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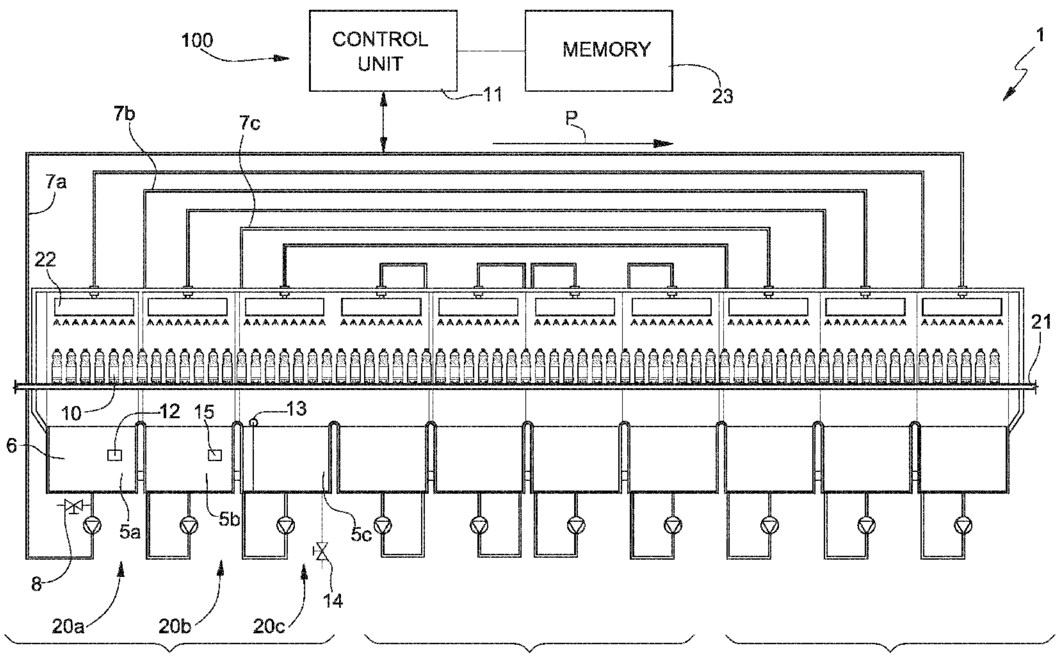

FIG. 1

(57) Abstract: A control method for controlling a machine (1); the machine (1) comprises a temperature-processing zone (2, 3, 4), which comprises a collection tank (5a, 5b, 5c); an injection assembly (7a, 7b, 7c); and a control unit (11); the method comprises the steps of: i) determining a temperature (t) of the processing fluid (6); ii) comparing the temperature (t) determined with a desired temperature range by means of control unit (11); iii) detecting a level (1) of processing fluid (6) inside tank (5a, 5b, 5c) by means of a level sensor (13); iv) comparing level (1) with a desired level range by means of control unit (11); v) controlling by means of control unit (11) a drainage valve (14) to discharge processing fluid (6) from tank (5a, 5b, 5c), if temperature (t) is outside the desired temperature range and level (1) is within desired level range; vi) controlling by means of control unit (11) an inlet valve (8) of machine (1) to allow

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the injection of fresh processing fluid (9) in tank (5a, 5b, 5c), if temperature (t) is outside desired temperature range and level (1) is outside desired level range.

"CONTROL METHOD AND SYSTEM FOR CONTROLLING A MACHINE FOR THE TEMPERATURE PROCESSING OF CONTAINERS OF FOOD PRODUCTS; METHOD FOR RETROFITTING SUCH MACHINE"

The present invention relates to a control method for controlling a machine, generally intended for temperature processing of containers designed to contain food products; in particular, the following discussion will make explicit reference, without this implying any loss of generality, to the control method of a tunnel pasteurising machine (or pasteuriser) for pasteurising packaged food products.

The present invention also relates to a control system for controlling a machine for the temperature processing of containers of food products and to a method for retrofitting such machine.

As is known, in a tunnel pasteuriser, food products to be pasteurised, packaged in bottles, cans or other containers, are fed by a conveyor along a forward movement path, which is usually divided into three main processing zones: a heating zone in which the product temperature is gradually raised; a heat-treatment zone in which the product temperature is brought to, and kept at, a pasteurising temperature for a desired time interval; and a cooling zone in which the product temperature is gradually lowered to a desired output temperature.

At the end of the temperature processing (i.e. at the output of the pasteuriser), it is required for the food products to have been kept above a predetermined temperature for at least a predetermined time, so as to accumulate at least a predetermined quantity of pasteurisation units (PUs). In this way, effective pasteurisation of the processed products may be assured.

Each processing zone is, in turn, divided into a plurality of sub-zones, each one of which is operable and controllable independently of the others. The products, in each sub-zone, are processed by injecting thereon a flow of a fluid at a desired predetermined temperature. Usually, the fluid is a liquid, such as water, which is injected, sprayed, or applied in any equivalent manner on the products, although other fluids may as well be used, like a gas, such as air.

In particular, each sub-zone comprises a spraying unit positioned above the forward movement path of the products, and, in a possible solution, at least one collection tank positioned below the same forward movement path to collect the liquid, sprayed by the spraying unit, after it has wet the products.

According to a known solution, the processing liquid fed to the spraying units of the various sub-zones is taken, at least in part, from the collection tanks.

In particular, a process of recirculation is implemented, according to which the liquid fed to the spraying units of the heating sub-zones is taken from the tanks of the cooling sub-zones, whilst the liquid fed to the spraying means of the cooling sub-zones is taken from the tanks of the heating sub-zones. In this way, it is possible to achieve an effective energy saving, thanks to the fact that the heat transferred to the processing liquid by the products in the cooling zones may be used to heat the products in the heating zones, while the cooled down processing liquid collected in the heating zones may be used to cool down the products in the cooling zones. Moreover, in the heat treatment zone, the liquid fed to the spraying means of each sub-zone is usually taken directly from the collection tank of that sub-zone.

An example of tunnel pasteuriser is known from EP2702879.

In detail, in many applications, in order to guarantee the final quality of the processed products, it is required that the output temperature of the products at the end of the temperature processing is maintained in a desired range, and a control action is required so that the output temperature is not higher than an upper output temperature threshold. The output temperature may further be controlled to be higher than a lower output temperature threshold of the desired range, so as to avoid condensation on the containers of the processed products.

In known machines, fresh fluid is injected in one of the tanks of the heating sub-zones, in order to maintain the output temperature of the products at the end of the temperature processing below the upper output temperature threshold. As a consequence, the temperature of the fluid inside the tanks of the heating sub-zones is lowered as well as the spraying temperature of the liquid exiting the spraying means of the cooling sub-zones, which is taken from such tanks.

However, in order to substantially vary the temperature of the fluid inside the tanks, it is necessary to inject large volumes of fresh fluid in the tanks of the heating sub-zones. This is due to the fact that the amount of fresh fluid to be injected depends on the temperature and mass of the fluid inside the tanks before fresh fluid injection.

This solution leaves room for improvement, because it causes fluid waste.

In view of this, a need is felt within the sector for a control method allowing to control the output temperature of the products at the end of the temperature processing in an efficient manner, while minimizing the fluid waste.

It is important to point out, at the same time, that the biochemical quality of the fluid is of the outmost importance for a pasteurising machine pasteurising packaged food products.

In this respect, it is necessary to consider that over time the fluid processed in the machine tends to become turbid and its corrosive power increases. In addition, biofilm progressively forms and bacteria like Legionella could proliferate.

In known machines, the fluid is periodically completely replaced by fresh fluid, in order to restore the desired biochemical quality. However, this solution is clearly suboptimal, because it causes a large amount of fluid to be wasted and requires the machine to be stopped.

As a consequence, a need is also felt for a control method allowing to control the biochemical quality of the fluid, while minimizing the fluid waste.

It is an object of the present invention to provide a control method, which allows to meet at least one of the abovementioned needs in a simple and economic manner.

This object is achieved by the present invention, as it relates to a control method for controlling a machine for the temperature processing of containers of food products, as claimed in claim 1 and in claim 11.

The invention also relates to a control system for a machine for the temperature processing of containers for food products, as claimed in claim 12, and to a method for retrofitting a machine for the temperature processing of containers for food products, as claimed in claim 10.

One preferred embodiment is hereinafter disclosed for a better understanding of the present invention, by way of a non-limitative example and with reference to the accompanying drawings, in which:

- Figure 1 is a functional scheme of a machine according to the present invention, with parts removed for clarity;

- Figure 2 is a block diagram of a portion of the machine of Figure 1, with parts removed for clarity;

- Figures 3 to 5 are respective flow charts relating to operations performed by the control method and system according to the present invention; and

- Figures 6 to 8 are flow charts relating to the operations illustrated in Figures 3 to 5, respectively, comprising further details on these operations.

In the following of the present description and in the claims the expression "in use" means "during operation".

Figure 1 schematically shows a tunnel pasteurising machine, denoted as a whole with 1, comprising a control system 100 and a forward movement element 21, which may consist, for example, of one or more conveyor belts or any other type of conveyor, for moving food products packaged in containers 10 along a movement path P.

Machine 1 comprises a heating zone 2, a heat treatment zone 3 and a cooling zone 4 positioned one after another along movement path P, in order to carry out pasteurisation of the products in containers 10.

In detail, in heating zone 2 the temperature of containers 10 is gradually raised; in heat-treatment zone 3 the temperature of containers 10 is brought to, and kept at, a pasteurising temperature for a desired time interval; and in cooling zone 4 the temperature of containers 10 is gradually lowered to a desired output temperature.

Each one of the heating, heat treatment and cooling zones 2, 3, 4 is further divided into a number of sub-zones 20a, 20b, 20c positioned one after another along movement path P; in the exemplary embodiment shown in Figure 1, heating zone 2 is divided into three respective sub-zones.

Each one of the sub-zones 20a, 20b, 20c is provided with a respective collection tank 5a, 5b, 5c for storing a processing fluid 6 (for example water) and a respective injection assembly 7a, 7b, 7c for injecting processing fluid 6 from the respective collection tank 5a, 5b, 5c onto containers 10 that are carried by movement element 21.

In detail, each tank 5a, 5b, 5c is in fluidic communication with the other tanks 5a, 5b, 5c of the same zone 2, 3 or 4.

Each injection assembly 7a, 7b, 7c comprises, in turn, a plurality of spraying nozzles 22 for spraying processing fluid 6 onto containers 10.

In detail, collection tanks 5a, 5b, 5c are also adapted to collect processing fluid 6 after it has been sprayed on containers 10 (i.e. after it has exchanged heat with containers 10). In the shown embodiment, nozzles 22 and collection tanks 5a, 5b, 5c are positioned above and, respectively, below the forward movement element 21, so as to exploit the gravity effect for the movement of processing fluid 6.

In the following of the present description, reference will be made to heating zone 2 only.

In particular, collection tanks 5a, 5b, 5c of heating zone 2 are arranged in succession in such a manner that tank 5a is the upstream-most tank of heating zone 2 and tank 5c is the downstream-most tank of heating zone 2 according to movement path P.

In addition, the temperature of processing fluid 6 inside tank 5b is higher than the temperature of processing fluid 6 inside tank 5a; the temperature of processing fluid 6 inside tank 5c is higher than the temperature of processing fluid 6 inside tank 5b.

Machine 1 further comprises an inlet valve 8 for the inlet of a fresh processing fluid 9 from outside machine 1.

