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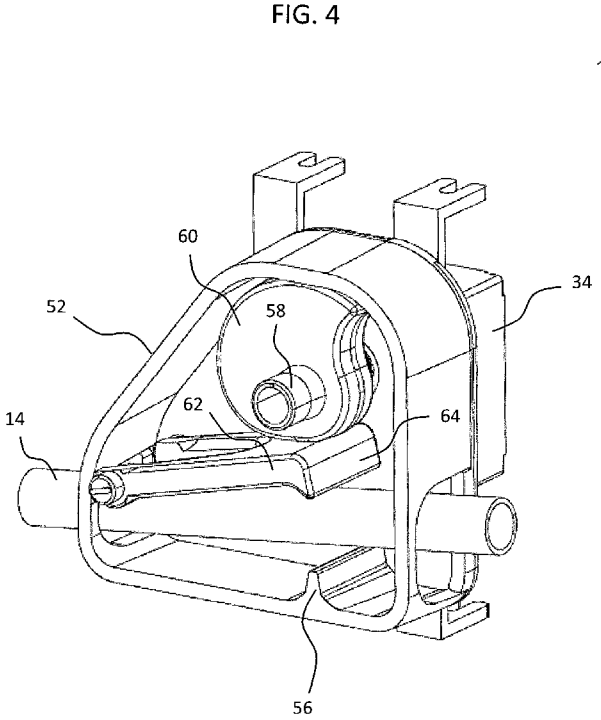
(54) Title: METHOD AND APPARATUS FOR CONTROLLING FLUID FLOW IN FLEXIBLE TUBE SYSTEM

FIG. 4



(57) Abstract: Method and apparatus in flexible tube systems for the automatic control of the flow of fluids and gases contaminated with dry matters. We use pinch valves with cam mechanism designed in the tube system with a unique characteristic driven by a controlled servomotor. The driven cam mechanism clenches a tilting element on the tube, against an opposite fixed edge and thus it pinches it off. The motor control units connect to a programmable CU which instructs to close or open the pinch valves taking into consideration the planned and measured flow data. The pinch valves with one or more saw-tooth cam mechanisms installed during the procedure generate pressure surges periodically to prevent the dry matter from deposition. The apparatus made for the system is equipped with the already mentioned pinch valves. For example, the small apparatus called "BREWIE" developed for an invention is suitable for domestic beer-brewing.

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Method and apparatus for controlling fluid flow in flexible tube system

Field of the Invention

Method and apparatus in flexible tube systems for the automated control of fluid and gas flow. The use of the invented method and apparatus is especially beneficial in food and chemical processes when there is a need for the automated control of the flow of fluids and gases contaminated by dry matters.

Below we only talk about fluids instead of fluids and/or gases, but we do not narrow down the application of our invention solely to fluids.

Background of the Invention

It is a general practice in food and chemical processes to apply flexible, thin-wall tubes (in short: FT). FT tubes are made, for example, of silicon which complies with the food regulations.

In tube systems composing of FT tubes (in short: FTS) the fluid flow is controlled and regulated between the various containers with valves, typically with the installation and operation of the so-called pinch valves (hereinafter referred to as PV) built at the desired points.

The PV narrows down the cross-section of the FT tube to the desired extent from the primary state by clenching the flexible tube resulting in the reduction of fluid flow. The complete closure of the tube in a given cross-section is made by the tube's clenching, as a result of which the fluid flow terminates in the given cross-section. If the PV is opened to some extent again, the fluid flow starts again in the cross-section due to the flexibility of the tube.

The PV can be operated manually in a unique case, but the motorised version is the universal practice. In the latter case, the PV is typically operated by a low voltage

electric motor. In our invention, we refer to PVs built together with an engine as "Pinch Valve Assembly", in short, PVA.

The motor in the PVA is controlled with instructions received from the control unit (hereinafter referred to as CU) linked to the motor.

The CU generates the instructions in various ways. One solution is that the characteristics of the fluid flow are measured with one or more sensors. In this case, the CU gives instructions for the modification of the PVA valve's settings taking the measured values into account.

These characteristics may include physical features, for example, the fluid's temperature, colour, the weight of the fluid passed through and appeared in the storage tank, the bubble distribution measured optically in the fluid, duration and other physical features.

The measurement of chemical characteristics with sensors is also well-known in technical practice. For example, it is possible to measure the alkalinity/acidity of the fluid, the presence/radioactivity or other characteristics of individual solvents, and these data may generate instructions in the CU regarding the operation of the PVA.

Another solution for the operation of the PVA is when we define the fluid flow in a cross-section in advance and record the operation of the given PVA in a programmable CU. Thus, the operation of the valve is defined in advance and we achieve the fluid flow according to the desired walkthrough with automatically set tube cross-section changes.

In our invention, we call this control unit programmable control unit. (hereinafter referred to as PCU)
PCU is especially important when there are more than one PVAs in the FTS, and it is a complex process. In this case, we talk about the combinatorial application of the

physical and chemical characteristics measured in the system as well as the pre-planned programme.

One of the main problems of the technical practice described above is that there is not any PVA valve which meets all requirements while remaining reliable and deployable.

Another problem is that in case of fluids contaminated with some pollutants the pollutant often forms a deposit or arches in the FT systems. The contaminants may cause narrowing or clog in the given cross-section of the FTS. This problem is rather frequent in the branches, fractures, corners of the FTS to which there is not any solution in the FT systems.

The planning and implementation of an automatic beer-brewing apparatus is a challenge in the field of food industry. For example, a small beer-brewing apparatus must be equipped with an FTS in which the fluid flow can be implemented with PVA units controlled by PCU.

The fluid in such an apparatus is contaminated with dry matters due to the technology of brewing which prevents the planned fluid flow when the critical value is reached. One of the technological processes is called lautering. Boiling is an integral part of brewing excellent beers, but the beer does not remain free from dry matters. Thus, proteins get separated from it or hop pellet gets into the wort which arches in the tube or causes complete clogging. Clogging can stop the process, as a result of which the automatic operation of the system stops.

The summary of abbreviations introduced above which we continue to use in our description:

FT – Flexible Tube
FTS – Flexible Tube System
PV – Pinch Valve

PVA – Pinch Valve Assembly

CU – Control Unit

PCU – Programmable Control Unit

One of the main purposes of our invention was to create PVA valves which can be applied in FT systems well in the case of contaminated fluids. It is essential to avoid flow loss in the system when they are used and to prevent the clogging or narrowing of all cross-sections of the FTS system.

