective process module 2 to increase a mass inflow into this process module 2 if the amount of material that is respectively present in this process module 2 and is to be processed by this process module 2 is less than the limit value for the amount, the inflow at the same time being an outflow of a further process module 2 connected directly upstream of this process module 2 for production purposes. The production plant 1 or the process modules 3 thereof consequently operate on the pulling principle. To be able to increase the respective inflow correspondingly, on each line 4 forming an outflow for an upstream process module 2 and at the same time an inflow for a process module 2 connected downstream of this process module 2 there is arranged an electrically activatable valve 5 connected for communication purposes to the electronic device 3 of the downstream process module 2.

Each process module 2 also comprises a filling level sensor 6 detecting the filling level of the material in this process module 2 and connected for communication purposes to the electronic device 3 of this process module 2, the electronic device 3 being set up to determine from the filling level of material respectively detected by means of the filling level sensor 6 the amount of material that is respectively present in the process module 2 and is to be processed by the process module 2. Alternatively or in addition, each process module 2 may have a pressure sensor (not represented) detecting the pressure in this process module 2 and connected for communication purposes to the electronic device 3 of this process module 2, the electronic device 3 being set up to determine from the pressure respectively detected by means of the pressure sensor the amount of material that is respectively present in the process module 2 and is to be processed by the process module 2. For this purpose, each electronic device 3 may have a microprocessor and a suitable storage medium.

Figure 2 shows a schematic illustration of a further exemplary embodiment of a production plant 1 according to the invention. This production plant 1 differs from the exemplary embodiment shown in Figure 1 in particular in that each electronic device 3 is set up to actuate an outflow of the respective process module 2 to increase the mass outflow from this process module 2 when the amount of material that is respectively present in this process module 2 and is to be processed by this process module 2 is greater than the limit value for the amount, the outflow at the same time being an inflow of a further process module 2 connected directly downstream of this process module 2 for production purposes. On each line 4 forming an outflow for an upstream process module 2 and at the same time an inflow for a process module 2 connected downstream of this process module 2 there is arranged an electrically activatable valve 5 connected for communication purposes to the electronic device 3 of the upstream process module 2.

Patentkrav

1. Fremgangsmåde til drift af et produktionsanlæg (1), der har produktionsteknisk med hinanden forbundne, reguleringsteknisk autarke procesmoduler (2), til produktionen af et kemisk og/eller farmaceutisk produkt, hvorved for hvert procesmodul (2) kontinuerligt eller diskret en respektive i dette procesmodul (2) eksisterende materialemængde, der skal forarbejdes af dette procesmodul (2), registreres og sammenlignes med en forudfastsat mængdegrænseværdi, hvorved

- en tilledning af masse til det respektive procesmodul (2) forøges, når den respektive i dette procesmodul (2) eksisterende materialemængde, der skal forarbejdes af dette procesmodul (2), er mindre end mængdegrænseværdien, hvorved tilledningen af masse samtidig er en bortledning af masse fra et yderligere procesmodul (2), der produktionsteknisk er umiddelbart forankoblet dette procesmodul (2), således at alle procesmoduler (2) i produktionsanlægget (1) i fællesskab arbejder efter pull-princippet, eller
- en bortledning af masse fra det respektive procesmodul (2) forøges, når den respektive i dette procesmodul (2) eksisterende materialemængde, der skal forarbejdes af dette procesmodul (2), er større end mængdegrænseværdien, hvorved bortledningen af masse samtidig er en tilledning af masse til et yderligere procesmodul (2), der produktionsteknisk er umiddelbart efterkoblet dette procesmodul (2), således at alle procesmoduler (2) i produktionsanlægget (1) i fællesskab arbejder efter push-princippet.

2. Fremgangsmåde ifølge krav 1, kendetegnet ved, at de produktionsteknisk med hinanden forbindbare, reguleringsteknisk autarke procesmoduler (2) er udformet som som helhed transporterbare enheder, som kan transporteres til et ønsket produktionssted, på hvilket der skal opstilles et tilsvarende udstyret, modulært opbygget produktionsanlæg (1), og kan transporteres væk fra dette sted efter afslutningen af den ønskede produktion.