In detail, fresh processing fluid 9 is a processing fluid that has not yet been inlet and processed in machine 1.

Preferably, processing fluid 6 and fresh processing fluid 9 differ only in terms of physical-biochemical properties, such as temperature and/or pH.

Furthermore, the physical-biochemical properties of fresh processing fluid 9 approximate those of processing fluid 6 after a given number of operating hours of machine 1.

In the embodiment shown, fresh processing fluid 9 has a lower temperature than processing fluid 6.

In detail, inlet valve 8 is controllable in an open configuration, in which it allows the inlet of fresh processing fluid 9, or in a closed configuration, in which it prevents fresh processing fluid 9 from being inlet inside machine 1.

In detail, inlet valve 8 is adapted to allow the injection of fresh processing fluid 9 directly in the upstream-most collection tank 5a according to movement path P (Figure 1).

Heating zone 2 further comprises:

- a temperature sensor 12, which is adapted to detect a temperature t of processing fluid 6; and

- a level sensor 13, which is adapted to detect a level l of processing fluid 6 inside one of collection tanks 5a, 5b, 5c.

In the embodiment shown, level sensor 13 is a level probe.

Preferably, temperature t is the temperature of processing fluid 6 inside one of collection tanks 5a, 5b, 5c.

In the embodiment shown, temperature sensor 12 is arranged at upstream-most tank 5a and, therefore, temperature t is the temperature of processing fluid 6 inside upstream-most tank 5a.

Heating zone 2 further comprises a drainage valve 14, which is controllable in an open configuration, in which it allows the drainage of at least part of processing fluid 6 from one collection tank 5a, 5b, 5c, or in a closed configuration, in which it prevents the drainage of processing fluid 6 from said one collection tank 5a, 5b, 5c.

Preferably, level sensor 13 is arranged in the same collection tank 5a, 5b, 5c from which drainage valve 14 allows or prevents the drainage of processing fluid 6.

In the embodiment shown, drainage valve 14 is adapted to allow or prevent the drainage of processing fluid 6 from the downstream-most tank 5c according to movement path P (figure 1).

Furthermore, control system 100 of machine 1 comprises a control unit 11, which is operatively connected to temperature sensor 12 and level sensor 13 (Figure 2).

Advantageously, control unit 11 is configured to set drainage valve 14 in the open configuration if temperature t is outside a desired temperature range and level l is within a desired level range; and to set inlet valve 8 in the open configuration if temperature t is outside the desired temperature range and level l is outside the desired level range (Figures 3 and 6).

Preferably, control unit 11 is configured to set drainage valve 14 in the closed configuration when inlet valve 8 is in the open configuration.

Control system 100 further comprises a memory 23 configured to store the desired temperature range and the desired level range, with their respective upper and lower thresholds. Memory 23 is operatively connected to control unit 11 (Figures 1 and 2).

In detail, control unit 11 is configured to set drainage valve 14 in the open configuration if temperature t is higher than an upper threshold t* of the desired temperature range and level l is higher than a lower threshold l* of the desired level range (Figure 3). Preferably, if drainage valve 14 is set in the open configuration, control unit 11 is configured to keep drainage valve 14 in such configuration as long as temperature t is higher than upper threshold t* and until level l is lower than lower threshold l* (Figure 6).

Moreover, control unit 11 is configured to set inlet valve 8 in the open configuration if temperature t is higher than the upper threshold t* of the desired temperature range and level l is lower than the lower threshold l* of the desired level range (Figure 3). Preferably, if inlet valve 8 is set in the open configuration, control unit 11 is configured to keep inlet valve 8 in such open configuration as long as temperature t is higher than upper threshold t* and until level l is greater than an hysteresis level threshold l** of the desired level range (Figure 6), which is greater than lower threshold l* but lower than an upper threshold l*** of the desired level range. In particular, upper threshold l*** corresponds to the maximum amount of processing fluid 6 that can be stored in tank 5c without overflowing.

In addition, even more preferably, control unit 11 is configured to set drainage valve 14 in the open configuration only if level l is greater than hysteresis level threshold l** (Figure 6). As a consequence, if temperature t is higher than the upper threshold t* and level l is higher than lower threshold l* but lower than hysteresis level threshold l**, control unit 11 is configured to keep drainage valve 14 in the closed configuration and to set inlet valve 8 in the open configuration. Also in this case, control unit 11 is preferably configured to keep inlet valve 8 in the open configuration as long as temperature t is higher than upper threshold t* and until level l is greater than hysteresis level threshold l** (Figure 6).

Hysteresis level threshold l** is chosen so as to avoid a rapid and repeated switching of drainage valve 14 and inlet valve 8 between the respective open and closed configurations, which could damage the valves.

In particular, memory 23 is further configured to store the hysteresis level threshold l** of the desired level range.

Alternatively or in addition, control unit 11 is configured to set drainage valve 14 in the open configuration only if a predetermined amount of time has passed since drainage valve 14 was set in the closed configuration.

Heating zone 2 further comprises a biochemical quality detector 15, which is adapted to detect a biochemical quality indicator k of processing fluid 6.

In detail, biochemical quality indicator k may be pH and/or a parameter of the microbial load of processing fluid 6. Accordingly, biochemical quality detector 15 may be a pH meter and/or a microbial load analyzer.

Preferably, biochemical quality detector 15 is arranged inside one of tanks 5a, 5b, 5c of heating zone 2 (Figure 1).

Biochemical quality detector 15 is operatively connected to control unit 11 (Figure 2).

In particular, memory 23 is further configured to store a desired biochemical quality range Δk and control unit 11 is configured to compare biochemical quality indicator k detected by biochemical quality detector 15 with the desired biochemical quality range Δk.

Advantageously, control unit 11 is configured to set drainage valve 14 in the open configuration if biochemical quality indicator k is outside desired biochemical quality range Δk and level l is within the desired level range; and to set inlet valve 8 in the open configuration if biochemical quality indicator k is outside the desired biochemical quality range Δk and level l is outside the desired level range (Figures 4 and 7).

In detail, control unit 11 is configured to set drainage valve 14 in the open configuration and to subsequently set inlet valve 8 in the open configuration if biochemical quality indicator k is outside desired biochemical quality range Δk and level l is higher than the lower threshold l* of the desired level range (Figure 4).

Preferably, if drainage valve 14 is set in the open configuration, control unit 11 is configured to keep drainage valve 14 in such open configuration until level l is lower than lower threshold l* (Figure 7).

In addition, if inlet valve 8 is set in the open configuration, control unit 11 is configured to keep inlet valve 8 in such open configuration as long as biochemical quality indicator k is outside desired biochemical quality range Δk and until level l is greater than hysteresis level threshold l** (Figure 7).

Moreover, control unit 11 is configured to set inlet valve 8 in the open configuration if biochemical quality indicator k is outside desired biochemical quality range Δk and level l is lower than the lower threshold l* of the desired level range (Figure 4).

In addition, even more preferably, control unit 11 is configured to set drainage valve 14 in the open configuration only if level l is greater than hysteresis level threshold l** (Figure 7).

As a consequence, if biochemical quality indicator k is outside desired biochemical quality range Δk and level l is higher than lower threshold l* but lower than hysteresis level threshold l**, control unit 11 is configured to keep drainage valve 14 in the closed configuration and to set inlet valve 8 in the open configuration as long as biochemical quality indicator k is outside desired biochemical quality range Δk and until level l is greater than hysteresis level threshold l**.

Alternatively or in addition, control unit 11 is configured to set drainage valve 14 in the open configuration only if a predetermined amount of time has passed since drainage valve 14 was set in the closed configuration.

With reference to the embodiment of Figures 5 and 8, control unit 11 is configured to set drainage valve 14 in the open configuration and to subsequently set inlet valve 8 in the open configuration if temperature t is within the desired temperature range, biochemical quality indicator k is outside desired biochemical quality range Δk and level l is within the desired level range.

In detail, control unit 11 is configured to set drainage valve 14 in the open configuration and to subsequently set inlet valve 8 in the open configuration if temperature t is within the desired temperature range, biochemical quality indicator k is outside desired biochemical quality range Δk and level l is higher than the lower threshold l* of the desired level range (Figure 5).

Preferably, if drainage valve 14 is set in the open configuration, control unit 11 is configured to keep drainage valve 14 in such open configuration until level l is lower than lower threshold l* (Figure 8).Furthermore, control unit 11 is also configured to set inlet valve 8 in the open configuration if temperature t is within the desired temperature range, biochemical quality indicator k is outside desired biochemical quality range Δk and level l is outside the desired level range (Figures 5 and 8).

In detail, control unit 11 is configured to set inlet valve 8 in the open configuration if temperature t is within the desired temperature range, biochemical quality indicator k is outside desired biochemical quality range Δk and level l is lower than the lower threshold l* of the desired level range (Figure 5).

Preferably, if inlet valve 8 is set in the open configuration, control unit 11 is configured to keep inlet valve 8 in such open configuration as long as biochemical quality indicator k is outside desired biochemical quality range Δk and until level l is greater than hysteresis level threshold l** (Figure 8).

In addition, even more preferably, control unit 11 is configured to set drainage valve 14 in the open configuration only if level l is greater than hysteresis level threshold l** (Figure 8).

As a consequence, if biochemical quality indicator k is outside desired biochemical quality range Δk and level l is higher than lower threshold l* but lower than hysteresis level threshold l**, control unit 11 is configured to keep drainage valve 14 in the closed configuration and to set inlet valve 8 in the open configuration as long as biochemical quality indicator k is outside desired biochemical quality range Δk and until level l is greater than hysteresis level threshold l**.

Alternatively or in addition, control unit 11 is configured to set drainage valve 14 in the open configuration only if a predetermined amount of time has passed since drainage valve 14 was set in the closed configuration.

In use, machine 1 performs periodically (e.g. every two seconds) the determination of temperature t of processing fluid 6 and/or of containers 10 output from cooling zone 4 (step 30) and the comparison between the determined temperature t and the desired temperature range by means of control unit 11 (step 31) (Figures 3 and 6). In this condition, both inlet valve 8 and drainage valve 14 are in their respective closed configurations.

If temperature t is outside the desired temperature range, machine 1 performs the detection of level l of processing fluid 6 inside tank 5c by means of level sensor 13 (step 32) and the comparison between the detected level l and the desired level range by means of control unit 11 (step 33) (Figures 3 and 6).

In detail, if temperature t is higher than the upper threshold t* of the desired temperature range and level l is higher than the lower threshold l* of the desired level range, control unit 11 sets drainage valve 14 in the open configuration, so as to discharge at least part of processing fluid 6 from tank 5c (step 34 of Figure 3).

As a consequence, some processing fluid 6 moves from tanks 5a and 5b towards tank 5c, by virtue of the principle of the communicating vessels. In detail, processing fluid 6 inside tank 5c mixes with some processing fluid 6 from tanks 5b and/or 5a and processing fluid 6 inside tank 5b mixes with some processing fluid 6 from tank 5a.

Since the temperature of processing fluid 6 is higher inside tank 5b than inside tank 5a and the temperature of processing fluid 6 is higher inside tank 5c than inside tank 5b, this may be sufficient to bring temperature t within the desired temperature range (i.e. below upper threshold t*). Otherwise, temperature t will still be detected outside the desired temperature range.

Preferably, inlet valve 8 is set in the closed configuration when drainage valve 14 is in the open configuration.