As an example, we provide the general requirements related to the PVA valves to be built in an FTS, in a beer-brewing apparatus:

a) A PVA should make thousands of openings - closings possible in a given cross-section

b) It must not clench the tube under any circumstances

c) It must be able to close a silicon tube of at least 16-mm diameters

d) It must work with a low-voltage electric motor (maximum 12 V)

e) It must be able to exert as great force as possible with a low-voltage electric motor

f) It must be self-locking in case of power failure

g) It must resist 50°C ambient temperature

h) It must resist 100°C fluid temperature in the silicon tube

i) It must resist 1 bar pressure in the silicon tube during closing and must not leak

j) Flow control and measurement must be provided without sensors

k) The simplest design to prevent failure

l) It must be as light and small as possible

m) It must be produced cheaply in small and large volumes.

Also, the goal of our invention was to design a unique PVA with which fluid flow in an FT system can be manipulated without clogging.

Besides, our goal was to design a beer-brewing apparatus in the FT system with PVAs and with their installation and operation.

During the design of our invention, we realised that we need to plan and apply such PVs to provide multiple-stage, proper fluid flow with parameters and settings ensuring optimal conditions.

By understanding the parameters of an FT system, we can design a cam mechanism in the PVs which can meet the desired parameters also without fine-tuning and settings. To do this, we need to set those sections of the cam mechanisms to a constant value which are responsible for the appropriate volume flow rate. Thus, the valve will be unresponsive to the possible faults arising from control. The PV's applicability will be less determined by the technological circumstances.

We also realised that if we intersperse the flow constant in the FT systems with pressure surges, then the initial depositions of contaminants are torn open by the pressure surges, so there is less chance for the tube to clog.

The frequency and extent of pressure surges are highly dependent upon the parameters of the medium being transported and the including dry matter contents. If we know the necessary parameters in an FT system, we can create unique PVAs which adapt to the given circumstances and generate the desired pressure surges on the instructions of the PCU.

Summary of the Invention

Our invention is a method for the automated control and regulation of fluid and gas flows with PVA valves in flexible tube systems.

In addition, our invention includes a PVA valve operated with an electric motor and controlled by a program in which a cam mechanism with a predefined characteristic

clenches an element tilting on an axle which clamps to the desired extent the flexible tube passing through the PVA valve against a contralateral element.

The major advantages of the developed PVA (24) in the FT systems (14) are the following:

a) it makes possible the improvement of known FT systems
b) it provides large freedom when it comes to the design of an FT system
c) it is a space-saving solution
d) special needs can be served easily too
e) it does not break the continuity of the tube system
f) it expands the possibilities of any flexible tube system
g) it is in line with all food, chemical and medical rules
h) it is energy saving using any drive
i) it keeps its position when the drive terminates
j) flow control and measurement are provided without the application of separate sensors.

Besides, the goal of our invention is to create an FT system in which we install PVA valves invented by us in an apparatus suitable for beer-brewing.

We hereinafter refer to the beer-brewing apparatus as BREWIE.

Owing to the methods implemented with BREWIE, we can produce special-quality beers because the fluid flow can be planned freely and the presence of dry matter does not cause any problem. Specific advantages are that the beer-brewing apparatus

- makes possible the optimisation of certain beer-brewing processes
- increases stability during operation

We would like to emphasise that the PVAs invented by us and the processes implemented by using them to control the flow of fluids contaminated with dry matters

as well as the apparatus which makes the method possible can be utilised in many fields.

BREWIE is an implementation example which does not limit the use of the invention and the claims extend to further applications.

We present our invention in details with drawings.

Brief description of the drawings

FIG. 1 – Example of the design and operation of an FT system with PVA valves
FIG. 2 – Control electronics of the PVA valve
FIG. 3 – The assembly of the PVA valve
FIG. 4 – Perspective representation of the PVA valve
FIG. 5 – Self-repairing mechanism of the PVA valve
FIG. 6 – The change in effort necessary for the closure of the flexible tube
FIG. 7 – Radial characteristic of the cam mechanism
FIG. 8 – PVA valves with different cam mechanisms
FIG. 9 – Perspective representation of the BREWIE beer-brewing apparatus
FIG. 10 – FT system in the BREWIE beer-brewing apparatus
FIG. 11 – Scheme for the presentation of BREWIE beer-brewing processes
FIG. 12 – 13 – First example of quality beer brewing in the BREWIE
FIG. 14 – 15 – Second example of quality beer brewing in the BREWIE
FIG. 16 – 17 – Third example of quality beer brewing in the BREWIE

List of References

10 – Example of the design and operation of an FT system with PVA valves

12 – Contaminated fluid

14 – Flexible tube system (FTS)

16 – Pump

18 – Programmable Control Unit

20 – Pinch Valve Assembly, Base (PVA1)

22 – Pinch Valve Assembly Saw Tooth (PVA2)

24 – Pinch Valve Assembly, General (PVA)

26 – Sensor

30 – Control electronics of the PVA valve

32 – Pinch valve

34 – Servomotor

36 – Current sensing circuit

38 – ADC

40 – Servo control circuit

50 – The assembly of the PVA valve

52 – Valve housing

54 – Gap

56 – Fixed edge

58 – Gear

60 – Cam mechanism

62 – Tilting element

64 – Cutter

70 – Perspective representation of the PVA valve

80 – Self-repairing mechanism of the PVA valve

82 – V-shaped rib

90 – The change in the effort necessary for the closure of the flexible tube

100 – Radial characteristic of the cam mechanism

110 – PVA valves with different cam mechanisms

112 – Pinch valve assembly, graded

140 – Perspective representation of the BREWIE beer-brewing apparatus

150 – FT system in the BREWIE beer-brewing apparatus

180 – Scheme for the presentation of BREWIE beer-brewing processes

200 – First example of quality beer brewing in the BREWIE

300 – Second example of quality beer brewing in the BREWIE

400 – Third example of quality beer brewing in the BREWIE

Detailed description of the Invention

There is a scheme of the flexible tube system (14) in FIG 1 with which we can introduce our method for the control and regulation of fluid flow with automated PVA valves in flexible tube systems.

The figure displays one detail of the FTS system (14) which connects to a fluid tank marked 'A' and 'B'. Tank 'A' contains fluid contaminated with dry matters (12), tank 'B' is empty.

A sensor (26) connecting to tank 'A' measures the volume of the fluid. In an alternative case, the sensor may be, for example, a temperature sensor or any other sensor.

There is a pump (16) built in the FT system (14) to move the contaminated liquid as well as a PVA1 valve (20), a PVA2 valve (22) and a non-specified PVA valve (24).

PVA1 valve (20) is a pinch valve which performs the control of the fluid flow so that it performs a continuous cross-section narrowing or opening in the FTS system (14) between the fully open and fully closed state of the given tube cross-section.

PVA2 valve (22) is a pinch valve which brings about abrupt pressure change in the fluid flow. PVA2 valve (22) implements this function so that it provides the closure and opening of the tube cross-section without warning.