3. Fremgangsmåde ifølge krav 2, kendetegnet ved, at procesmodulerne (2) på produktionsstedet fortrinsvis via standardiserede koblinger kan tilsluttes til et fast installeret kommunikationsnet og til et forsyningsnet, med hvilket procesmodulerne (2) kan forsynes med stof og/eller energi, og/eller ind i hvilket stoffer kan afgives, således at der ved hjælp af procesmodulerne (2) i det væsentlige autarkt kan gennemføres i det mindste en kemisk batch-reaktion og/eller en kontinuerlig produktion.

4. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at til registreringen af den respektive i i det mindste et af procesmodulerne (2) eksisterende materialemængde, der skal forarbejdes af dette procesmodul (2), registreres et fyldningsniveau i dette (2) procesmodul (2).

5. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at til registreringen af den respektive i i det mindste et af procesmodulerne (2) eksisterende materialemængde, der skal forarbejdes af dette procesmodul (2), registreres et tryk i dette procesmodul (2).

6. Produktionsanlæg (1) til produktionen af et kemisk og/eller farmaceutisk produkt, hvilket produktionsanlæg har i det mindste to produktionsteknisk med hinanden forbindbare, reguleringsteknisk autarke procesmoduler (2), hvor hvert procesmodul (2) har en elektronisk indretning (3), især styre- og/eller reguleringsindretning, der er indrettet til kontinuerligt eller diskret at registrere en respektive i det respektive procesmodul (2) eksisterende materialemængde, der skal forarbejdes af dette procesmodul (2), og sammenligne den med en forudfastsat mængdegrænseværdi, hvor hver elektronisk indretning (3) endvidere er indrettet til

- at aktivere en tilledning i det respektive procesmodul (2) med henblik på forøgelse af en tilledning af masse til dette procesmodul (2), når den respektive i dette procesmodul (2) eksisterende materialemængde, der skal forarbejdes af dette procesmodul (2), er mindre end mængdegrænseværdien, hvor

tilledningen samtidig er en bortledning i et yderligere procesmodul (2), der produktionsteknisk er umiddelbart forankoblet dette procesmodul (2), således at alle procesmoduler (2) i produktionsanlægget (1) i fællesskab arbejder efter pull-princippet, eller

- at aktivere en bortledning i det respektive procesmodul (2) med henblik på forøgelse af en bortledning af masse fra dette procesmodul (2), når den respektive i dette procesmodul (2) eksisterende materialemængde, der skal forarbejdes af dette procesmodul (2), er større end mængdegrænseværdien, hvor bortledningen samtidig er en tilledning til et yderligere procesmodul (2), der produktionsteknisk er umiddelbart efterkoblet dette procesmodul (2), således at alle procesmoduler (2) i produktionsanlægget (1) i fællesskab arbejder efter push-princippet.

7. Produktionsanlæg (1) ifølge krav 6, kendetegnet ved, at i det mindste et procesmodul (2) har i det mindste en fyldningsniveausensor (6), der registrerer materialefyldningsniveauet i dette procesmodul (2) og kommunikationsteknisk er forbundet med den elektroniske indretning (3) i dette procesmodul (2), hvor den elektroniske indretning (3) er indrettet til af det respektive via fyldningsniveausensoren (6) registrerede materialefyldningsniveau at bestemme den respektive i procesmodulet (2) eksisterende materialemængde, der skal forarbejdes af procesmodulet (2).

8. Produktionsanlæg (1) ifølge krav 6 eller 7, kendetegnet ved, at i det mindste et procesmodul (2) har i det mindste en tryksensor, der registrerer trykket i dette procesmodul (2) og kommunikationsteknisk er forbundet med den elektroniske indretning (3) i dette procesmodul (2), hvor den elektroniske indretning (3) er indrettet til af det respektive via tryksensoren registrerede tryk at bestemme den respektive i procesmodulet (2) eksisterende materialemængde, der skal forarbejdes af procesmodulet (2).

