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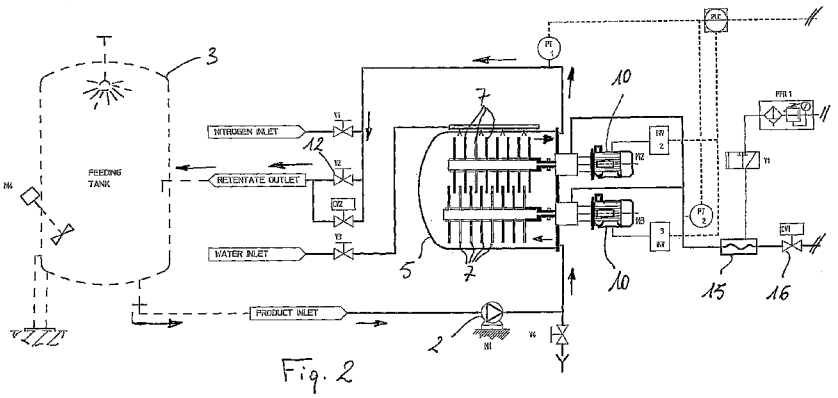


Fig. 2

(57) Abstract: The present invention refers to an apparatus and a method for filtering liquid products, particularly wine. The apparatus includes a filtration bell (5) provided with filtering means (6) and connected to an inflow circuit (13) and a first outlet circuit (14) of the retentate, and to a second outlet circuit (18) of the filtered liquid. The apparatus also includes: - a monitoring and control unit (21); - a first and second sensing means (22,23) suitable for detecting the value of a first pressure PTl in the first outlet circuit (18) and of a second pressure PT2 in the second outlet circuit (18); - flow rate detection means (17) for detecting the value of a first flow rate FIT in the second outlet circuit (18); value means (15,16) arranged in the second circuit (18) downstream of the second sensing means (23). The monitoring and control unit (21) includes means to control the closure of said valve means (15,16) and to start a process of backwashing said filtering means (6).

APPARATUS AND METHOD FOR FILTERING LIQUIDS, PARTICULARLY ORGANIC LIQUIDS

DESCRIPTION

TECHNICAL FIELD OF INVENTION

The present invention refers to an apparatus and a method for filtering liquid products, particularly organic liquids. The apparatus and the method forming the subject matter of the present invention are in fact particularly suitable for wine filtering applications in the winemaking industry.

STATE OF THE ART

Currently known systems for filtering liquids, used particularly in wine filtering, include a filtration bell containing a filtering device and connected, on one side, to a feeding tank containing the liquid to be filtered, and on the other side, to a filtered liquid collecting tank. Generally, the filtration bell is provided with two outlets: a first outlet for the filtered liquid, or "permeate", which is sent to the collecting tank, and a second outlet for the liquid that is not completely filtered due to its not having passed through the filtering device, a liquid denominated "concentrate" or "retentate"; the second outlet is connected to the feeding tank through a return circuit, where the liquid is sent in order to be

reintroduced into the feeding circuit for filtration.

Among filtering systems are known systems including a number of membranes in the form of disks of microporous material stacked in arrays and integral with a rotating shaft with respect to the filtration bell. The rotation of the shaft integral with the membranes has the purpose of favouring the filtration of the liquid through the same membranes, so as to have a more effective filtration process, and also of reducing the sticking of the filtration residues to the surfaces of the membranes.

To improve the efficiency of the filtration process and maintain the state of cleanliness of the membrane filtering surfaces at an acceptable level during the filtration process, some filtration devices are equipped with a reverse filtering, or backwashing, system, the purpose of which is to carry out a washing of the filtering device at preset intervals during the filtering process so as to eliminate from the membrane surfaces the residues of particles separated from the liquid. The reverse filtering uses part of the liquid already filtered, or permeate, to wash the membranes. The permeate is intercepted along the outlet circuit toward the collecting tank and, through a reverse path along the same circuit, it is reintroduced into the filtration bell, it is made to pass through the

membranes and sent back to the feeding tank along the retentate return circuit to be added into the feeding circuit and undergo a new filtration process.

Examples of plants of this type are provided by the European patent EP 0121105, by the French patent application FR 2588767 and by the international patent application WO 03/048049.

In particular, the first patent EP 0121105 describes an apparatus for filtering liquids, also including organic liquids such as wine, the apparatus including two filtering units arranged in series and in which the reverse filtering system is controlled by the pressure values detected (i) on inflow to the first filtering unit, (ii) on outflow from the same or, which is equivalent, on inflow to the second filtering unit; (iii) on outflow from the second filtering unit upstream of the unit that intercepts the filtered liquid for reverse filtering, and (iv) downstream of the intercepting unit before the filtered liquid collecting tank. The activation of the reverse filtering process is determined by the comparison of these pressure values based on a particular algorithm.

A first drawback of this system arises from the presence of two filtering units arranged in series, which involve a complexity in the construction and a considerable

size of the apparatus.

In addition, the method of activating the reverse filtration based exclusively on the detection and comparison of the pressure values read at different points in the system is not completely satisfactory and reliable to guarantee the best efficiency of the operation of cleaning the filtering surfaces during the filtration process.

Another drawback caused by a scarcely efficient reverse filtration consists of the reduction of the membrane life caused by the rapid wear of the filtering surfaces.