In our example, the PVA valve (24) can be a valve with an optional function.

The control of the pump (12) and the valves is carried out by a wired or wireless PCU (programmable control unit) (18).

The task is to deliver the contaminated fluid through the FT system with success without clogging from tank 'A' to tank 'B'.

We solve this task according to predefined steps with the direct intervention of the PCU (18) according to which:

Step 1:

We open the PVA2 valve (22) completely

Step 2:

We check the state of the PVA valve (24), and if it is open we close it completely

Step 3:

Considering the planned fluid flow, we open the PVA1 valve (20) to an extent appropriate for the desired gap

Step 4:

We start the pump (16) and thereby the fluid flow from tank 'A' to tank 'B'

Step 5:

We open the PVA1 valve (20) periodically, for example, in 2 seconds to a bigger gap to provide the free flow of contaminants in the contaminated fluid (12)

Step 6:

We close the PVA valve (22) completely, then after a given time, for example, after 2-5 seconds we open it again, thereby we generate pressure surges in the FT system (14). We tear open the possibly deposited contaminants with the pressure surges and prevent the clogging of the FT system (14).

Step 7:

We detect the empty state of tank 'A' with the sensor (26), as a result of which we stop the pump (16).

So with our invention we can provide the flow of the contaminated fluid (12) free from deposition and clogging in the flexible tube system (14) by generating pressure surges in the flowing medium by operating one specially designed pinch valve (22) and we make the flow of the liberated contaminants possible through additional pinch valves (20, 24) built in the flexible tube system with their partial or complete, periodical opening.

We present the pinch valves developed by us and suitable for the method below.

It is a PVA pinch valve controlled according to a program and operated with an electric motor in which a cam mechanism with predefined characteristic clamps an element tilting on an axle which clenches the flexible tube passing through the PVA valve against a contralateral element to the desired extent.

FIG. 2 presents the electronics of the control of PVA valves (30).

There is a servomotor (20) connected to the PV (20).
The PV (20) can be closed, opened or set with the servomotor (34) according to the requirements.

The servomotor (34) can be in an appropriate position. It is possible to set the speed at which the position is reached.

The servomotor connects to the current sensing circuit (36) which detects the amount of current drawn by the servo which is processed by an analogue digital converter (38) and forwards it to the PCU (18).

The PCU (18) calculates and sends the control instruction to the servomotor (34) from the received data through the servo controller (40) based on the abovementioned data.

For example, it checks whether the valve closed after the closure due to the current drawn by the servo. FIG. 6 shows that the force needed for the complete closure of the PV increases exponentially. It is known from the current drawn by the servo that the closing point has arrived.

FIG. 3 displays the assembly of the PVA pinch valve (50) with which we explain its parts and operation.

The PVA pinch valve (20) composes of two main parts, a pinch valve (32) placed in the valve housing (52) to which an electronically driven servomotor connects (34) add the servomotor (34) connecting to a programmable control unit (18) with wire.

The valve housing (52) has a gap appropriate for the flexible tube's leading through. It is designed in a way to be suitable for its fixation to a defined cross-section of the FT system (14).

The tilting element (62) of the pinch valve (32) serving for clenching the tube is on the axle fixed to the valve housing, while the fixed edge (56) is in the wall of the valve housing (52).

The tilting element (62) ends with a cutter (64) to clamp the tube. Due to the design of the cutter (64) it is not possible to completely pinch off the flexible tube (14). It is because the clenching edge of the cutter (64) is semi-circle. For the same reason,

the design of the fixed edge (56) may be semi-circle, thereby it is not a sharp surface which impressed the tube wall.

The servomotor (34) fixed to the valve housing (52) connects to the cam mechanism (60) with a gear (58).

PVA pinch valve's (20) operation: the servomotor (34) – on the instruction given by the PCU (18) – turns the cam mechanism (60) through the gear (58) in the right angle and thereby it grasps the tilting element (62) on the flexible tube (14). The tube cross-section between the cutter of the tilting element (64) and the fixed edge (56) becomes flat or closes.

Due to the fact that against the clamping force the reaction force generated in the wall of the FTS flexible tube (14) is nearly radial, the PVA pinch valve (20) becomes self-closing. The servomotor's (34) intervention is needed only when a gap is set. Therefore the energy use is minimal.

We achieve the development of the nearly radial reaction force by designing the cam mechanism (60) developed in our study. We present them with FIG 6 - FIG 7.

The PCU (18) determines whether the valve is completely closed from the change in the power of the servomotor (34) connected to the cam mechanism (60) during the closing of the PVA pinch valve (20).

In case of a servomotor (34) with angle signal transmitter, we can accurately set the valve's opening gap with the signal transmitter after the complete closing method with which we can set an accurate flow rate without any monitoring tool.

FIG. 4 – Perspective representation of the PVA valve (70).

FIG. 5 shows the self-repairing mechanism (80) of the PVA valve.

Considering that for the provision of the desired flow rate in FT systems (14) it is a requirement to accurately set the gap in a given cross-section or the complete, stripe-less close of the cross-section, the self-repairing setting of the tilting element (62) is indispensable.

In order to eliminate the angular errors between the tilting element (62) and the fixed edge (56) we designed a V-shaped rib (82) surrounding the cam mechanism (60).

The V-shaped rib (82) exerts even force on the tilting element (62) thus ensuring complete closure. This design simplifies the construction; it is not necessary to seek for parallel guidance and simplifies the production of the PVA valve (20).

FIG. 6 shows the change in the effort necessary for the closure of the flexible tube (90). It can be seen that the biggest effort is needed at the end of the closure. As a result, due to the design of the cam mechanism (60) we are able to optimise the power of the servomotor (34) applied in the PVA pinch valve (20).

The radial characteristic of the cam mechanism (60) is demonstrated in FIG 7. As it can be seen, the characteristic of the cam mechanism (60) increases in the beginning, while it slows down in the end. Owing to this changing increase in radius we have achieved that at the end of the closure we can exert larger force with the same torque with more massive angular displacement.

FIG. 8 depicts two versions of the PVA pinch valve.

Solution type 'A' shows a cam mechanism designed in the PVA2 pinch valve saw-tooth unit (22) which received its name after its saw teeth. The use of this unit in an FT system (14) provides the generation of pressure surges during the delivery of contaminated fluids (12).

Type 'A' pinch valve's (22) operation: we turn the cam mechanism (60) periodically until it closes the tube's cross-section completely, thus it stops flowing, then turning it further it opens it up suddenly.

This process is repeated periodically. In our practical solution, for example, in the case of wort when the flow was 0.5 - 0.8 l/min, we programmed the assembly so that it generated 7 pressure surges per minute.