9. Produktionsanlæg (1) ifølge et af kravene 6 til 8, kendetegnet ved, at der på hver ledning (4), der danner en bortledning for et forankoblet procesmodul (2) og samtidig en tilledning for et til dette procesmodul (2) efterkoblet procesmodul (2), er anbragt i det mindste en elektrisk aktiverbar ventil (6), der er forbundet kommunikationsteknisk med den elektroniske indretning (3) i det forankoblede procesmodul (2) eller det efterkoblede procesmodul (2).

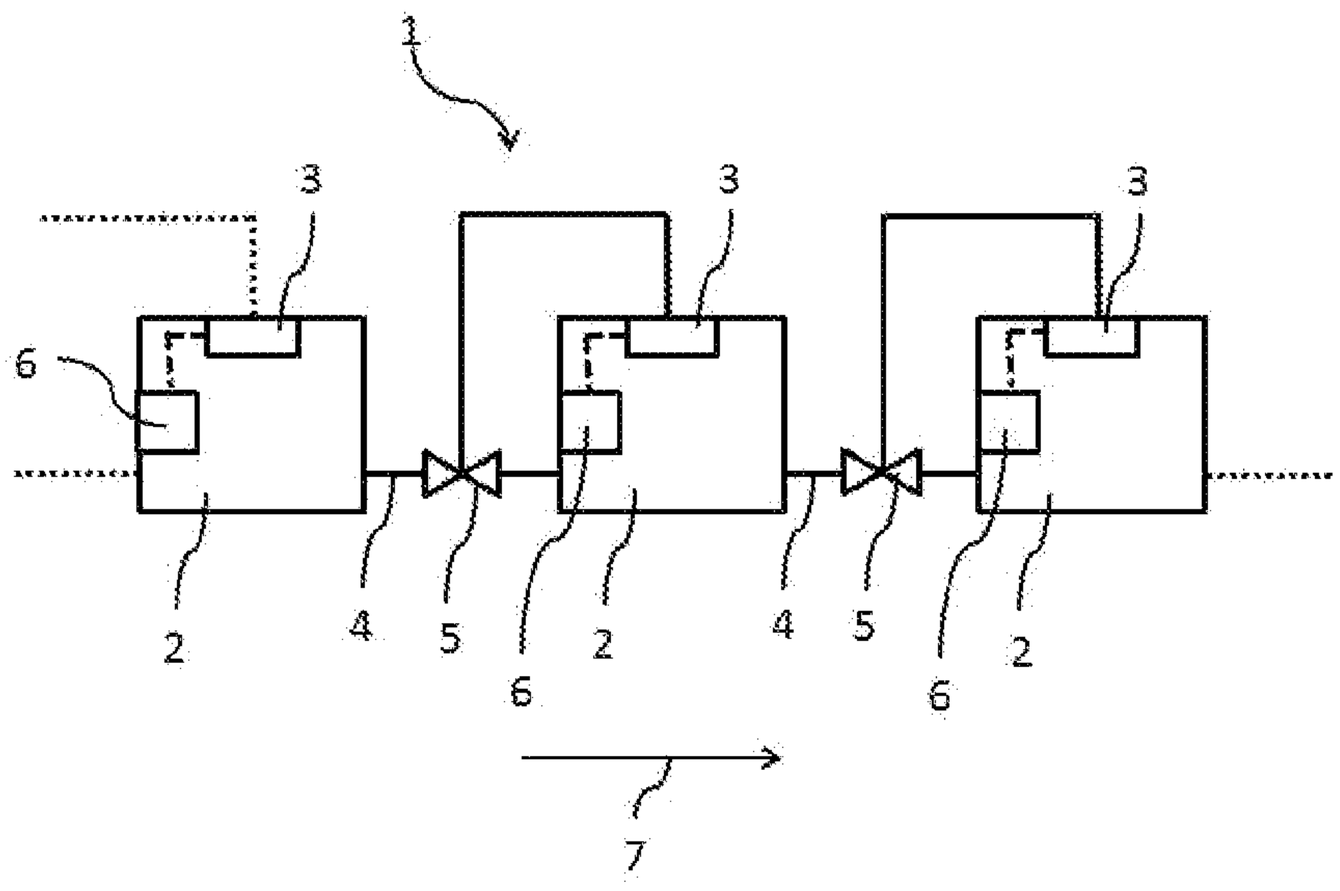

FIG. 1

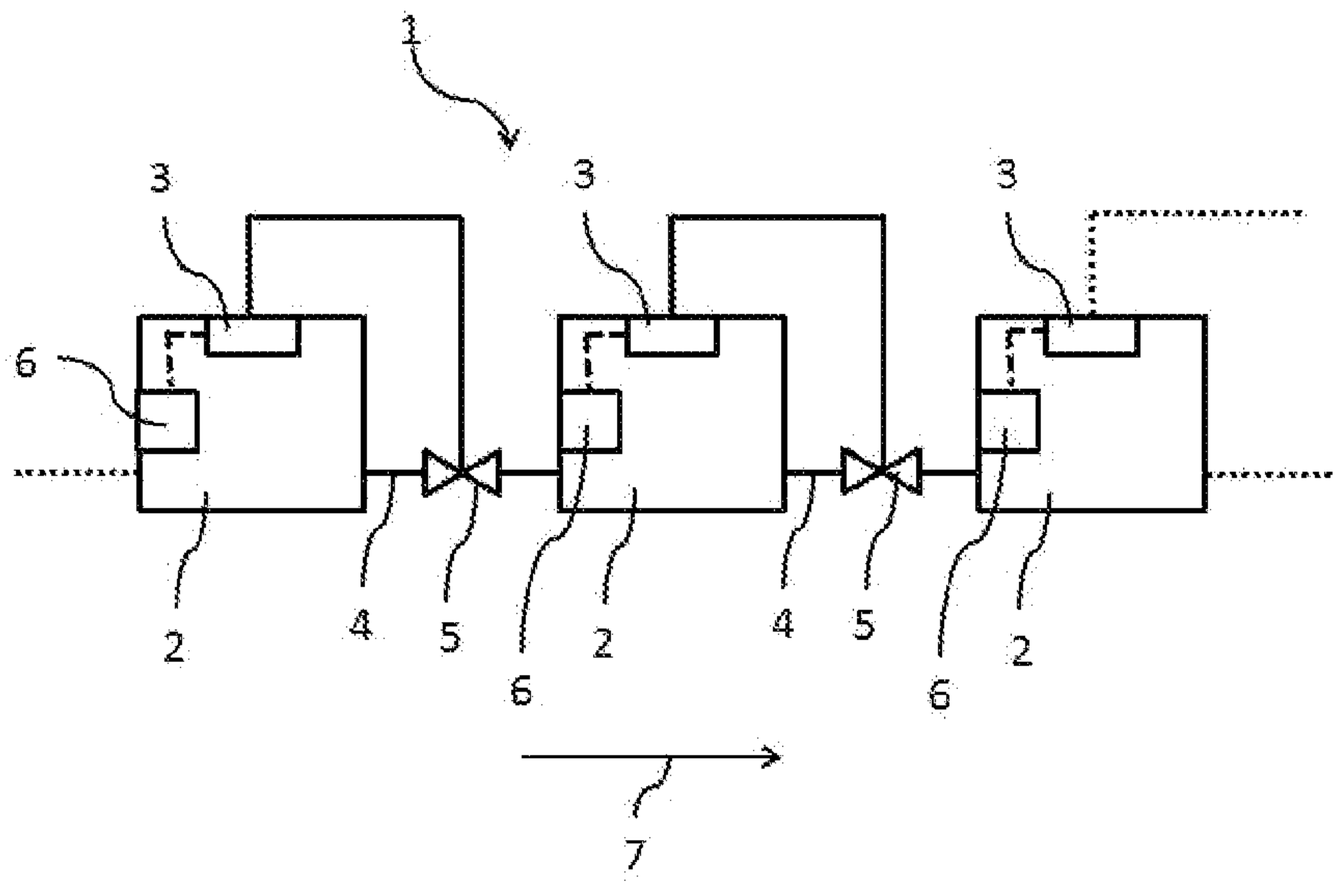

FIG. 2