SUMMARY OF THE INVENTION

The main task of the subject-matter of the present invention is to devise an apparatus and a method for filtering liquid products, particularly organic liquids such as wine, capable of overcoming the drawbacks of the state of the art exemplified above.

In the scope of the above task, one objective of the present invention is to devise a filtering apparatus and method that makes it possible to optimize and improve the efficiency of the work cycle, and in particular the reverse filtering process.

Another objective is to devise a filtration apparatus and method that guarantees an optimal cleaning of the

filtering membranes so as to cut down wear and extend the life of the membranes, with a consequent saving in the plant operating costs.

A further objective is to devise an apparatus and method that make it possible to achieve a finer and more accurate filtration of the liquid, so that the product resulting from the filtration will be of a higher quality.

A further objective is to devise a filtering apparatus and a method substantially capable of self-adjusting or of performing a self-adaptation of the operating cycle parameters as a function of the characteristics of the liquid to be filtered and/or the conditions of the system, or based on variations from such characteristics and/or conditions during the operating cycle.

One still other objective is to devise a filtering apparatus and method that, through the optimization of the reverse filtering process, makes it possible to achieve an appreciable energy saving in the operating cycle.

A further objective is to devise a filtering apparatus and method capable of using smaller amounts of water and detergents in the end-of-cycle membrane washing phase, while guaranteeing an optimal cleanliness of the same membranes; in this manner it will be possible to obtain a further saving in the costs of operating the apparatus,

which will also be more advantageous from the point of view of environmental protection.

One no lesser objective is to devise a filtering apparatus and method that achieves the above task and objectives at competitive costs and that can be realized with the usual known machinery and equipment.

The task and the objectives indicated above, and others that will become more evident in the following description, will be achieved by a filtering apparatus as defined in claim 1 and by a filtration method as defined in claim 12.

BRIEF DESCRIPTION OF THE DRAWINGS

Further characteristics and advantages of a filtering apparatus and method according to the present invention will become more evident from the following description of a particular, but not exclusive, embodiment illustrated purely by way of example and not of limitation with reference to the enclosed figures, in which:

- Figure 1 is a schematic drawing of an apparatus according to the present invention;

- Figure 2 is a schematic drawing of a preliminary phase of filling and starting the system;

- Figure 3 is a schematic drawing of an operating phase of the filtration cycle;

- Figure 4 is a schematic drawing of an operating phase

of the reverse filtration cycle.

DETAILED DESCRIPTION OF THE INVENTION

With reference to the enclosed drawings, reference numeral 1 indicates a filtration apparatus for liquid products, particularly designed for wine-filtering applications in the winemaking industry.

The apparatus 1 includes:

- a pump 2 that draws up the liquid to be filtered from a feeding tank 3 and sends it, through a feeding circuit 13, to a filtering unit 4 that includes in turn a filtration bell 5 containing one or more filtering means 6;

- each filtering means 6 includes an array of filtering membranes 7, preferably in the form of disks of microporous material, rotatable with respect to the filtration bell 5; the filtering membranes 7 are integrally supported by a shaft 8 that is internally provided with a cavity 9 that communicates, at one end 31, with an outlet circuit 18 of the filtered liquid and is closed at the opposite end; the cavity 9 also communicates with the filtering membranes 7 through one or more ducts within the same membranes 7 and arranged substantially in a radial direction to allow the outflow of the filtered liquid from the filtration bell 5; the shaft 8 is rotatably supported by the filtration bell 5 and the rotation movement is given by an electric motor 10

connected to and controlled by an inverter 11, preferably servo-ventilated;

- a first valve 12, preferably manually controlled, installed in a return circuit 14 for the unfiltered liquid, called concentrate or retentate, suitable to create a pressure differential in the same circuit 14 that reflects in the filtration bell 5, and therefore also on the filtering membranes 7; the return circuit 14 includes a controlled deviation controlled by a fourth valve 30, preferably servo-controlled;

- a second valve 15 and a third valve 16, preferably servo-controlled, and means to detect the flow rate 17 and arranged in sequence along a filtered liquid, or permeate, outlet circuit 18 toward the collecting tank 19; preferably, the second valve 15 is pneumatically driven, and therefore it is connected to pneumatic actuation means 20;

- first sensing means 22 to detect the pressure PT1 in the retentate return circuit 14;

- second sensing means 23 to detect the pressure PT2 in the permeate outlet circuit 18;

- a monitoring and control unit 21 to which are connected for signal communication the first sensing means 22 and the second sensing means 23 for the detection and

acquisition, respectively, of the pressures of the retentate liquid (PT1) and of the permeate liquid (PT2), the inverters 11 controlling the electric motors 10, and the means 17 of detection and acquisition of the permeate liquid rate of flow toward the collecting tank 19;

- washing means 24 for the filtering membranes 7, said washing means connected, through an interposed fifth valve 25 preferably manually controlled, to the water supply or to a hydraulic circuit; the washing means 24 include a plurality of nozzles 26 arranged perpendicularly to the longitudinal extension of the filtration bell 5 so that the water jets hit the filtering membranes 7 tangentially.

The operation of the apparatus is as follows: after a first preliminary phase of filling the filtration bell 5, in which the liquid is drawn from the feeding tank 3 through the pump 2 and circulated, with the filtering membranes 7 in stopped position, in the filtration bell 5 and from this to the feeding tank 3 (Figure 2), there is a second preliminary phase to start the rotation of the membranes 7 by activating the motor 10 and partly choking the first valve 12 to the desired pressure value PT1 to create a pressure differential in the filtration bell 5; the second and the third valve 15, 16 are brought to the open position.