Solution type 'B' is the gradual version (112) of PVA3 pinch valve. The characteristic of the cam mechanism (60) shows a break with gradual nature.

'B'-type cam mechanism (60) mainly serves to set the predefined flow rate accurately. The rounding of the cam mechanism (60) is designed so that the radius is constant in a relatively long section in the appropriate places.

This is beneficial because different flow rates belong to each point of the continuously increasing cam mechanism (60) profile. Here, however, it is possible to set the predefined flow rate even with plain control accurately.

So our invention is a pinch valve assembly (24) controlled according to a program and operated with an electric motor in which a cam mechanism (60) with a predefined characteristic clamps an element tilting on an axle with a cutter (62) which clenches the flexible tube passing through the pinch valve against a contralateral fixed edge (56) to the desired extent.

In addition, our invention includes the design of the FT system (14) with PVA pinch valves (24) in an apparatus suitable for beer brewing.

The technology of beer-brewing and its steps are well known in the field, therefore we do not introduce them. The domestic beer-brewing apparatuses are extensively popular, literature provides many solutions.

FIG. 9 includes one implementation plan for the application of our invention, the BREWIE beer-brewing apparatus (140). We marked the primary processes of beer-brewing, namely the brewing, hopping and lautering in the figure.

The flow is provided in the BREWIE apparatus (140) with an FT system (14) with automatically operated PVA pinch valves (20, 22, 24). The PVA pinch valves (20, 22, 24) are controlled by a PCU (18). FIG. 10 is the overview drawing of our solution in which we marked only a few elements which belong to the essence of our invention.

In FIG. 10 we market the FTS (14) with a thicker line, while the PVA pinch valves (24) with a text "PVA". The PVA pinch valves (24) are connected to the PCU (18) with an electric wire.

Considering that the fluid circulated during the beer-brewing in BREWIE (140) is a fluid contaminated with dry matters (12), we make the application of our method possible with the building in of two PVA saw-tooth pinch valves (22). The operation of these two pinch valves (22) generates the pressure surges which provide a clog-free operation of the BREWIE (140).

We do not mention here the introduction of additional PVA pinch valves (24). The characteristic of cam mechanisms (24) placed in those PVA pinch valves (24) has been designed in compliance with the flow parameters typical in the given tube cross-section.

Our invention extends to all beer-brewing apparatuses in which we carry out the control of flow with PVA pinch valves (24) from which at least two are equipped with a cam mechanism with different characteristic (60).

So our invention is a beer-brewing apparatus (140) in which we control the flow in the FTS (flexible tube system) (14) with VA pinch valves (24) prepared with a cam mechanism of different characteristic (60) from which at least one valve can generate pressure surge.

The application of our invention provides an opportunity to brew unique quality beers in an apparatus suitable for beer-brewing in which the fluid flow is provided by the automated control of PVA pinch valves (24) in an FT system (14).

As compared to other beer-brewing apparatuses, the uniqueness of our beer-brewing method is because we have implemented an opportunity to brew unique beers in the BREWIE apparatus (140) meeting the flavour and composition expected by the users.

The opportunity for lautering or the programming of optional brewing processes so that the dry matters getting into or precipitating from the wort does not influence the procedures is a good example for this.

FIG. 11 shows a scheme for the internal design of the BREWIE apparatus (140) in which we marked all elements which play a role in the beer-brewing processes with numbers.

Processes under the example described in FIG. 12-17. to brew quality beer in the BREWIE apparatus. In the methods we refer back to the numbers in FIG. 11.

FIG. 12-13 show the process of quality beer-brewing in the BREWIE apparatus (140) as per the first example.

FIG. 14 – 15 show the process of quality beer brewing in the BREWIE apparatus (140) as per the second example.

FIG. 16 – 17 show the process of quality beer brewing in the BREWIE apparatus (140) as per the third example.

We do not explain the figures in detail; the texts demonstrate the steps of processes in themselves.

We made only one marking in all three examples. Our marking shows how to generate pressure surges which are generated by the PVA pinch valves (22) made with saw-tooth cam mechanism marked with number 2 in FIG. 11 as often as it was programmed.

So our invention provides an opportunity to brew quality beers in an automated beer-brewing apparatus in which we implement all elements of the traditional domestic beer-brewing in our automatic system. During the specific steps of beer-brewing, we create the desired wort by merging or mixing the basic materials needed for beer-brewing. This process does not require a flexible tube system (14) if it is handmade; we carry out the part-processes separately with direct human intervention. When using a flexible tube system (14) we can carry out the same methods as essentially as by hand since we only need to change the place of fluid among the different vessels.

Due to the characteristics of the generated fluid the FT systems (14) cannot be used efficiently according to the traditional interpretation. Therefore, the FT system (14) needs to be prepared for the properties of the fluid. We implemented this preparation with different unique cam mechanisms (60) resulting in the professionalism of the beer-brewing steps.

The full utilisation of our invention is a compound technical solution for the control of flow processes in flexible tube systems (14) delivering media contaminated with dry matters.

Claims

1. A pinch valve (20) for the control of fluids or gases flowing in a flexible tube (14) by changing the cross-section of the flexible tube (14) with a valve housing (52) to which a cam mechanism (60) connects on a fixed gear (58) which compresses a tilting element (62) turning on one axle against a contralateral fixed edge (56) and compresses or pinches the flexible tube (14) off on the pinch valve (20) with the following characteristics

- the radial characteristic of the cam mechanism (60) has been designed in compliance with the flow parameters needed in the given cross-section of the flexible tube (14);

- there is a servomotor (34) connected to the gear (58); and

- the servomotor (34) is controlled by a programmable control unit (18).

2. The pinch valve (20) under claim 1 with the characteristics that the cam mechanism (60) has been designed with saw-teeth.

3. The pinch valve (20) under claim 1 with the characteristics that the cam mechanism (60) has been designed with a scalar characteristic.

4. The pinch valve (20) under claim 1 with the characteristics that there is a V-shaped rib around the outline of the cam mechanism (60).

5. The pinch valve (20) under claim 1 with the characteristics that the end of the tilting element (62) which compresses the flexible pipe (14) has been designed in a semi-circle way.

6. The pinch valve (20) under claim 1 with the characteristics that a current sensing circuit (36) is connected to the servomotor (34) to measure the drawn current

and an analogue digital converter (38) is designed to process the amount of the detected current which is connected to a programmable control unit (18).

7. The pinch valve (20) under claim 6 with the characteristics that the digital converter (38) and the servo control circuit (36) is connected to the programmable control unit with a wireless communication tool.

8. A method to generate pressure surge in a fluid (12) flowing in a flexible tube system (14) during which we completely close the cross-section of the tube gradually decreasing one of the cross-sections of the flexible tube system (14), then we permit its opening in the whole cross-section without gradualness with the characteristics that we carry out the procedural step with the pinch valve described in claim 2.