Preferably, once drainage valve 14 is set in the open configuration, control unit 11 keeps drainage valve 14 in such open configuration as long as temperature t is higher than upper threshold t* and until level l is lower than lower threshold l* (step 34 of Figure 6). In other words, if temperature t becomes lower than upper threshold t* while processing fluid 6 is discharged from drainage valve 14, control unit 11 sets drainage valve 14 back in the closed configuration, even if level l is higher than lower threshold l*. This is possible because machine 1 performs periodically the determination of temperature t and the comparison of the determined temperature with the desired temperature range and the detection of level l and the comparison of the detected level l with the desired level range.

If, on the contrary, temperature t is higher than the upper threshold t* of the desired temperature range and level l is lower than the lower threshold l* of the desired level range, control unit 11 sets inlet valve 8 in the open configuration, so as to allow the injection of fresh processing fluid 9 directly in tank 5a (step 35 of Figure 3).

Preferably, drainage valve 14 is set in the closed configuration when inlet valve 8 is in the open configuration.

In addition, once inlet valve 8 is set in the open configuration, control unit 11 preferably keeps inlet valve 8 in such open configuration as long as temperature t is higher than upper threshold t* and until level l is greater than hysteresis level threshold l** of the desired level range (step 35 of Figure 6). In other words, if temperature t becomes lower than upper threshold t*, control unit 11 sets inlet valve 8 back in the closed configuration, even if level l is lower than hysteresis level threshold l**.

In addition, preferably, control unit 11 sets drainage valve 14 in the open configuration only if level l is greater than hysteresis level threshold l** (step 33 of Figure 6).

As a consequence, if temperature t is higher than the upper threshold t* and level l is higher than lower threshold l* but lower than hysteresis level threshold l**, control unit 11 keeps drainage valve 14 in the closed configuration and sets inlet valve 8 in the open configuration as long as temperature t is higher than upper threshold t* and until level l is greater than hysteresis level threshold l**. Therefore, if temperature t becomes lower than upper threshold t* while fresh processing fluid 9 is injected trough inlet valve 8, control unit 11 sets inlet valve 8 back in the closed configuration, even if level l is lower than hysteresis level threshold l**.

Alternatively or in addition, control unit 11 sets drainage valve 14 in the open configuration only if a predetermined amount of time has passed since drainage valve 14 was set in the closed configuration.

In one embodiment, machine 1 detects periodically (e.g. every two seconds) level l of the processing fluid 6 inside tank 5c (step 32) independently of the determination of temperature t (step 30).

Machine 1 also performs periodically (e.g. every 5 minutes) the detection of biochemical quality indicator k of processing fluid 6 by means of biochemical quality detector 15 (step 36) and the comparison between the detected biochemical quality indicator k and the desired biochemical quality range Δk by means of control unit 11 (step 37) (Figures 4 and 7).

In detail, the detection of biochemical quality indicator k (step 36) may be carried out independently of the determination of temperature t (step 30).

If the detected biochemical quality indicator k is outside the desired biochemical quality range Δk, machine 1 performs the detection of level l inside tank 5c by means of level sensor 13 (step 32) and the comparison between the detected level l and the desired level range by means of control unit 11 (step 33) (Figures 4 and 7).

In detail, if biochemical quality indicator k is outside the desired biochemical quality range Δk and level l is higher than the lower threshold l* of the desired level range, control unit 11 controls drainage valve 14 in the open configuration, so as to discharge at least part of processing fluid 6 from tank 5c (step 34 of Figure 4).

Preferably, once drainage valve 14 is set in the open configuration, control unit 11 keeps drainage valve 14 in such open configuration until level l is lower than lower threshold l* (step 34 of Figure 7).

Subsequently, control unit 11 controls inlet valve 8 in the open configuration, so as to allow the injection of fresh processing fluid 9 directly in tank 5a (step 35 of Figures 4 and 7).

Preferably, once inlet valve 8 is set in the open configuration, control unit 11 keeps inlet valve 8 in such open configuration as long as biochemical quality indicator k is outside desired biochemical quality range Δk and until level l is greater than hysteresis level threshold l**, which is greater than lower threshold l* (step 35 of Figure 7). In other words, if biochemical quality indicator k moves within desired biochemical quality range Δk while fresh processing fluid 9 is injected trough inlet valve 8, control unit 11 sets inlet valve 8 back in the closed configuration, even if level l is lower than hysteresis level threshold l**.

If, on the contrary, biochemical quality indicator k is outside the desired biochemical quality range Δk and level l is lower than the lower threshold l* of the desired level range, control unit 11 controls inlet valve 8 in the open configuration, so as to allow the injection of fresh processing fluid 9 directly in tank 5a (step 35 of Figure 4).

In addition, even more preferably, control unit 11 sets drainage valve 14 in the open configuration only if level l is greater than hysteresis level threshold l** (step 33 of Figure 7).

As a consequence, if biochemical quality indicator k is outside desired biochemical quality range Δk and level l is higher than lower threshold l* but lower than hysteresis level threshold l**, control unit 11 is configured to keep drainage valve 14 in the closed configuration and to set inlet valve 8 in the open configuration as long as biochemical quality indicator k is outside desired biochemical quality range Δk and until level l is greater than hysteresis level threshold l**. Therefore, if biochemical quality indicator k moves within desired biochemical quality range Δk while fresh processing fluid 9 is injected through inlet valve 8, control unit 11 sets inlet valve 8 back in the closed configuration, even if level l is lower than hysteresis level threshold l**.

Alternatively or in addition, control unit 11 sets drainage valve 14 in the open configuration only if a predetermined amount of time has passed since drainage valve 14 was set in the closed configuration.

In the embodiment shown in Figures 5 and 8, machine 1 also performs the detection of biochemical quality indicator k of processing fluid 6 (step 36) and the comparison between the detected biochemical quality indicator k and the desired biochemical quality range Δk (step 37) every time machine 1 performs the determination of temperature t (step 30).

Preferably, in the embodiment shown in Figures 5 and 8, the detection of biochemical quality indicator k (step 36) is carried out after the determination of temperature t (step 30) and the comparison between temperature t and the desired temperature range (step 31). Even more preferably, the detection of biochemical quality indicator k (step 36) is carried out if temperature t is within the desired temperature range (step 31) (Figures 5 and 8).

In detail, if temperature t is within the desired temperature range (step 31), biochemical quality indicator k is outside desired biochemical quality range Δk and level l is higher than the lower threshold l* of the desired level range, control unit 11 controls drainage valve 14 in the open configuration, so as to discharge at least part of processing fluid 6 from tank 5c (step 34 of Figure 5).

Preferably, once drainage valve 14 is set in the open configuration, control unit 11 keeps drainage valve 14 in such open configuration until level l is lower than lower threshold l* (step 34 of Figure 8).

Subsequently, control unit 11 controls inlet valve 8 in the open configuration, so as to allow the injection of fresh processing fluid 9 directly in tank 5a (step 35 of Figures 5 and 8).

If, on the contrary, temperature t is within the desired temperature range (step 31), biochemical quality indicator k is outside the desired biochemical quality range Δk and level l is lower than the lower threshold l* of the desired level range, control unit 11 controls inlet valve 8 in the open configuration, so as to allow the injection of fresh processing fluid 9 directly in tank 5a (step 35) (Figure 5).

Preferably, once inlet valve 8 is set in the open configuration, control unit 11 keeps inlet valve 8 in such open configuration as long as biochemical quality indicator k is outside desired biochemical quality range Δk and until level l is greater than hysteresis level threshold l** (step 35 of Figure 8). In other words, if biochemical quality indicator k moves within desired biochemical quality range Δk while fresh processing fluid 9 is injected through inlet valve 8, control unit 11 sets inlet valve 8 back in the closed configuration, even if level l is lower than hysteresis level threshold l**.

In addition, preferably, control unit 11 sets drainage valve 14 in the open configuration only if level l is greater than hysteresis level threshold l** (step 33 of Figure 8).

As a consequence, if biochemical quality indicator k is outside the desired biochemical quality range Δk and level l is higher than lower threshold l* but lower than hysteresis level threshold l**, control unit 11 keeps drainage valve 14 in the closed configuration and sets inlet valve 8 in the open configuration as long as biochemical quality indicator k is outside the desired biochemical quality range Δk and until level l is greater than hysteresis level threshold l**. In other words, if biochemical quality indicator k moves within desired biochemical quality range Δk while fresh processing fluid 9 is injected through inlet valve 8, control unit 11 sets inlet valve 8 back in the closed configuration, even if level l is lower than hysteresis level threshold l**.

Alternatively or in addition, control unit 11 sets drainage valve 14 in the open configuration only if a predetermined amount of time has passed since drainage valve 14 was set in the closed configuration.

The advantages of the control method, control system 100 and method for retrofitting according to the present invention will be clear from the above description.

In particular, since control unit 11 is configured to control drainage valve 14 to discharge at least part of processing fluid 6 from tank 5c, it is possible to control temperature t in an efficient manner, while minimizing the waste of processing fluid 6.

In fact, before injecting fresh processing fluid 9 in tank 5a, some processing fluid 6 is drained through drainage valve 14, if the detected level l is higher than the lower threshold l* or the hysteresis level threshold l** of the desired level range. In this case, the mass and the thermal inertia of processing fluid 6 inside tanks 5a, 5b, 5c is reduced, before any injection of fresh processing fluid 9. Therefore, the amount of fresh processing fluid 9 that needs be injected for the purpose of obtaining a given variation of temperature t is lower than in the known machines discussed in the introductory part of the present description.

Furthermore, since the drainage of processing fluid 6 is carried out before the injection of fresh processing fluid 9 if the detected level l is higher than the lower threshold l*, the biochemical quality of processing fluid 6 is improved. In fact, the fresh processing fluid 9 injected after the drainage mixes with processing fluid 6 having a lower mass than before the drainage.

In addition, since the drainage of processing fluid 6 and the injection of fresh processing fluid 9 may be carried out also on the basis of the detected biochemical quality indicator k, the biochemical quality of processing fluid 6 can be even more accurately controlled during the operation of machine 1. In detail, the detection of biochemical quality indicator k may be carried out in concomitance with the determination of temperature t or independently of it (e.g.

periodically).

Furthermore, since the drainage of processing fluid 6 and/or the injection of fresh processing fluid 9 may be carried out as soon as the biochemical quality indicator k is outside the desired biochemical quality range Δk, the complete substitution of processing fluid 6 with fresh processing fluid 9 is required very infrequently or not at all.

The Applicant has also observed that when drainage valve 14 is adapted to allow or prevent the drainage of processing fluid 6 from the downstream-most tank 5c, the reduction of temperature t is particularly efficient.

In fact, when some fluid is discharged from tank 5c, processing fluid 6 inside tank 5c mixes with some processing fluid 6 from tanks 5b and/or 5a and processing fluid 6 inside tank 5b mixes with some processing fluid 6 from tank 5a.

Since the temperature of processing fluid 6 is higher inside tank 5b than inside tank 5a and the temperature of processing fluid 6 is higher inside tank 5c than inside tank 5b, this may be sufficient to bring temperature t within the desired temperature range (i.e. below upper threshold t*). Otherwise, temperature t will still be detected to be outside the desired temperature range.

The reduction of temperature t is even more efficient when inlet valve 8 injects fresh processing fluid 9 directly in the upstream-most collection tank 5a.