At the completion of the preliminary filling and start-up phases, the apparatus is brought to its regular running state and starts the filtration cycle is started (Figure 3), during which the liquid to be filtered is drawn from the feeding tank 3 through the pump 2 and sent to the filtration bell 5 through the feeding circuit 13; the pressure differential in the filtration bell 5, created by the first valve 12 adjusted to the pressure PT1 and by the pressure drop to which the filtrate is subjected through the filtering means, favours the passage of the liquid through the filtering membranes 7, which in this manner is filtered by permeating through the disks of microporous material. The rotation of the membranes 7 makes it possible to reduce their clogging due to the self-cleaning effect obtained on the filtering surfaces of the disks determined by the tangential speed created by rotation.

The liquid that is filtered through the membranes 7, technically denominated "permeate", enters into the cavity 9 of the shaft 8 through the radial ducts found within each membrane 7 and flows along the cavity 9 until it exits the filtration bell 5 through the open end 31 of the shaft 8 communicating with a conveyor 27; the liquid that could not pass through the filtering membranes 7, technically denominated "concentrate" or "retentate", exits the

filtration bell 5 through the retentate return circuit 14, through which it returns to the feeding tank 3, mixing with the unfiltered liquid to be let into the cycle again; at the outlet from the filtration bell 5 and upstream of the first valve 12 the pressure value PT1 of the retentate is detected by the first sensing means 22.

From the conveyor 27, the permeate is conveyed along the outlet circuit 18 toward the collecting tank 19; downstream of the conveyor 27, and with the second and third valve 15, 16 open, the pressure values PT2 and the flow rate values FIT1 of the permeate are detected before the entrance into the collecting tank 19 by means of the second sensing means 23 and the detection means 17, respectively.

During the filtration cycle, a reverse filtration or "backwashing" cycle, controlled by the monitoring and control unit 21, is carried out at determined intervals on the basis of the detected pressure and flow values, as will be better explained in the description hereunder. The monitoring and control unit 21 acquires the pressure value PT1 detected by the first sensing means 22, the pressure value PT2 detected by the second sensing means 23 and the permeate flow rate value FIT detected by the flow sensing means 17, and performs a comparison with preset values of

the difference Dp between the PT1 and PT2 pressure values, which we will define DpSet, and of a preset flow-rate value, which we will define FITSet. The above values are detected at predetermined intervals ΔT, conveniently preset at 60 seconds. The comparison process is performed by the monitoring and control unit 21 as follows:

(i) the pressure difference between PT1 and PT2 is calculated and compared with DpSet:

PT1 - PT2 = Dp

if Dp $\leq$ DpSet, the value of P = 1 is assigned, whereas

if Dp > DpSet, the value of P = Dp/DpSet is assigned;

(ii) the flow rate value FIT detected is compared with FITSet:

if FITSet $\leq$ FIT, the value of F = 1 is assigned, whereas

if FITSet > FIT, the value of F = FIT/FITSet is assigned;

(iii) the value of k = (P + F)/2 is calculated:

if k $\geq$ 1, the time period previously set is confirmed to start a new reverse filtering cycle; if at the end of the time period the condition is still k $\geq$ 1, the cycle start is postponed to a subsequent check, carried out after a time interval ΔT, until the condition of k < 1 is reached;

if k < 1, a new reverse filtering cycle is started and the time interval between the new cycle and the previous cycle is memorized in the monitoring and control unit 21.

When the monitoring and control unit 21 supplies the consent signal to start the reverse filtering cycle, the same unit 21 actuates the closure of the third valve 16, which shuts off the permeate flowing toward the collecting tank 19, and then closes the second valve 15. Advantageously, the latter is a pneumatically controlled valve that includes a sleeve 28 of elastically deformable material suitable to be compressed by actuation means 20, such as for example compressed air or other gaseous fluid injected in a pneumatic circuit, and a body 29 in communication with the pneumatic circuit. The permeate flows within the sleeve 28, and the compression of the sleeve shuts off the flow of permeate toward the collecting tank 19, while the air or gas, injected into the body 29, are prevented from coming into contact with the permeate.

The permeate then flows backward along the outlet circuit 18 (Figure 4), returning toward the conveyor 27 due to the back pressure created by the closure of the sleeve 28 and the opening of a fourth valve 30 located in a shunt in the return circuit 14 to favour the outflow of the retentate bypassing temporarily the first valve 12, partly

choked to the pressure PT1.

From the conveyor 27, the permeate is fed into the cavity 9 of the shaft 8 through the opening at the end 31 connected to the motor 10. The permeate then flows into the radial ducts inside the membranes 7 and passes through the filtering surfaces of the same membranes 7, thereby removing particles and residues held on those surfaces, thus synergically increasing the cleaning action given by only the continuous rotation of the membranes 7. The liquid, which now contains the residues and particles removed from the membranes 7, flows out of the filtration chamber 5 through the retentate return circuit 14, where the flow is facilitated by the opening of the fourth valve 30, and is fed again into the filtration cycle through the feeding tank 3.

For convenience, the duration of the reverse filtering cycle described above is preset on the average at about 5 seconds, although the operator may vary this duration through the monitoring and control unit 21.