9. A method to automatically control the flow of fluid (12) contaminated with dry matters in the flexible tube system (14) with the pinch valves described in claim 1 during which:

a) we design and record the desired flow and/or other parameters of the contaminated fluid (12) in the programmable control unit (18) in the tube cross-sections belonging to the pinch valves (20);

b) we start the flow of the contaminated fluid (12) by switching on the pump (16);

c) we measure with one or more sensors (26) the flow and/or other actual parameters of the contaminated fluid (12) and forward them to the programmable control unit (18);

d) we compare the measured values to the predefined parameters and determine the differences;

e) we eliminate the differences in the programmable control unit (18) with instructions given for the closing or opening of the suitable pinch valves (20); and

f) in order to decrease or terminate the deposition of dry matters we generate pressure surges during the procedure by opening and closing one or more pinch valves (22).

10. The method described under claim 9 with the characteristics that the sensor (26) measures the fluid's weight.

11. The method described under claim 9 with the characteristics that the sensor (26) measures the fluid's temperature.

12. The method described under claim 9 with the characteristics that the sensor (26) measures the fluid's chemical composition.

13. The method described under claim 9 with the characteristics that we determine the flow parameters from the position of the swiveling axle of the servomotors (34) by applying the pinch valves (20) designed according to claim 6.

14. The method described under claim 9 with the characteristics that we periodically repeat the pressure surges during the procedure taking into consideration the impurity of the contaminated fluid (12).

15. The method described under claim 14 with the characteristics that we generate the pressure surges by the opening and closing of the pinch valve (22) described under claim no. 2.

16. An apparatus for the implementation of the method under paragraph 9 which has containers to store the contaminated fluids (12) and a flexible tube system (20) to deliver the contaminated fluid (12) between the containers in which there are one or more pumps (16), one or more sensors (26) and one or more pinch valves (24) which connect to a programmable control unit (18) with the characteristics that

a) one or more pinch valves (24) is a pinch valve designed according to claim no. 6. (24) and

b) one or more pinch valves (24) is a pinch valve designed according to claim no. 2. (22) which is equipped with a cam mechanism (60) designed with the saw-tooth characteristic.

17. The apparatus described under claim no. 16 with the characteristics that the contaminated flowing fluid (12) is wort in which 5-10 pressure surges are generated per minute due to the dry matter contents.

18. The apparatus described under claim no. 16 with the characteristics that the flexible tube system (14) is made of silicon.

19. The apparatus described under claim no. 16 with the characteristics that the detector is served to measure the weight or pressure of the fluid.

20. The apparatus described under claim no. 16 with the characteristics that there is a program installed in the programmable control unit (18) which determines the actual state of the pinch valves (24) from the characteristic curve of power consumption.