The discussed solution may also be easily fitted (with a so called "retrofit" operation) to existing machines, by: arranging inlet valve 8 at machine 1, preferably so as to be adapted to inject fresh processing fluid 9 directly in collection tank 5a; arranging temperature sensor 12 and/or biochemical quality detector 15 at heating zone 2; arranging level sensor 13 in collection tank 5a, 5b, 5c; arranging drainage valve 14 in collection tank 5a, 5b, 5c, preferably in collection tank 5c; operatively connecting level sensor 13, temperature sensor 12 and/or biochemical quality detector 15 to control unit 11; configuring control unit 11 to set drainage valve 14 in the open configuration if temperature t is outside the desired temperature range and/or biochemical quality indicator k is outside the desired biochemical quality range and level l is within the desired level range; and configuring control unit 11 to set inlet valve 8 in the open configuration if temperature t is outside the desired temperature range and/or biochemical quality indicator k is outside the desired biochemical quality range and level l is outside the desired level range.

Furthermore, since control unit 11 is preferably configured to keep inlet valve 8 in the open configuration as long as temperature t is higher than upper threshold t* and until level l is greater than hysteresis level threshold l** and control unit 11 is configured to set drainage valve

14 in the open configuration only if level l is greater than hysteresis level threshold l**, damage to drainage valve 14 and inlet valve 8 caused by the rapid switching between the respective open and closed configurations is avoided.

Since alternatively or in addition, control unit 11 is configured to set drainage valve 14 in the open configuration only if a predetermined amount of time has passed since drainage valve 14 was set in the closed configuration, damage to drainage valve 14 and inlet valve 8 is even less likely.

Finally, it is apparent that modifications and variants not departing from the scope of protection of the claims may be made to control method and system according to the present invention.

In particular, the claimed control method and system may be applied also to heat treatment zone 3 or to cooling zone 4.

In addition, machine 1 may comprise more than one inlet valve 8 and/or more than one drainage valve 14. For example, machine 1 may comprise an inlet valve 8 and/or a drainage valve 14 for each collection tank 5a, 5b, 5c.

Furthermore, heating zone 2 may comprise a plurality of temperature sensors 12, each arranged at a respective collection tank 5a, 5b, 5c. Accordingly, control unit 11 may be operatively connected to the plurality of temperature sensors 12 and configured to compare the temperature detected by each of the temperature sensors 12 with a respective desired temperature range.

Similarly, heating zone 2 may comprise a plurality of biochemical quality detectors 15, each arranged at a respective collection tank 5a, 5b, 5c. Accordingly, control unit 11 may be operatively connected to the plurality of biochemical quality detectors 15 and configured to compare the biochemical quality indicator k detected by each of the biochemical quality detectors 15 with a respective desired biochemical quality range.

CLAIMS

1.- A control method for controlling a machine (1) for the temperature processing of containers (10) of food products; said machine (1) comprising a control unit (11) and at least one temperature-processing zone (2, 3, 4), where the containers (10) are processed by injecting a processing fluid (6) on them; the temperature-processing zone (2, 3, 4) comprising, in turn:

- at least one collection tank (5a, 5b, 5c) for storing said processing fluid (6); and

- an injection assembly (7a, 7b, 7c) for injecting said processing fluid (6) from said at least one collection tank (5a, 5b, 5c) onto said containers (10);

said method being characterized by comprising the steps of:

i) determining a temperature (t) of said processing fluid (6) by means of a temperature sensor (12) of said machine (1) and/or a temperature (t) of said containers (10);

ii) comparing the temperature (t) determined at said step i) with a desired temperature range by means of said control unit (11);

iii) detecting a level (l) of said processing fluid (6) inside said at least one collection tank (5a, 5b, 5c) by means of a level sensor (13) of said machine (1);

iv) comparing the level (l) detected at said step iii) with a desired level range by means of said control unit (11);

v) controlling by means of said control unit (11) a drainage valve (14) of said at least one collection tank (5a, 5b, 5c) to discharge at least part of the processing fluid (6) from said at least one collection tank (5a, 5b, 5c), if the temperature (t) determined at step i) is outside said desired temperature range and the level (l) detected at step iii) is within said desired level range; and

vi) controlling by means of said control unit (11) an inlet valve (8) of said machine (1) to allow the injection of fresh processing fluid (9) from outside said machine (1) in said at least one collection tank (5a, 5b, 5c), if the temperature (t) determined at step i) is outside said desired temperature range and the level (l) detected at step iii) is outside said desired level range.

2.- The control method according to claim 1, characterized in that during said step v) said control unit (11) controls said drainage valve (14) to discharge at least part of the processing fluid (6) from said at least one collection tank (5a, 5b, 5c), if the temperature (t) determined at step i) is higher than an upper temperature threshold (t*) of said desired temperature range and the level (l) detected at step iii) is higher than a lower level threshold (l*; l**) of said desired level range; and in that during said step vi) said control unit (11) controls said inlet valve (8) to allow the injection of fresh processing fluid (9) from outside said machine (1) in said at least one collection tank (5a, 5b, 5c), if the temperature (t) determined at step i) is higher than said upper temperature threshold (t*) and the level (l) detected at step iii) is lower than said lower level threshold (l*; l**).

3.- The control method according to claim 2, characterized in that during said step v) said control unit (11) controls said drainage valve (14) to discharge at least part of the processing fluid (6) from said at least one collection tank (5a, 5b, 5c), if the temperature (t) determined at step i) is higher than said upper temperature threshold (t*) of said desired temperature range and the level (l) detected at step iii) is higher than an hysteresis level threshold (l**) of said desired level range; said hysteresis level threshold (l**) being greater than said lower level threshold (l*); and in that during said step vi) said control unit (11) controls said inlet valve (8) to allow the injection of fresh processing fluid (9) from outside said machine (1) in said at least one collection tank (5a, 5b, 5c) if the temperature (t) determined at step i) is higher than said upper temperature threshold (t*) of said desired temperature range and the level (l) detected at step iii) is lower than said hysteresis level threshold (l**).

4.- The control method according to claim 3, characterized in said step v) comprises the step vii) of controlling said drainage valve (14) by means of said control unit (11) to discharge the processing fluid (6) from said at least one collection tank (5a, 5b, 5c) until said level (l) is lower than said lower level threshold (l*); and in that said step vi) comprises the step viii) of controlling said inlet valve (8) by means of said control unit (11) to allow the injection of fresh processing fluid (9) from outside said machine (1) in said at least one collection tank (5a, 5b, 5c) until said level (l) is higher than said hysteresis level threshold (l**).

5.- The control method according to claim 4, characterized by comprising the further steps of:

ix) preventing by means of said control unit (11) said drainage valve (14) from discharging processing fluid (6) from said at least one collection tank (5a, 5b, 5c), if during said step vii) said temperature (t) of said processing fluid (6) and/or said temperature (t) of said containers (10) becomes lower than said upper temperature threshold (t*);

x) preventing by means of said control unit (11) said inlet valve (8) from allowing the injection of fresh processing fluid (9) in said at least one collection tank (5a, 5b, 5c), if during said step viii) said temperature (t) of said processing fluid (6) and/or said temperature (t) of said containers (10) becomes lower than said upper temperature threshold (t*).

6.- The control method according to claims 1 to 5, characterized in that said step v) comprises the further step xi) of controlling by means of said control unit (11) a drainage valve (14) of a downstream-most collection tank (5c) of said temperature-processing zone (2, 3, 4) according to a movement path (P) of said containers (1) along said machine (1), to discharge at least part of the processing fluid (6) from said downstream-most collection tank (5c); said temperature-processing zone (2, 3, 4) comprising a plurality of said collection tanks (5a, 5b, 5c), each being in fluidic communication with the other tanks (5a, 5b, 5c) of the same temperature-processing zone (2, 3, 4).

7.- The control method according to claim 6, characterized in that said step vi) comprises the further step xii) of controlling by means of said control unit (11) said inlet valve (8) to allow the injection of fresh processing fluid (9) directly in an upstream-most collection tank (5a) of said temperature-processing zone (2, 3, 4) according to said movement path (P).

8.- The control method according to any one of the foregoing claims, characterized by comprising the further steps of:

xiii) detecting a biochemical quality indicator (k) of said processing fluid (6) by means of a biochemical quality detector (15) of said machine (1); and

xiv) comparing the biochemical quality indicator (k) detected at said step xiii) with a desired biochemical quality range (Δk) by means of said control unit (11);

xv) controlling by means of said control unit (11) said drainage valve (14) to discharge at least part of the processing fluid (6) from said at least one collection tank (5a, 5b, 5c), if the biochemical quality indicator (k) detected at step xiii) is outside said desired biochemical quality range (Δk) and the level (l) detected at step iii) is within said desired level range; and subsequently controlling by means of said control unit (11) said inlet valve (8) to allow the injection of fresh processing fluid (9) in said at least one collection tank (5a, 5b, 5c); and

xvi) controlling by means of said control unit (11) said inlet valve (8) to allow the injection of fresh processing fluid (9) in said at least one collection tank (5a, 5b, 5c), if the biochemical quality indicator (k) detected at step xiii) is outside said desired biochemical quality range (Δk) and the level (l) detected at step iii) is outside said desired level range.

9.- The control method according to claim 8, characterized in that said steps xv) and xvi) are carried out if the temperature (t) determined at step i) is within said desired temperature range.

10.- Method for retrofitting a machine (1) for the temperature processing of containers (10) for food products; said machine (1) comprising at least one temperature-processing zone (2, 3, 4), where the containers (10) are processed by injecting a processing fluid (6) on them; said temperature processing-zone (2, 3, 4) comprising:

- at least one collection tank (5a, 5b, 5c) for storing said processing fluid (6); and

- an injection assembly (7a, 7b, 7c) for injecting said processing fluid (6) from said at least one collection tank

(5a, 5b, 5c) onto said containers (10);

said method being characterized by comprising the steps of:

xvii) arranging at said machine (1) an inlet valve (8) controllable in an open configuration, in which it allows the inlet of fresh processing fluid (9) from outside said machine (1), or in a closed configuration, in which it prevents fresh processing fluid (9) from being inlet inside said machine (1);

xviii) arranging at said temperature processing-zone (2, 3, 4) a temperature sensor (12) adapted to detect a temperature (t) of the processing fluid (6);

xix) arranging inside said at least one collection tank (5a, 5b, 5c) a level sensor (13) adapted to detect a level (l) of the processing fluid (6) inside said at least one collection tank (5a, 5b, 5c);

xx) arranging at said at least one collection tank (5a, 5b, 5c) a drainage valve (14), which is controllable in an open configuration, in which it allows the drainage of at least part of the processing fluid (6) from said at least one collection tank (5a, 5b, 5c), or in a closed configuration, in which it prevents the drainage of the processing fluid (6) from said at least one collection tank (5a, 5b, 5c);

xxi) operatively connecting said temperature sensor (12) and said level sensor (13) to a control unit (11) of said machine (1);

xxii) configuring said control unit (11) to set said drainage valve (14) in the open configuration if the temperature (t) of the processing fluid (6) and/or a temperature (t) of said containers (10) is outside a desired temperature range and said level (l) is within a desired level range; and configuring said control unit (11) to set said inlet valve (8) in said open configuration if the temperature (t) of the processing fluid (6) and/or the temperature (t) of said containers (10) is outside said desired temperature range and said level (l) is outside said desired level range.