Once the reverse filtering cycle is completed, the normal 21 cycle resumes, and the monitoring and control unit 12 opens the second and the third valve 15, 16 and restores the normal flow of the liquid from the feeding tank 3 toward the collecting tank 19 through the filtering

unit 4.

Another aspect of the present invention is the ability to adjust the speed of the motor 10 based on the viscosity of the liquid to be filtered and/or the extent of clogging of the membranes 7. The determination of the viscosity and/or of the degree of clogging is made on the basis of the motor 10 power input and of the permeate pressure PT2. The values sensed are sent to the monitoring and control unit 21 which, through a suitable processing, transmits an rpm variation signal to the inverter 11.

A further aspect of the present invention consists of the washing means 24 with the nozzles 26 turned so as to carry out, at the end of the cycle, a tangential washing of the membranes 7. This type of washing has proven to be particularly effective to quickly remove the organic and inorganic matter that settles on the membranes 7, making it possible to cut down the consumption of water and washing detergents. The effectiveness of this washing, combined with the continuous rotation of the membranes 7 and the reverse filtration optimized on the basis of the effective extent of membrane clogging, makes it possible to extend the life of the membranes 7, in addition to considerably cutting down the overall energy consumption of the apparatus.

According to a preferred embodiment, illustrated in Figures 1 to 4, a greater filtering capacity of the apparatus can be achieved by increasing the number of filtering means 6, which may include two or more shafts 8 driven by respective motors 10. The shafts 8 are arranged on parallel axes and support respectively a first and a second series of filtering membranes 7, which are advantageously arranged in "interleaved" fashion, that is, reciprocally alternated in longitudinal direction, so that the respective disks at least partially overlap each other. Each cavity 9 of the shafts 8 will therefore be in communication with a respective conveyor 27 which is itself provided with respective permeate outlets connected to the outlet circuit 18. The pressure PT2 will thus be sensed downstream of the connectors coupling the sections of the conveyor outlet circuit to the outlet circuit 18.

From the above, it is evident how the present invention achieves the objectives and advantages initially foreseen: in fact, the present inventors have devised an apparatus and a method for filtering liquid products, in particular organic liquids such as wine, capable of overcoming the drawbacks of the previous state of the art mentioned in the preamble of the present description.

The apparatus and the method described above make it

possible to optimize and improve the efficiency of the work cycle, and in particular the reverse filtering process, thanks to the capacity to start this process only when actually necessary based on the pressure and flow-rate parameters detected and processed by the monitoring and control unit 21. This avoids the possibility of starting the reverse filtering process too early with respect to the degree of clogging of the filtering membranes 7, resulting in a reduced efficiency of the apparatus and an unnecessary energy consumption, or of starting it late, when the filtering capacity of the membranes 7 has drastically declined due to clogging, again with the consequent reduced efficiency of the apparatus, because the quantity and quality of the permeate decreases, and moreover resulting in a reduction in the useful life of the membranes 7 and in the difficulty of removing the filtration residues on the filtering surfaces.

One significant advantage resulting from said operating modes of the reverse filtering process consists of the optimal cleaning of the filtering membranes 7 during all the filtering process, which makes it possible to reduce their wear and to extend their useful life, with a consequent saving in terms of the costs of operating the apparatus.

A further advantage of the apparatus and of the method according to the present invention lies in the capacity of achieving a finer and more accurate filtration of the liquid, thanks to the constant and optimal cleaning of the filtering membranes 7 provided, in a synergic manner, by the tangential speed caused by the rotation of the disks that continually removes the less resistant particles, by the optimal modes of controlling and starting the reverse filtering process as described above and by the tangential washing of the membranes 7 carried out at the end of the cycle by the washing means 24. With particular reference to this last washing phase, it is pointed out that it is possible to considerably reduce the use of water and detergents, thanks to the optimal degree of cleanliness of the membranes that is already achieved during the filtration cycle. This important aspect makes it possible to further reduce the costs of operating the apparatus, making it at the same time particularly advantageous at the ecological level.

One other advantage of the filtering apparatus and method according to the present invention lies in the substantial self-adjusting or self-adapting capacity of the work cycle parameters based on the characteristics of the liquid to be filtered as, for example, viscosity, and/or on

the conditions of the apparatus, such as the degree of clogging of the membranes 7, or based on the variation of said characteristics during the same work cycle, owing to the centralized monitoring and control unit 21 which receives and processes the values detected during the work cycle to activate the reverse filtering process or the variation of the rpm of the motors 10 through the inverters 11. These capacities of self-adjustment and optimization of the apparatus translate in the end into a better utilization of the apparatus and into a considerable energy saving, and therefore into an overall reduction of process costs.

Naturally, the present invention is open to the possibility of many applications, modifications or variations without departing from the scope of protection as defined by the independent claims 1 and 12.

In addition, the materials and equipment used to realize the present invention, as well as the shapes and dimensions of the individual components, may be the most suitable to fit the particular requirements.