FIG. 1

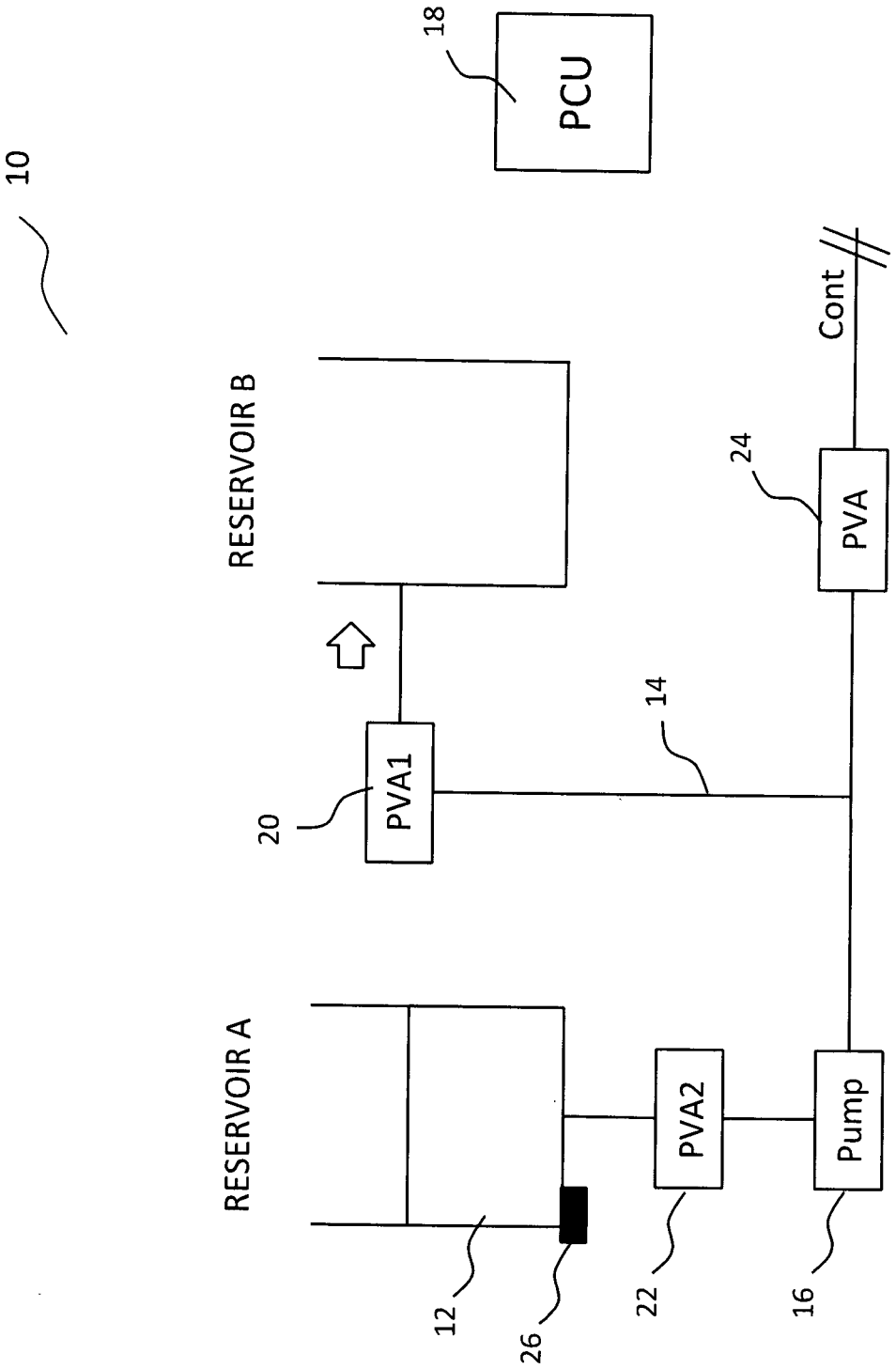

10
18
PCU
Cont
24
PVA
RESERVOIR B
14
20
PVA1
RESERVOIR A
PVA2
Pump
12
26
22
16

FIG. 2

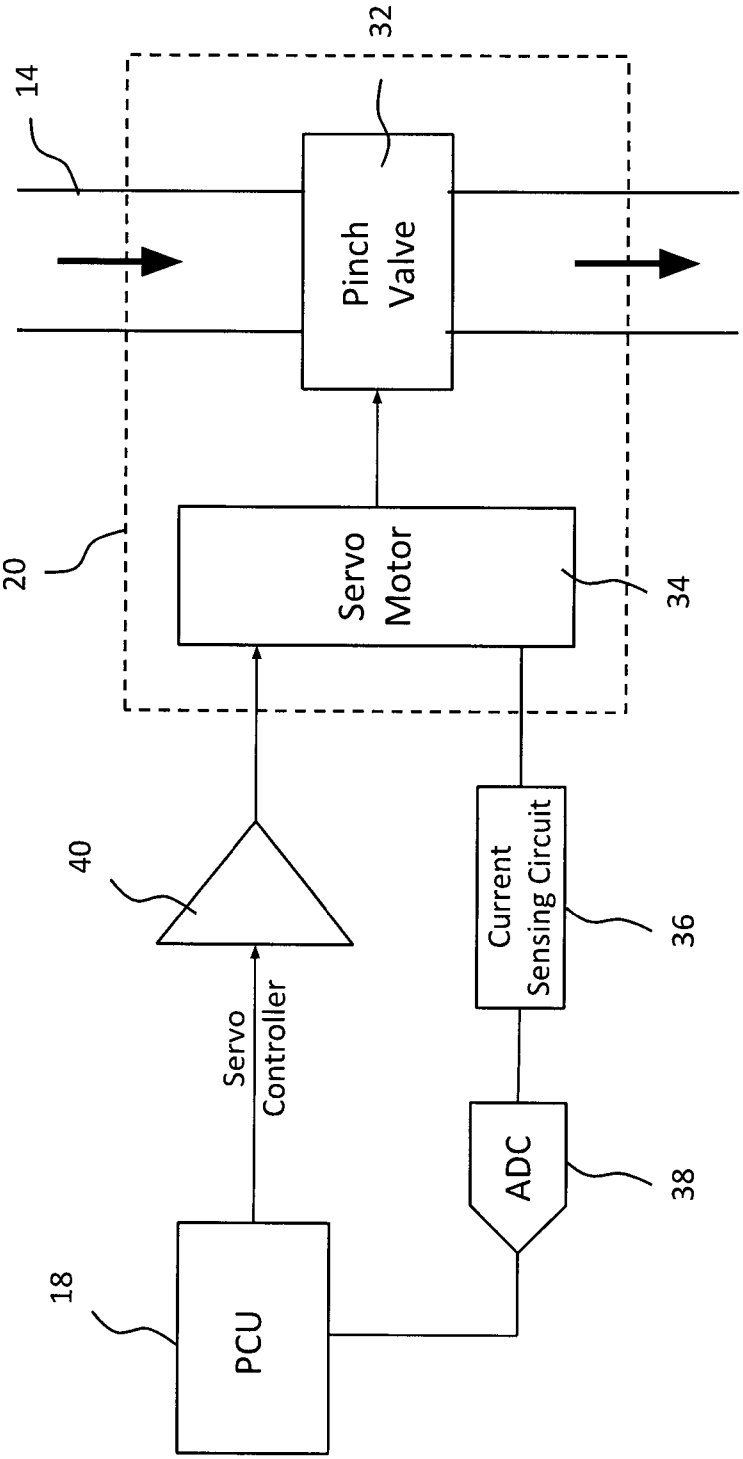

30
14
32
Pinch Valve
20
Servo Motor
34
40
Current Sensing Circuit
36
Servo Controller
ADC
38
18
PCU