11.- A control method for controlling a machine (1) for the temperature processing of containers (10) of food products; said machine (1) comprising a control unit (11), at least one temperature-processing zone (2, 3, 4), where the containers (10) are processed by injecting a processing fluid (6) on them; the temperature-processing zone (2, 3, 4) comprising, in turn:

- at least one collection tank (5a, 5b, 5c) for storing said processing fluid (6); and

- an injection assembly (7a, 7b, 7c) for injecting said processing fluid (6) from said at least one collection tank (5a, 5b, 5c) onto said containers (10);

said method being characterized by comprising the steps of:

i) detecting a biochemical quality indicator (k) of said processing fluid (6) by means of a biochemical quality detector (15) of said machine (1);

ii) comparing the biochemical quality indicator (k) detected at said step i) with a desired biochemical quality range (Δk) by means of said control unit (11);

iii) detecting a level (l) of said processing fluid (6) inside said at least one collection tank (5a, 5b, 5c) by means of a level sensor (13) of said machine (1);

iv) comparing the level (l) detected at said step iii) with a desired level range by means of said control unit (11);

v) controlling by means of said control unit (11) a drainage valve (14) of said at least one collection tank (5a, 5b, 5c) to discharge at least part of the processing fluid (6) from said at least one collection tank (5a, 5b, 5c), if the biochemical quality indicator (k) detected at step i) is outside said desired biochemical quality range (Δk) and the level (l) detected at step iii) is within said desired level range; and subsequently controlling by means of said control unit (11) an inlet valve (8) of said machine (1) to allow the injection of fresh processing fluid (9) from outside said machine (1) in said at least one collection tank (5a, 5b, 5c); and

vi) controlling by means of said control unit (11) an inlet valve (8) of said machine (1) to allow the injection of fresh processing fluid (9) from outside said machine (1) in said at least one collection tank (5a, 5b, 5c), if the biochemical quality indicator (k) detected at step i) is outside said desired biochemical quality range (Δk) and the level (l) detected at step iii) is outside said desired level range.

12.- A control system (100) for controlling a machine (1) for the temperature processing of containers (10) of food products; said machine (1) comprising at least one temperature-processing zone (2, 3, 4), where containers (10) are processed by injecting a processing fluid (6) on them; said temperature-processing zone (2, 3, 4) comprising, in turn:

- at least one collection tank (5a, 5b, 5c) for storing said processing fluid (6);

- an injection assembly (7a, 7b, 7c) for injecting said processing fluid (6) from said at least one collection tank (5a, 5b, 5c) onto said containers (10); and

- an inlet valve (8) controllable in an open configuration, in which it allows the inlet of a fresh processing fluid (9) from outside said machine (1), or in a closed configuration, in which it prevents fresh processing fluid (9) from being inlet inside said machine (1);

said temperature-processing zone (2, 3, 4) further comprising:

- a temperature sensor (12) adapted to detect a temperature (t) of said processing fluid (6);

- a level sensor (13) adapted to detect a level (l) of the processing fluid (6) inside said at least one collection tank (5a, 5b, 5c); and

- a drainage valve (14) controllable in an open configuration, in which it allows the drainage of at least part of the processing fluid (6) from said at least one collection tank (5a, 5b, 5c), or in a closed configuration, in which it prevents the drainage of the processing fluid (6) from said at least one collection tank (5a, 5b, 5c);

said control system (100) comprising a control unit (11) operatively connected to said machine (1);

said control unit (11) being configured to compare the temperature (t) determined by said temperature sensor (12) and/or a temperature (t) of said containers (10) with a desired temperature range and compare the level (l) detected by said level sensor (13) with a desired level range;

characterized in that said control unit (11) is configured to set, in use, said drainage valve (14) in said open configuration if the temperature (t) of the processing fluid (6) and/or the temperature (t) of said containers (10) is outside said desired temperature range and the level (l) is within said desired level range;

said control unit (11) being further configured to set, in use, said inlet valve (8) in said open configuration if the temperature (t) of the processing fluid (6) and/or the temperature (t) of said containers (10) is outside said desired temperature range and the level (l) is outside said desired level range.

13.- The control system according to claim 12 characterized in that said control unit (11) is configured to set, in use, said drainage valve (14) in said open configuration if the temperature (t) of the processing fluid (6) and/or the temperature (t) of said containers (10) is higher than an upper temperature threshold (t*) of said desired temperature range and the level (l) is higher than a lower level threshold (l*, l**) of said desired level range;

said control unit (11) being further configured to set, in use, said inlet valve (8) in said open configuration if the temperature (t) of the processing fluid (6) and/or the temperature (t) of said containers (10) is higher than said upper temperature threshold (t*) and the level (l) is lower than said lower level threshold (l*, l**).

14.- The control system according to claim 13, characterized in that said control unit (11) is configured to set, in use, said drainage valve (14) in said open configuration if the temperature (t) of the processing fluid (6) and/or the temperature (t) of said containers (10) is higher than an upper temperature threshold (t*) of said desired temperature range and the level (l) is higher than an hysteresis level threshold (l**) of said desired level range; said hysteresis level threshold (l**) being greater than said lower level threshold (l*);

said control unit (11) being further configured to set, in use, said inlet valve (8) in said open configuration if the temperature (t) of the processing fluid (6) and/or the temperature (t) of said containers (10) is higher than said upper temperature threshold (t*) and the level (l) is lower than said hysteresis level threshold (l**).

15.- The control system according to claim 14, characterized in that said control unit (11) is configured to keep said drainage valve (14) in said open configuration until, in use, said level (l) lower than said lower level threshold (l*) unless, in use, said temperature (t) of said processing fluid (6) and/or said temperature (t) of said containers (10) becomes lower than said upper temperature threshold (t*);

and in that said control unit (11) is configured to keep said inlet valve (8) in said open configuration until, in use, said level (l) is greater than said hysteresis level threshold (l**) unless, in use, said temperature (t) of said processing fluid (6) and/or said temperature (t) of said containers (10) becomes lower than said upper temperature threshold (t*).

16.- The control system according to claims 12 to 15 wherein said temperature-processing zone (2, 3, 4) comprises a plurality of collection tanks (5a, 5b, 5c); each tank (5a, 5b, 5c) being in fluidic communication with the other tanks (5a, 5b, 5c) of the same temperature-processing zone (2, 3, 4);

characterized in that said control unit (11) is further configured to control said drainage valve (14) of the downstream-most collection tank (5c) of said temperature-processing zone (2, 3, 4) according to a movement path (P) of said containers (10) along said machine (1).

17.- The control system according to claim 16, characterized in that said control unit (11) is further configured to set said inlet valve (8) in said open configuration, so as to allow the injection of fresh processing fluid (9) directly in the upstream-most collection tank (5a) of said temperature-processing zone (2, 3, 4) according to said movement path (P).

18.- The control system according to claims 12 to 17, wherein said temperature-processing zone (2, 3, 4) further comprises a biochemical quality detector (15), which is adapted to detect a biochemical quality indicator (k) of said processing fluid (6);

characterized in that said control unit (11) is further configured to compare, in use, said biochemical quality indicator (k) with a desired biochemical quality range (Δk).

19.- A machine (1) for the temperature processing of containers (10) for food products comprising at least one temperature-processing zone (2, 3, 4), where the containers (10) are processed by injecting a processing fluid (6) on them; said temperature processing-zone (2, 3, 4) comprising:

- at least one collection tank (5a, 5b, 5c) for storing said processing fluid (6);

- an injection assembly (7a, 7b, 7c) for injecting said processing fluid (6) from said at least one collection tank (5a, 5b, 5c) onto said containers (10); and

- an inlet valve (8) controllable in an open configuration, in which it allows the inlet of fresh processing fluid (9) from outside said machine (1), or in a closed configuration, in which it prevents fresh processing fluid (9) from being inlet inside said machine (1);

said temperature-processing zone (2, 3, 4) further comprising:

- a temperature sensor (12) adapted to detect a temperature (t) of the processing fluid (6);

- a level sensor (13) adapted to detect a level of the processing fluid (6) inside said at least one collection tank (5a, 5b, 5c); and

- a drainage valve (14) controllable in an open configuration, in which it allows the drainage of at least part of the processing fluid (6) from said at least one collection tank (5a, 5b, 5c), or in a closed configuration, in which it prevents the drainage of the processing fluid (6) from said at least one collection tank (5a, 5b, 5c);

characterized by comprising a control system (100) according to any one of claims 12 to 18.

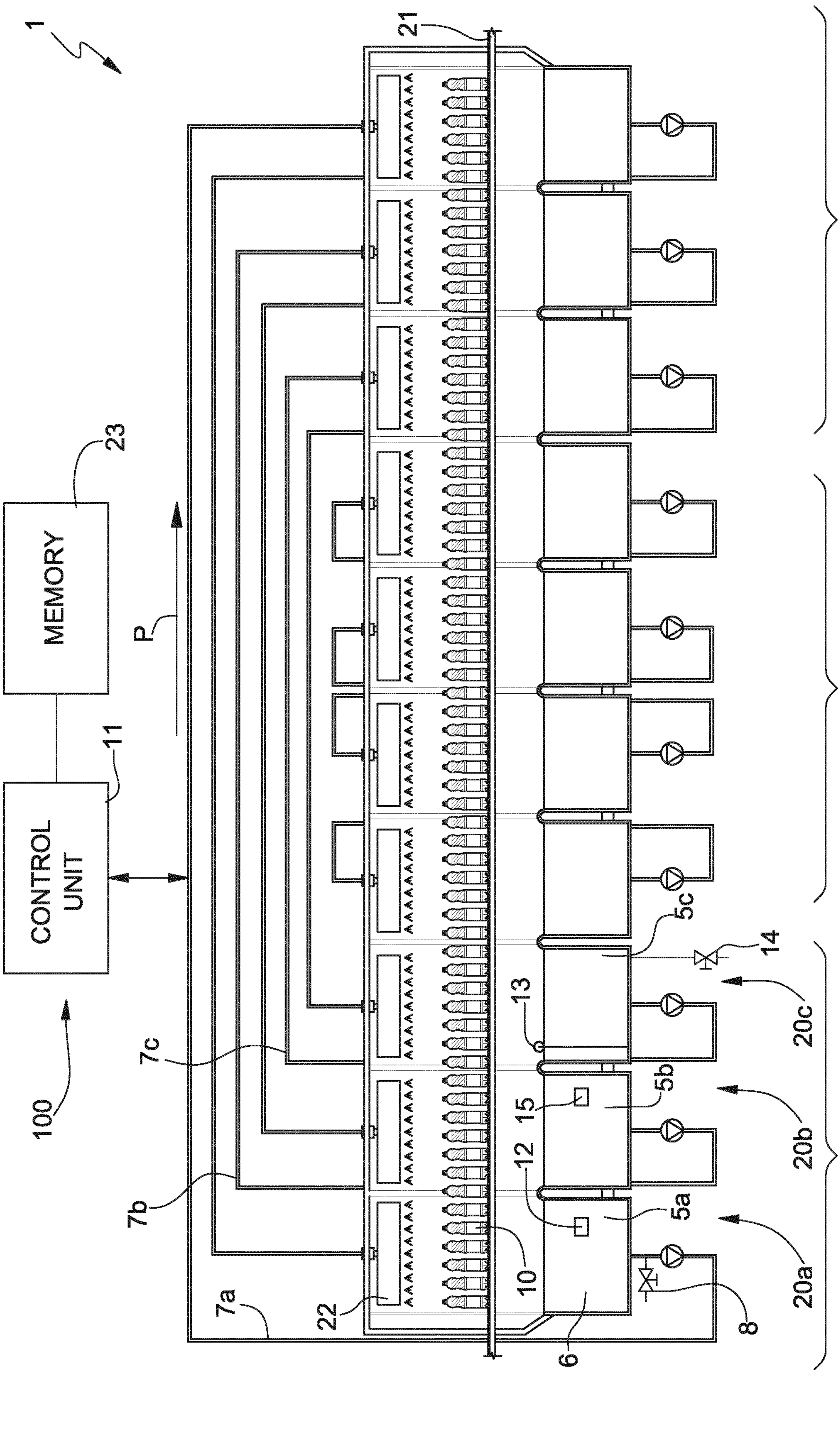
CONTROL UNIT
MEMORY
P
1
2
3
4
5a
5b
5c
6
7a
7b
7c
8
10
11
12
13
14
15
20a
20b
20c
21
22
23
100