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CLAIMS

1. Apparatus for filtering liquid products, particularly organic liquids, including a filtration bell (5) provided with filtering means (6), said filtration bell connected, on one side, to a feeding circuit (13) for the liquid to be filtered and, on the other side, to an unfiltered liquid, or retentate, return circuit (14), and to a filtered liquid, or permeate, outlet circuit (18), **characterized in that** it further includes:

- a monitoring and control unit (21);
- first sensing means (22) connected for signal communication with said monitoring and control unit (21) and suitable for detecting and acquiring at preset time intervals ΔT the value of a first pressure PT1 in said return circuit (14);
- second sensing means (23) connected for signal communication with said monitoring and control unit (21) and suitable for detecting and acquiring at preset time intervals ΔT the value of a second pressure PT2 in said outlet circuit (18);
- flow rate detection means (17) in signal communication with said monitoring and control unit (21) and suitable for detecting and acquiring at preset time intervals ΔT the flow rate value FIT in said outlet circuit (18);

- valve means (15, 16) arranged in said outlet circuit (18) downstream of said second sensing means (23) and controlled by said monitoring and control unit (21);
- said monitoring and control unit (21) including means for comparing and processing the values of said first pressure PT1, said second pressure PT2 and said flow-rate value FIT with respect to the preset values to control the closure of said valve means (15, 16) and start a backwashing process for said filtering means (6).

2. Apparatus as in claim 1, in which said filtering means (6) include to a plurality of filtering membranes (7), preferably in the form of disks of microporous material, stacked and integral to a shaft (8) rotating with respect to said filtration bell (5) and provided internally with at least one cavity (9) in communication, at one end, with one or more ducts arranged internally in each of said filtering membranes (7) and, at the other end, with said outlet circuit (18).

3. Apparatus as in claim 2, in which the rotation movement of said shaft (8) is given by a motor (10) driven and controlled, through an inverter (11), by said monitoring and control unit (21).

4. Apparatus as in claim 3, in which means are provided to measure the amperometric absorption of said motor (10) in

signal communication with said monitoring and control unit (21).

5. Apparatus as in claim 4, in which said monitoring and control unit (21) includes means for processing the value of said amperometric absorption in combination with said pressure value PT2 detected by said second sensing means (23) to control said inverter (11) and to determine the rpm variation of said motor (10).

6. Apparatus as in claim 1, in which said valve means (15, 16) include a second and a third servocontrolled valve (15, 16) located along said outlet circuit (18).

7. Apparatus as in claim 6, in which said second valve (15) is pneumatically driven through pneumatic actuation means (20).

8. Apparatus as in claim 6, in which said flow rate detection means (17) are arranged along said outlet circuit (18) downstream of said third valve (16).

9. Apparatus as in any one of the previous claims, which also includes washing means (24) having a plurality of nozzles (26) arranged approximately perpendicular to the longitudinal extension of said filtration bell (5) so that the jets sprayed from said nozzles (26) hit approximately tangentially said filtering membranes (7).

10. Apparatus as in any one of the previous claims, in

which said filtering means (6) include at least a first and a second plurality of filtering membranes (7) stacked and integral, respectively, with a first and a second shaft (8) rotating with respect to said filtration bell (5) and arranged along axes parallel to each other, each of said first and second shaft (8) being internally provided with at least one cavity (9) in communication, at one end, with said first and, respectively, second plurality of membranes (7) and, at the other end, with said outlet circuit (18).

11. Apparatus as in claim 1, in which said first and second plurality of membranes (7) are arranged reciprocally alternated in a longitudinal direction so as to at least partially overlap each other.

12. Method for filtering liquid products, in particular organic liquids, wherein the work cycle includes a filtration process of said liquid and a process of backwashing filtering means (6), **characterized in that** it includes the following phases:

a. detect and acquire at preset time intervals ΔT the value of a first pressure PT1 in a return circuit (14) of the unfiltered liquid from a filtration bell (5) during said filtration process;

b. detect and acquire at preset time intervals ΔT the value of a second pressure PT2 in an outlet circuit (18) of

the filtered liquid from said filtration bell (5) during said filtration process;

c. detect and acquire at preset time intervals ΔT the flow rate value FIT in said outlet circuit (18) during said filtration process;

d. calculate the value of Dp = (PT1 - PT2;

e. compare said Dp value with a preset DpSet value;

f. assign the value of P = 1 if Dp $\leq$ DpSet and P = Dp/DpSet if Dp > DpSet;

g. compare said flow rate value FIT with a preset FITSet value;

h. assign the value of F = 1 if FITSet $\leq$ FIT and F = FIT/FITSet if FITSet > FIT;

i. calculate the value of k = (P + F)/2;

j. if k $\geq$ 1, continue said filtration process;

k. if k < 1, start said reverse filtering process of said filtering means (6).

13. Method as in claim 12, in which, when the condition of k < 1 occurs, said filtered liquid is intercepted along said outlet circuit (18) by a second and a third valve (15, 16) and made to flow back toward said filtering means (6) to carry out said reverse filtering process.