FIG. 3

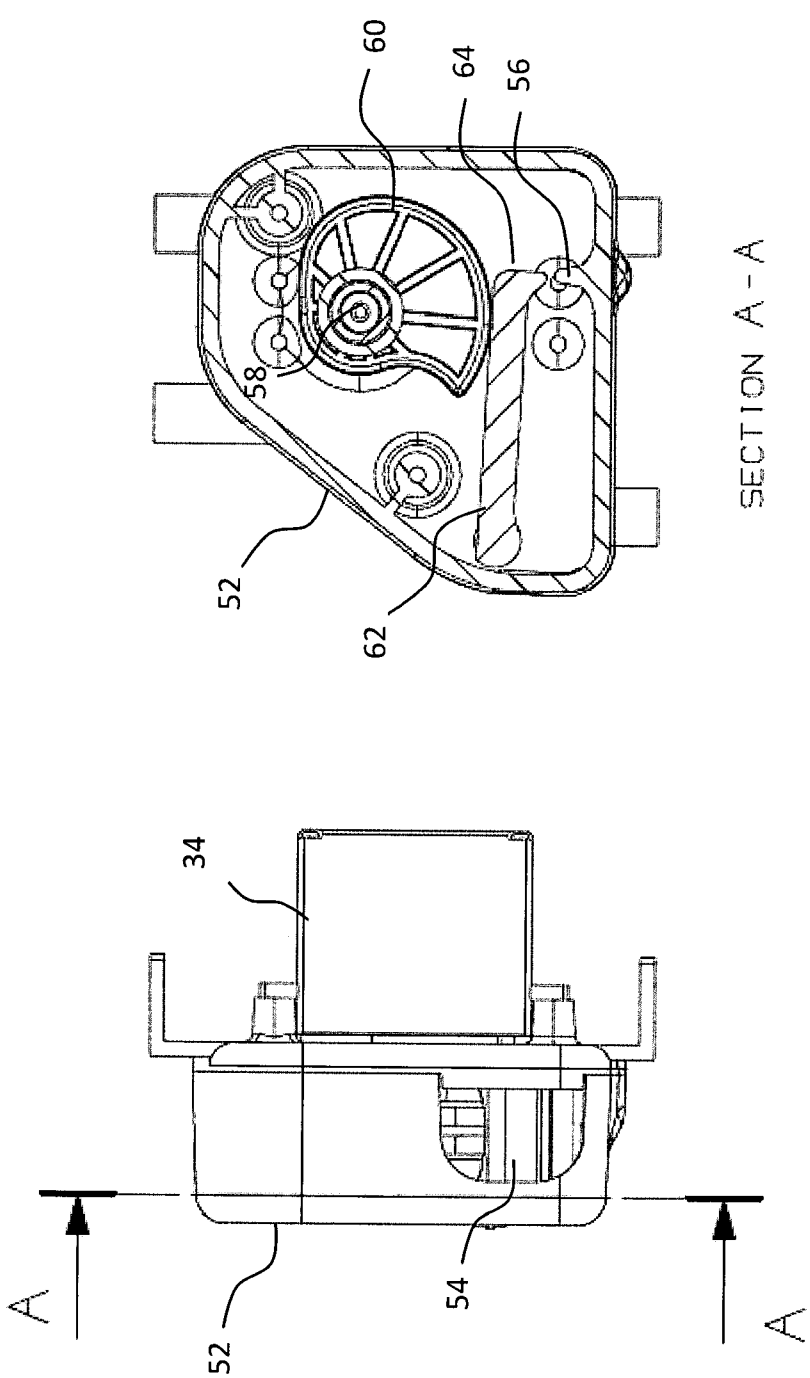


FIG. 4

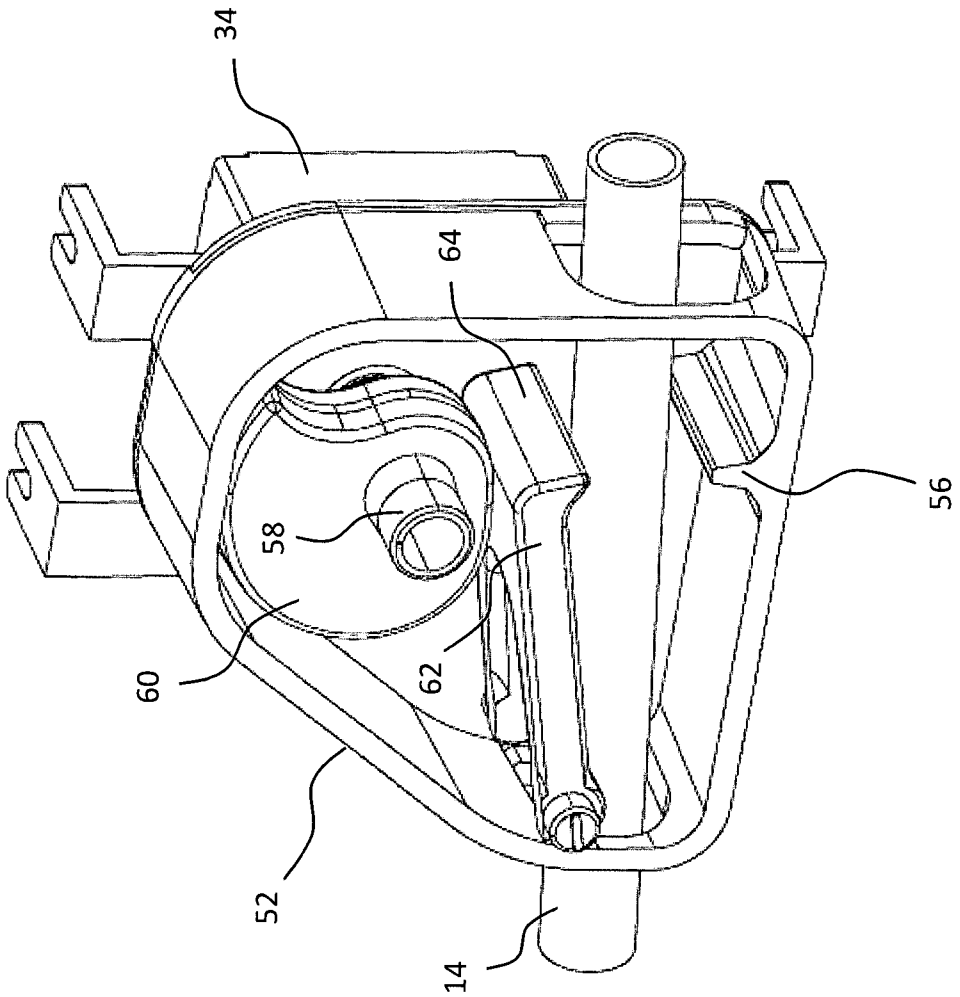


FIG. 5

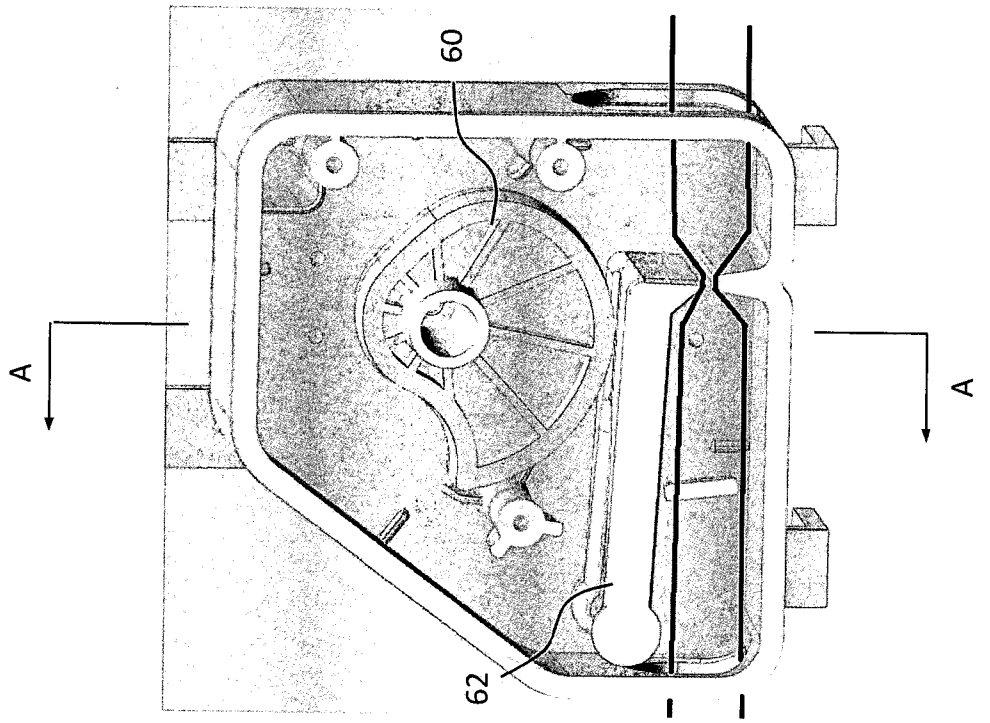

80
Section A – A
"V" shaped contact surface