FIG. 1

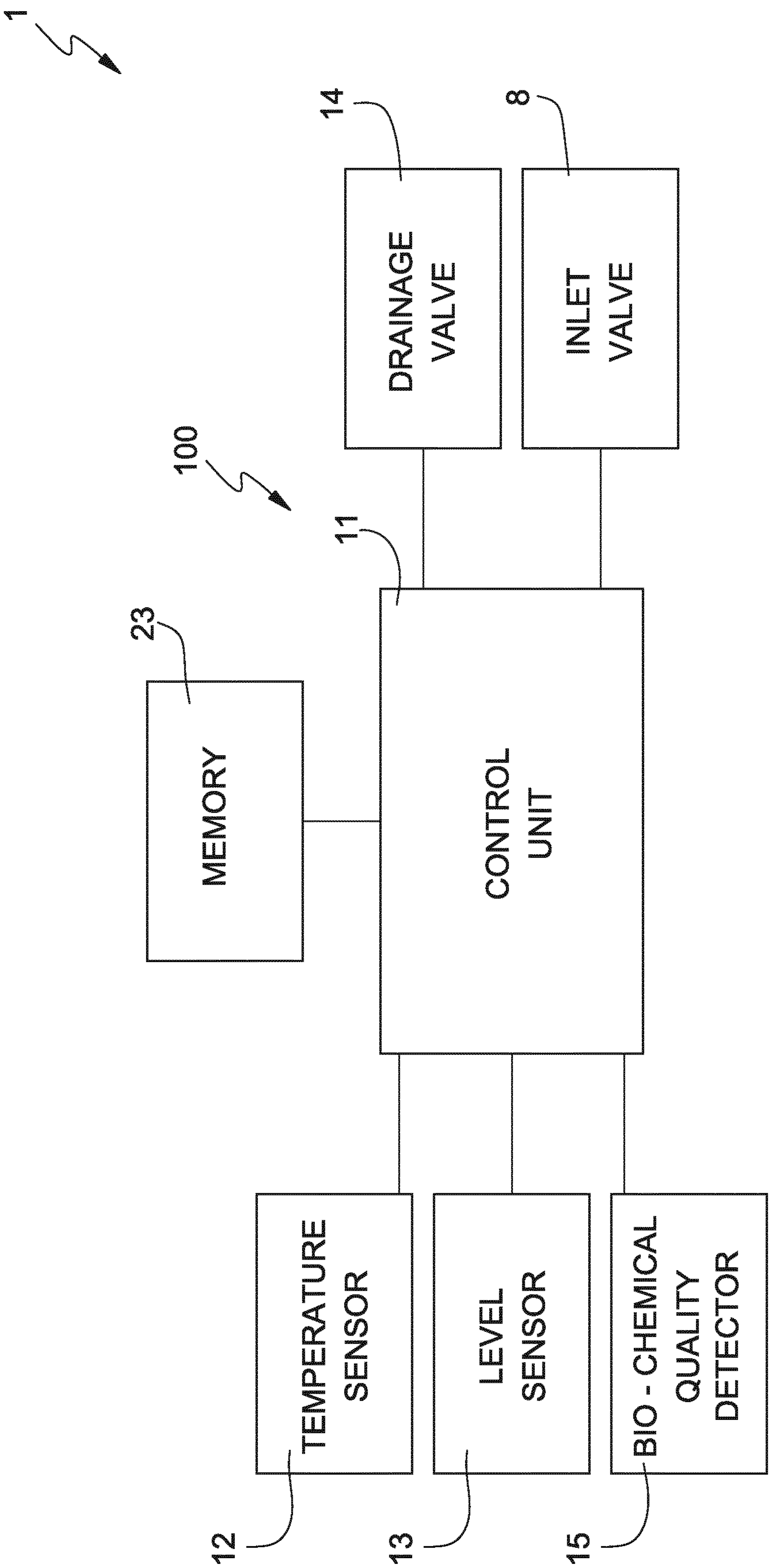
1
14
8
DRAINAGE VALVE
INLET VALVE
100
11
23
MEMORY
CONTROL UNIT
TEMPERATURE SENSOR
LEVEL SENSOR
BIO - CHEMICAL QUALITY DETECTOR
12
13
15

FIG. 2

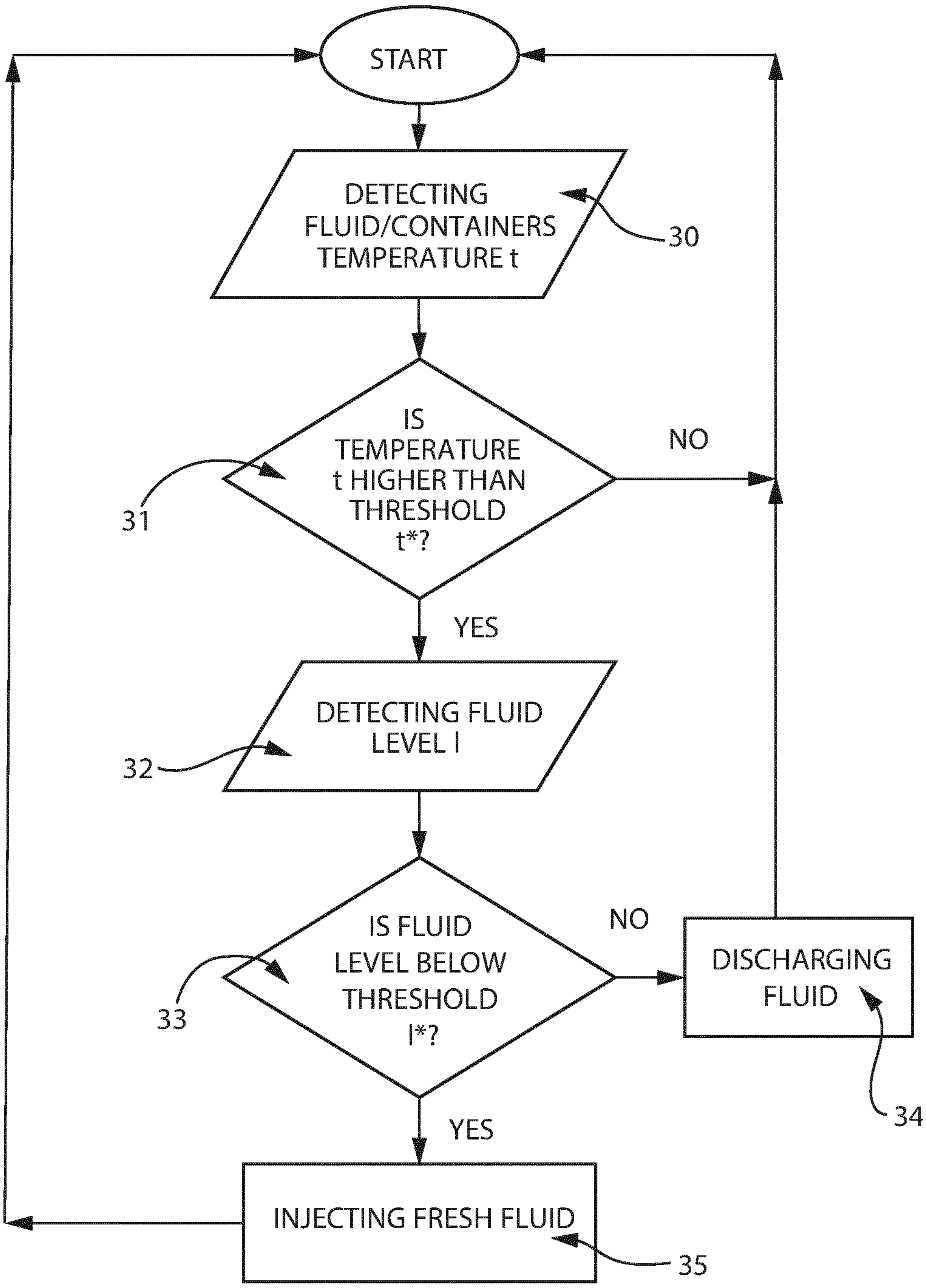
START
DETECTING FLUID/CONTAINERS TEMPERATURE t
30
IS TEMPERATURE t HIGHER THAN THRESHOLD t*?
31
NO
YES
DETECTING FLUID LEVEL l
32
IS FLUID LEVEL BELOW THRESHOLD l*?
33
NO
DISCHARGING FLUID
34
YES
INJECTING FRESH FLUID
35

FIG. 3

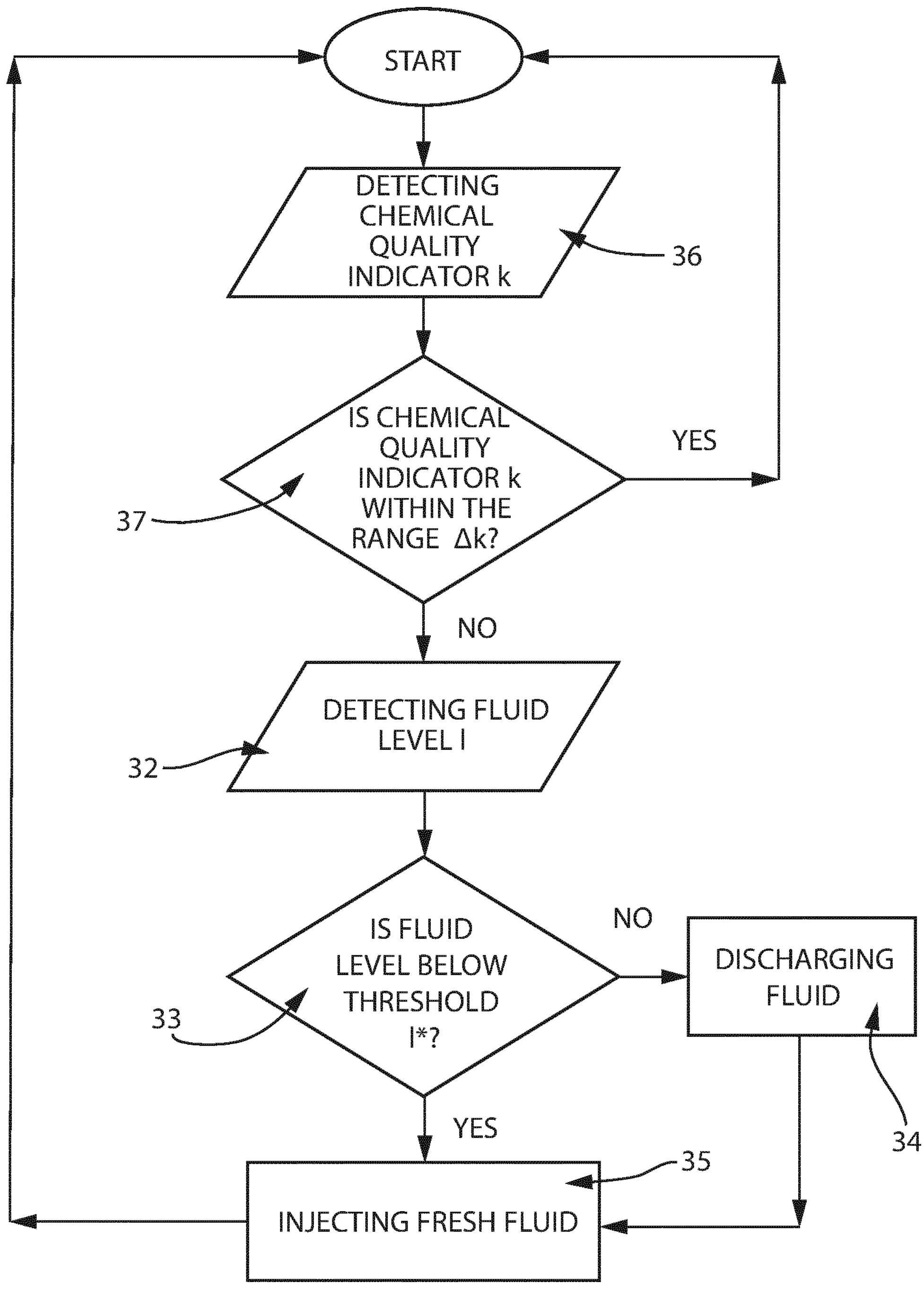
START
DETECTING CHEMICAL QUALITY INDICATOR k
36
IS CHEMICAL QUALITY INDICATOR k WITHIN THE RANGE Δk?
YES
37
NO
DETECTING FLUID LEVEL l
32
IS FLUID LEVEL BELOW THRESHOLD l*?
NO
DISCHARGING FLUID
33
YES
34
35
INJECTING FRESH FLUID