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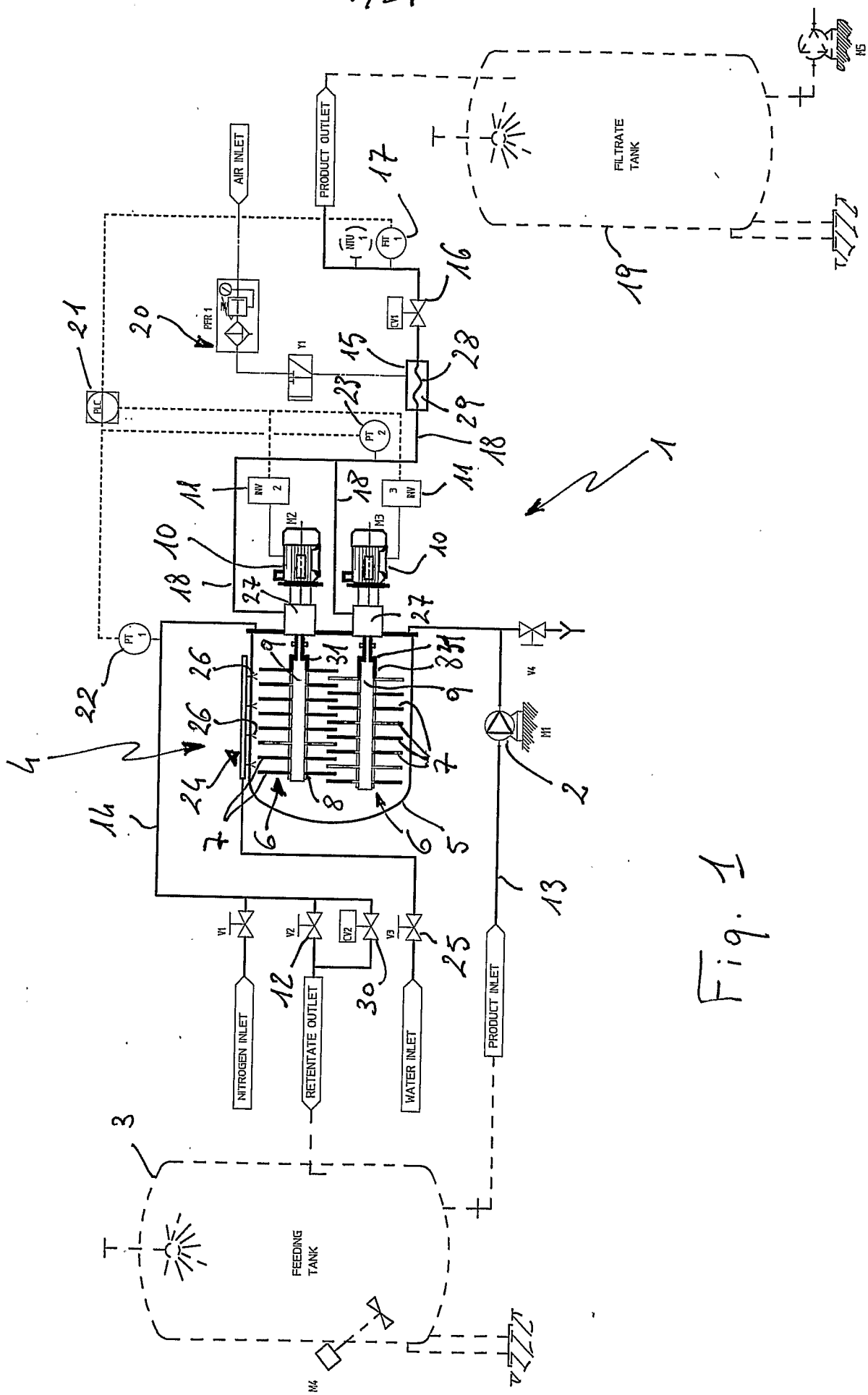

AIR INLET
PRODUCT OUTLET
FILTRATE TANK
FEEDING TANK
NITROGEN INLET
RETENTATE OUTLET
WATER INLET
PRODUCT INLET
PLC
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PIT 2
PT 1
PT 2
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Fig. 1