FIG. 4

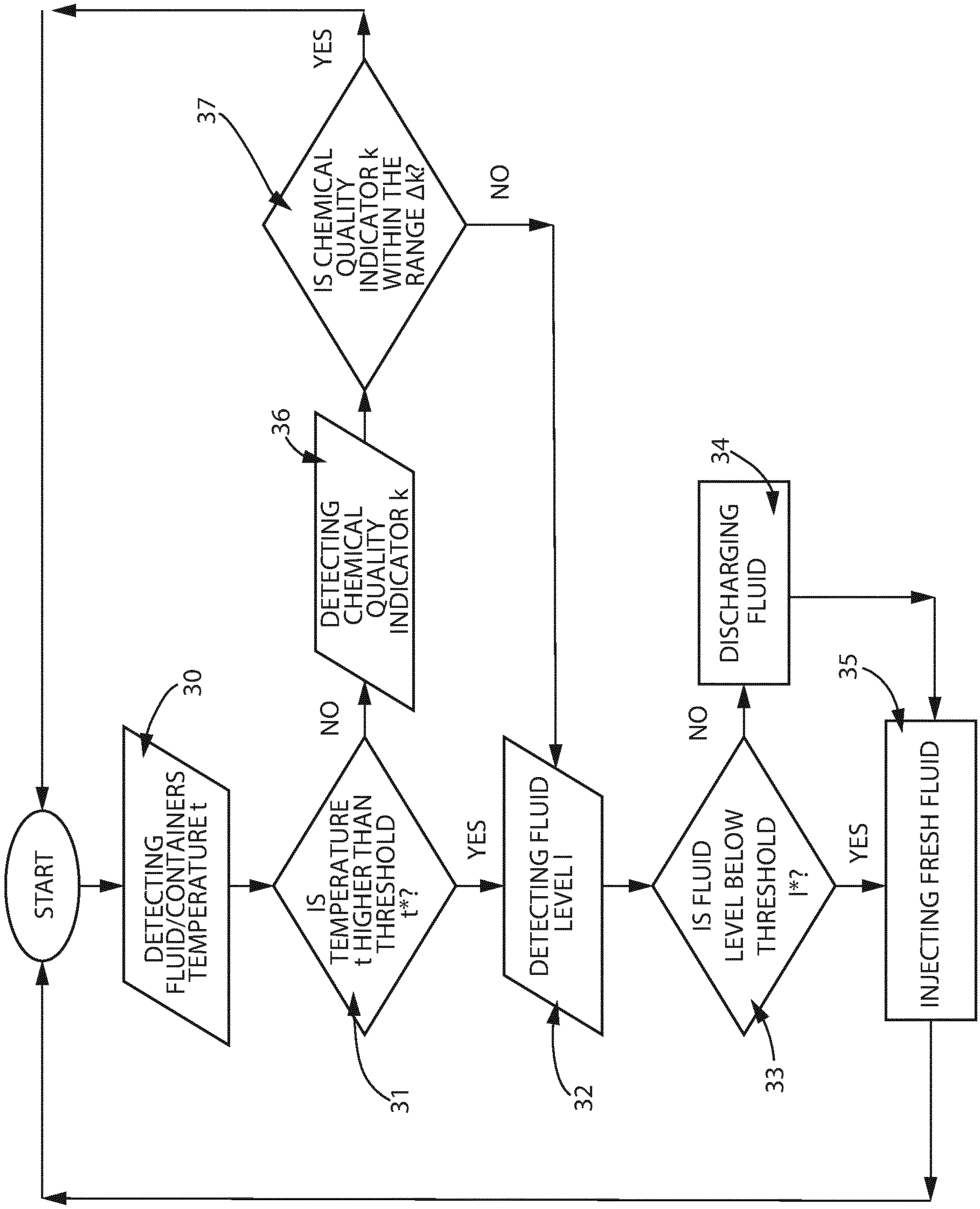
START
DETECTING FLUID/CONTAINERS TEMPERATURE t
30
IS TEMPERATURE t HIGHER THAN THRESHOLD t*?
31
YES
NO
DETECTING CHEMICAL QUALITY INDICATOR k
36
IS CHEMICAL QUALITY INDICATOR k WITHIN THE RANGE Δk?
37
YES
NO
DETECTING FLUID LEVEL l
32
IS FLUID LEVEL BELOW THRESHOLD l*?
33
YES
NO
DISCHARGING FLUID
34
INJECTING FRESH FLUID
35

FIG. 5

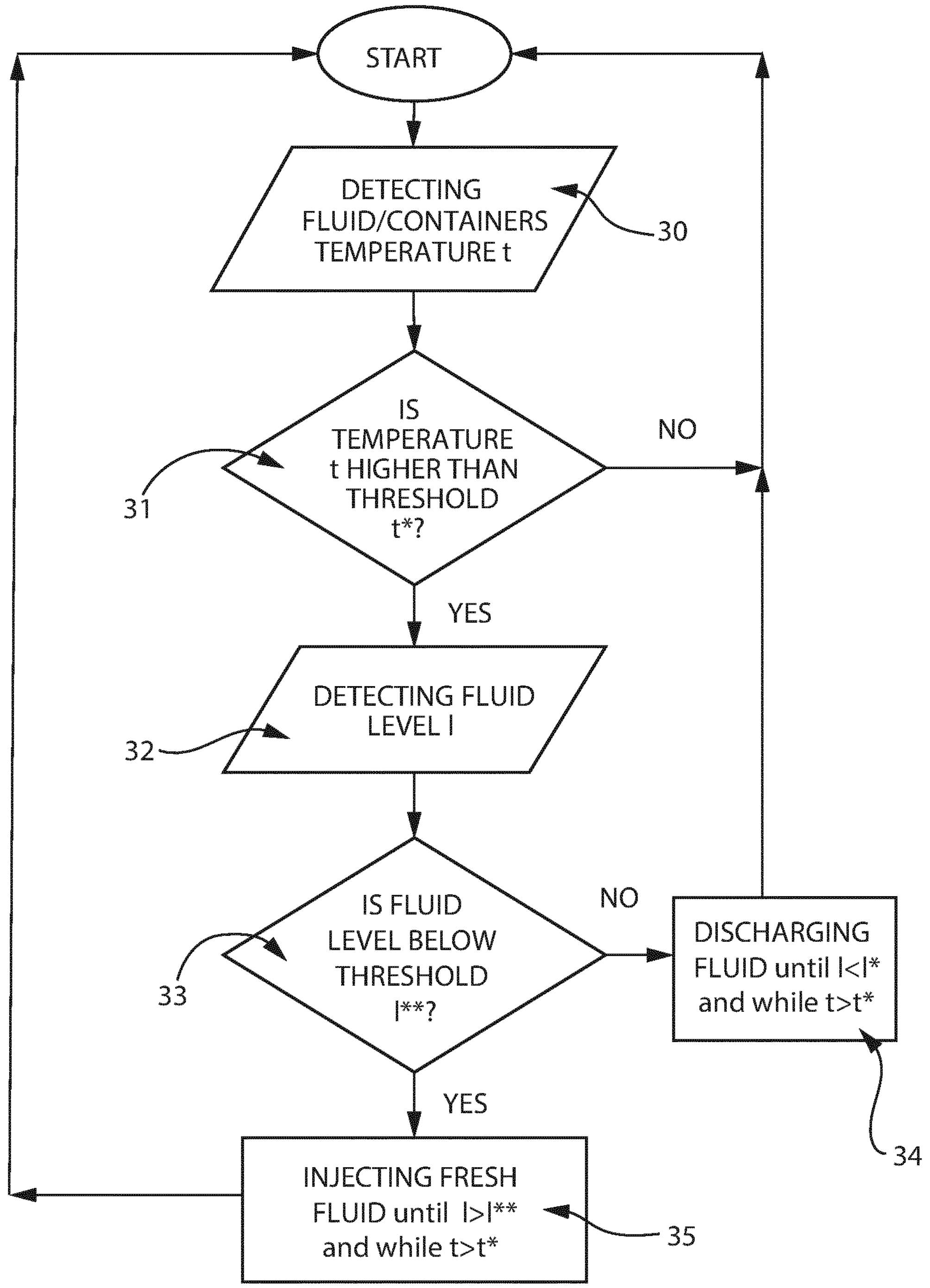
START
DETECTING FLUID/CONTAINERS TEMPERATURE t
30
IS TEMPERATURE t HIGHER THAN THRESHOLD t*?
NO
31
YES
DETECTING FLUID LEVEL l
32
IS FLUID LEVEL BELOW THRESHOLD l**?
NO
DISCHARGING FLUID until l<l* and while t>t*
33
YES
34
INJECTING FRESH FLUID until l>l** and while t>t*
35