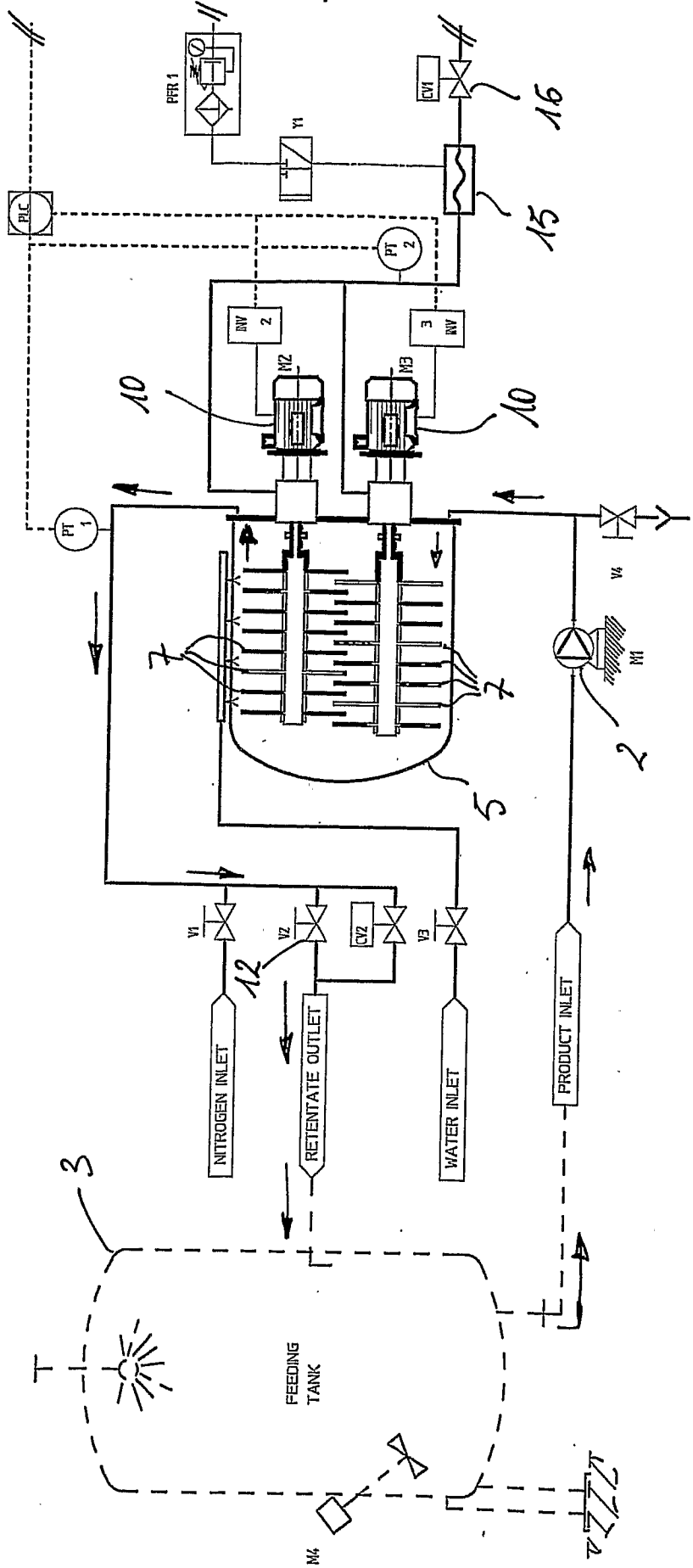

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Fig. 2

3/4

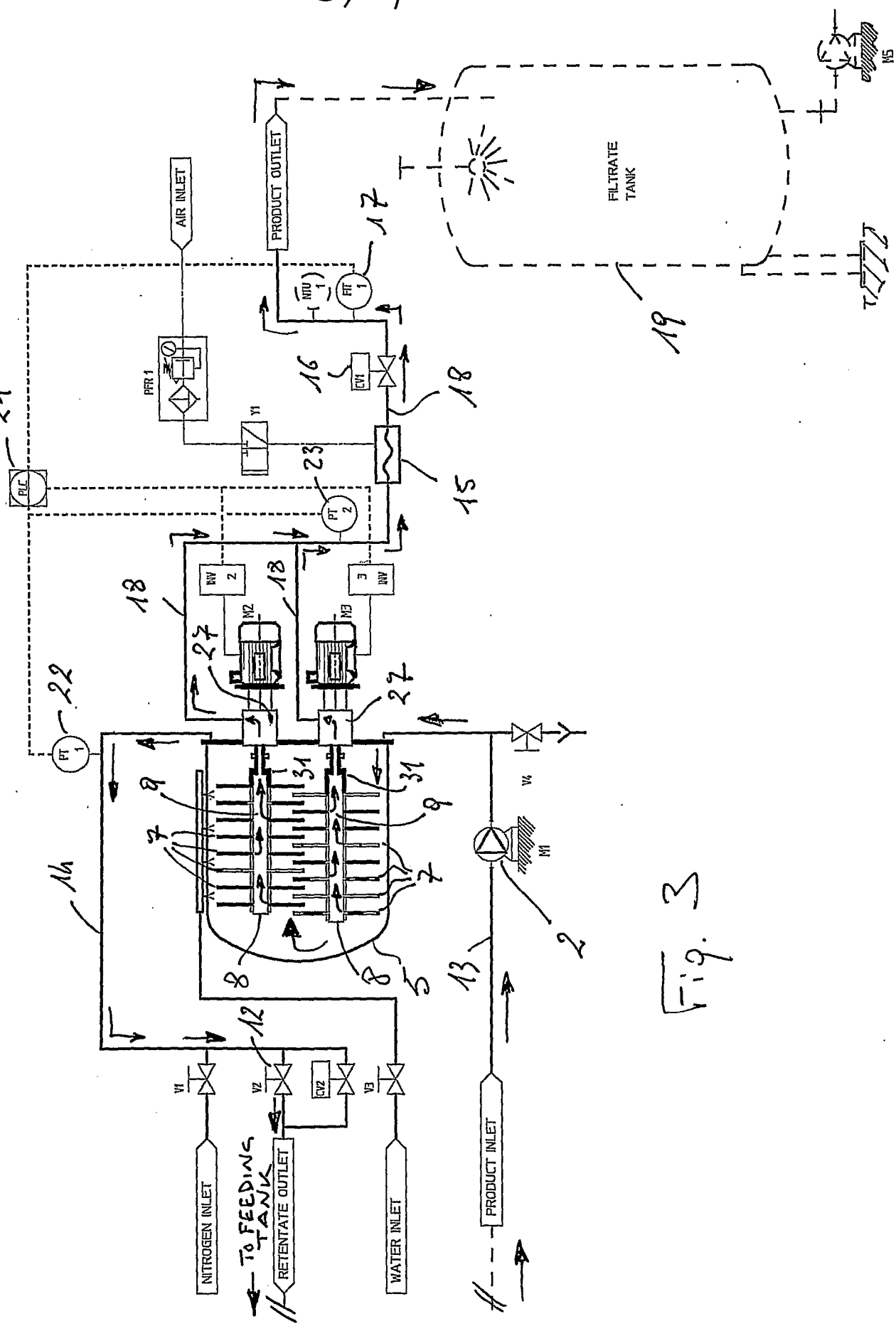

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FIT 1
PT 1
PT 2
NV 2
NV 3
M1
M2
M3
M5
V1
V2
V3
V4
CV2
NITROGEN INLET
RETENTATE OUTLET
WATER INLET
PRODUCT INLET
TO FEEDING TANK
1
2
5
7
8
9
12
13
14
15
16
17
18
19
21
22
23
27
31