FIG. 6

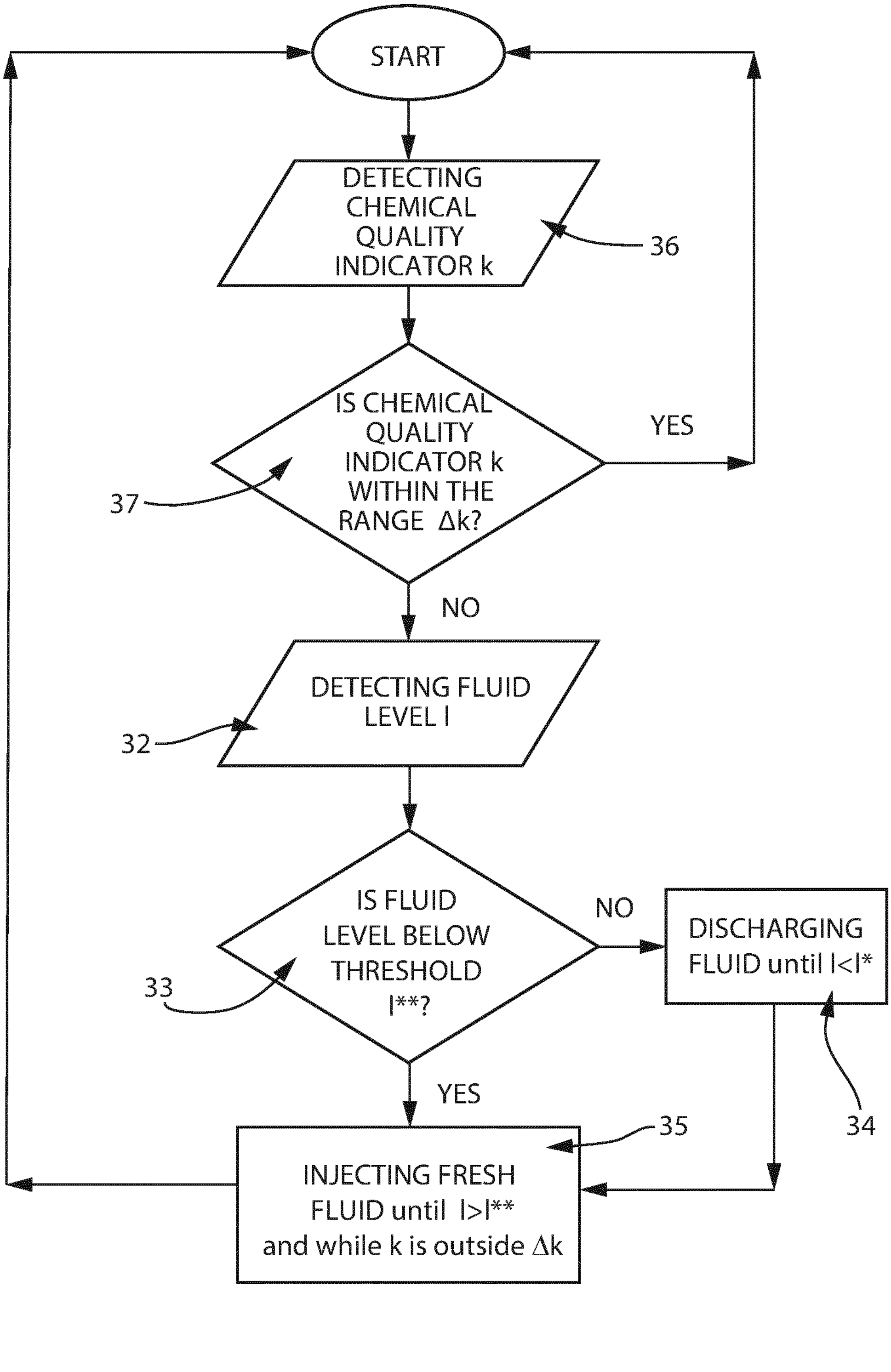
START
DETECTING CHEMICAL QUALITY INDICATOR k
36
IS CHEMICAL QUALITY INDICATOR k WITHIN THE RANGE Δk?
YES
37
NO
DETECTING FLUID LEVEL l
32
IS FLUID LEVEL BELOW THRESHOLD l**?
NO
DISCHARGING FLUID until l<l*
33
YES
35
34
INJECTING FRESH FLUID until l>l** and while k is outside Δk

FIG. 7

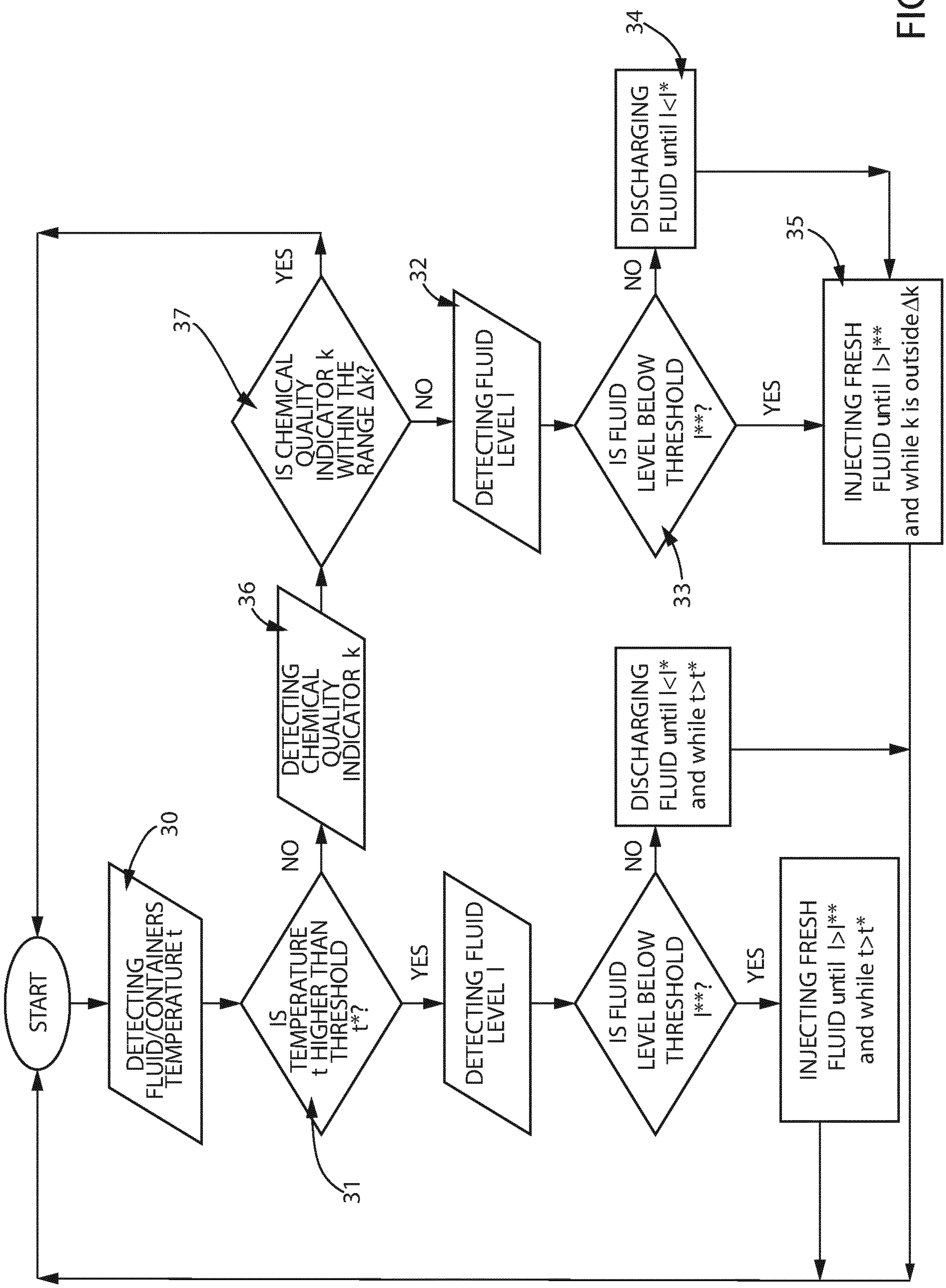
START
DETECTING FLUID/CONTAINERS TEMPERATURE t
30
IS TEMPERATURE t HIGHER THAN THRESHOLD t*?
31
YES
NO
DETECTING FLUID LEVEL l
IS FLUID LEVEL BELOW THRESHOLD l**?
YES
NO
INJECTING FRESH FLUID until l>l** and while t>t*
DISCHARGING FLUID until l<l* and while t>t*
DETECTING CHEMICAL QUALITY INDICATOR k
36
IS CHEMICAL QUALITY INDICATOR k WITHIN THE RANGE Δk?
37
YES
NO
DETECTING FLUID LEVEL l
32
IS FLUID LEVEL BELOW THRESHOLD l**?
33
YES
NO
DISCHARGING FLUID until l<l*
34
INJECTING FRESH FLUID until l>l** and while k is outside Δk
35

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/086265

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23L3/00 A23L3/04
ADD. B65B55/14 F28C3/00 F28F27/00

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)
A23L A23C F28F F28C C02F

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 practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/280222 A1 (NIELSEN JORGEN TAGE [DK] ET AL) 12 November 2009 (2009-11-12)	1,2,6,7, 10,12, 13, 15-17,19
A	paragraphs [0035] - [0052]; figures 1-4, 6-8	3-5,8,9, 11,14,18
A	US 4 849 235 A (BRAYMAND ROBERT [FR]) 18 July 1989 (1989-07-18) the whole document	1-19
A	EP 2 959 782 A2 (KRONES AG [DE]) 30 December 2015 (2015-12-30) paragraphs [0030], [0045] - [0060]; figure 4	1,8,11, 18

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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date
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"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
9 March 2022	17/03/2022
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Leclaire, Thomas

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 441 406 A (BECKER KENNETH W [US] ET AL) 10 April 1984 (1984-04-10) column 4, line 65 - column 7, line 44; figures 1-6 -----	1-19
A	US 2002/073652 A1 (WIEDEMANN ULRICH [DE]) 20 June 2002 (2002-06-20) paragraphs [0036] - [0058], [0101] - [0110]; figures 1, 2, 2A-2C -----	1-19
A	DE 30 29 113 A1 (BARRY WEHMILLER CO) 19 February 1981 (1981-02-19) page 8, line 8 - page 15, line 25; figures 1-4 -----	1-19

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2021/086265

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 2009280222	A1	12-11-2009	AT	421258	T	15-02-2009
			CN	101217888	A	09-07-2008
			DE	102005028195	A1	21-12-2006
			DK	1890560	T3	11-05-2009
			EP	1890560	A2	27-02-2008
			US	2009280222	A1	12-11-2009
			WO	2007101455	A2	13-09-2007
US 4849235	A	18-07-1989	DE	3637661	A1	07-05-1987
			DK	529086	A	06-05-1987
			ES	2007025	A6	01-06-1989
			FR	2589332	A1	07-05-1987
			GB	2182542	A	20-05-1987
			IT	1197934	B	21-12-1988
			US	4849235	A	18-07-1989
EP 2959782	A2	30-12-2015	AU	2015203274	A1	21-01-2016
			BR	102015015051	A2	24-04-2018
			CN	105198137	A	30-12-2015
			DE	102014108798	A1	24-12-2015
			EP	2959782	A2	30-12-2015
			EP	3461344	A2	03-04-2019
			ES	2700655	T3	18-02-2019
			HU	E041807	T2	28-05-2019
			MX	366686	B	19-07-2019
			PL	2959782	T3	31-05-2019
			US	2015368135	A1	24-12-2015
US 4441406	A	10-04-1984	NONE			
US 2002073652	A1	20-06-2002	NONE			
DE 3029113	A1	19-02-1981	AU	6097480	A	05-02-1981
			BE	884565	A	17-11-1980
			BR	8004838	A	12-05-1981
			CA	1136918	A	07-12-1982
			DE	3029113	A1	19-02-1981
			FR	2462878	A1	20-02-1981
			GB	2057850	A	08-04-1981
			JP	S5623883	A	06-03-1981
			JP	S6023827	B2	10-06-1985
			US	4263254	A	21-04-1981
			ZA	804658	B	29-07-1981