Fig. 3

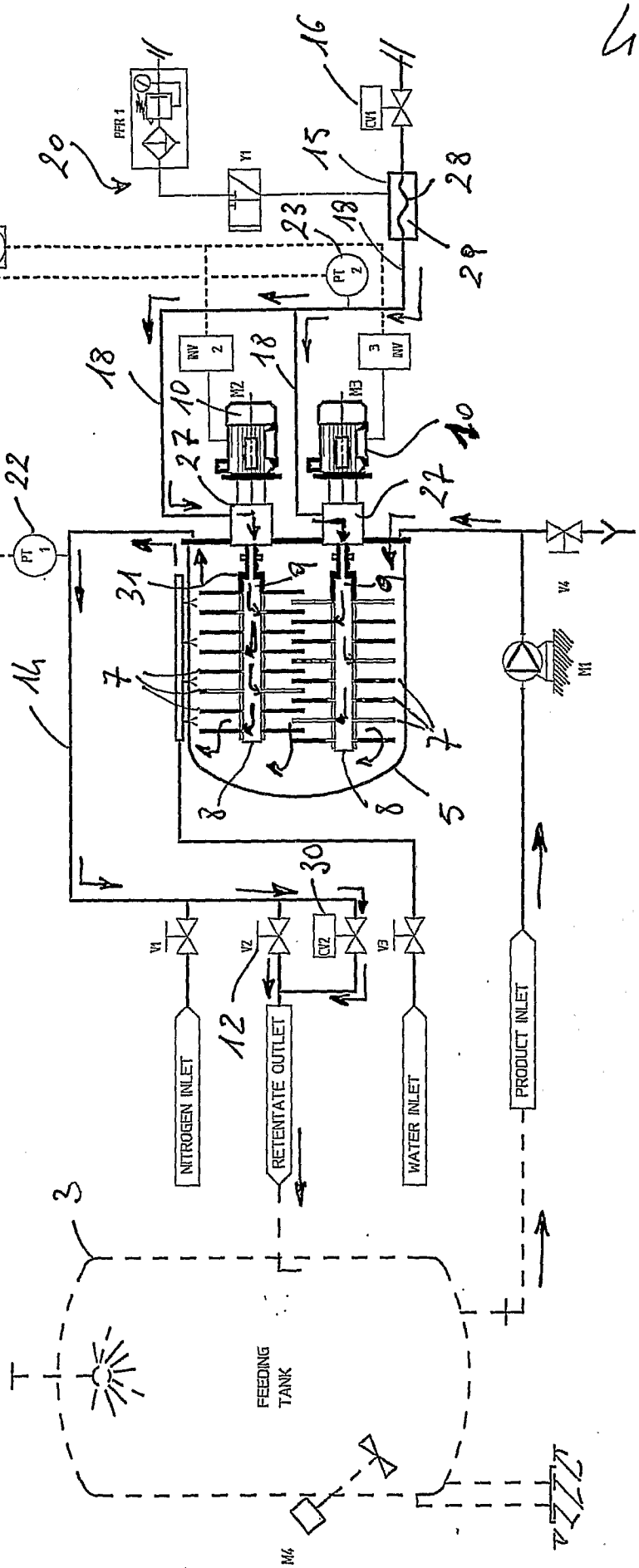

PLC
PFR 1
Y1
CV1
PT 1
PT 2
NW 2
NW 3
M2
M3
M1
M4
V1
V2
V3
V4
CV2
NITROGEN INLET
RETENTATE OUTLET
WATER INLET
PRODUCT INLET
FEEDING TANK

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2009/000420

A. CLASSIFICATION OF SUBJECT MATTER
INV. B01D61/22 B01D63/16 B01D65/02 C12H1/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B01D C12H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2009/076980 A1 (KMPT AG [DE]; SCHERER DIETER [DE]; FELLER JOHANNES [DE]) 25 June 2009 (2009-06-25)	1-3,6-8, 10,11
Y	page 4, paragraph 4 - page 5, paragraph 2; figure 1	4,5,9,12
A	JP 04 338219 A (HITACHI PLANT ENG & CONSTR CO) 25 November 1992 (1992-11-25) abstract; figure 1	1-3, 10-12
Y	US 6 375 847 B1 (HARTMANN EDUARD [CH]) 23 April 2002 (2002-04-23) column 3, line 29 - line 65; figures column 4, line 33 - line 52	4,5,12
Y	EP 0 425 725 A1 (TMCI PADOVAN S P A [IT]) 8 May 1991 (1991-05-08) column 3, line 24 - line 31; figure 6	9

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 June 2010	25/06/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Goers, Bernd

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2009/000420

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	JP 2007 105569 A (UEDA CHEMICAL KK) 26 April 2007 (2007-04-26) paragraph [0039]	12
Y	US 2005/230311 A1 (RODENBERG MICHAEL [DE] ET AL RODENBERG MICHAEL [DE] ET AL) 20 October 2005 (2005-10-20) column 2, line 5 - line 20; figure 1 column 5, line 33 - line 39	12

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