Tipper element
60
82
62
A
A
60
62

FIG. 6

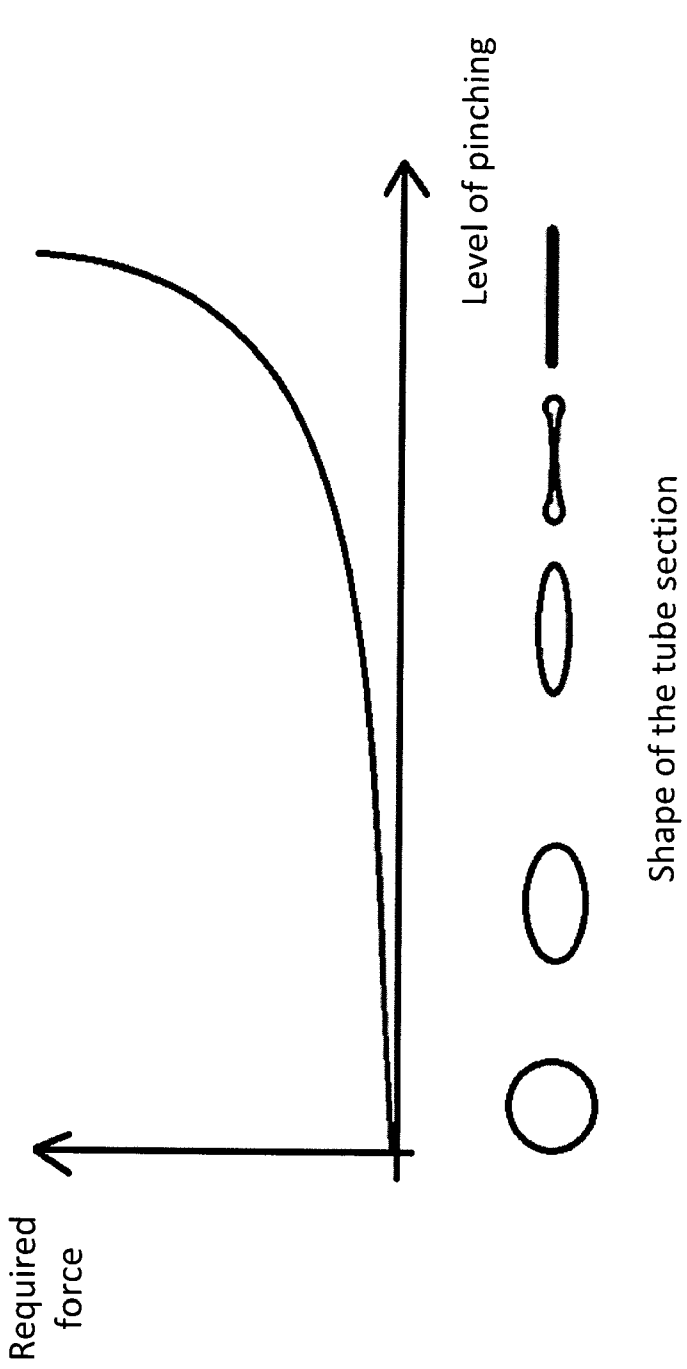

90
Level of pinching
Shape of the tube section
Required force

FIG. 7

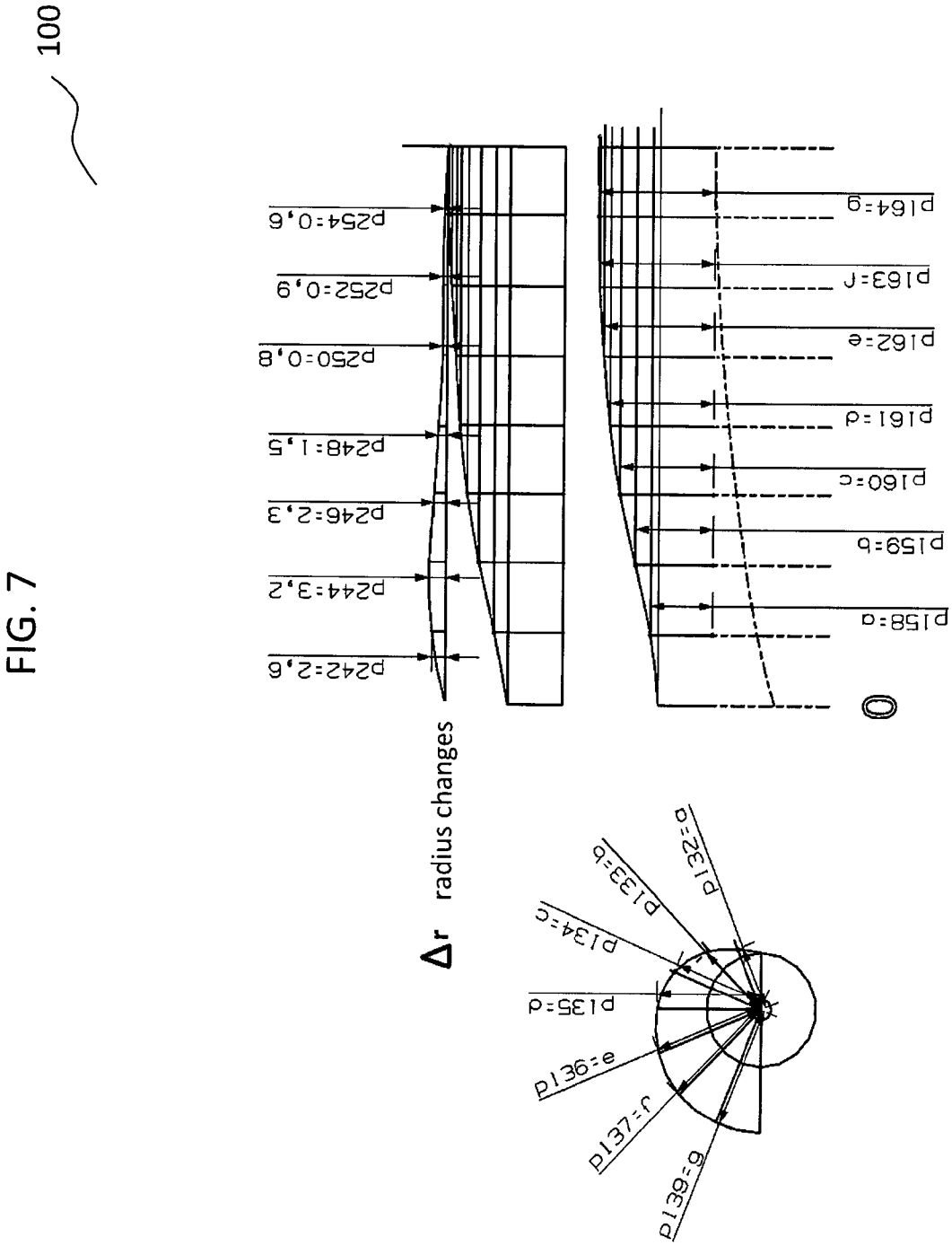
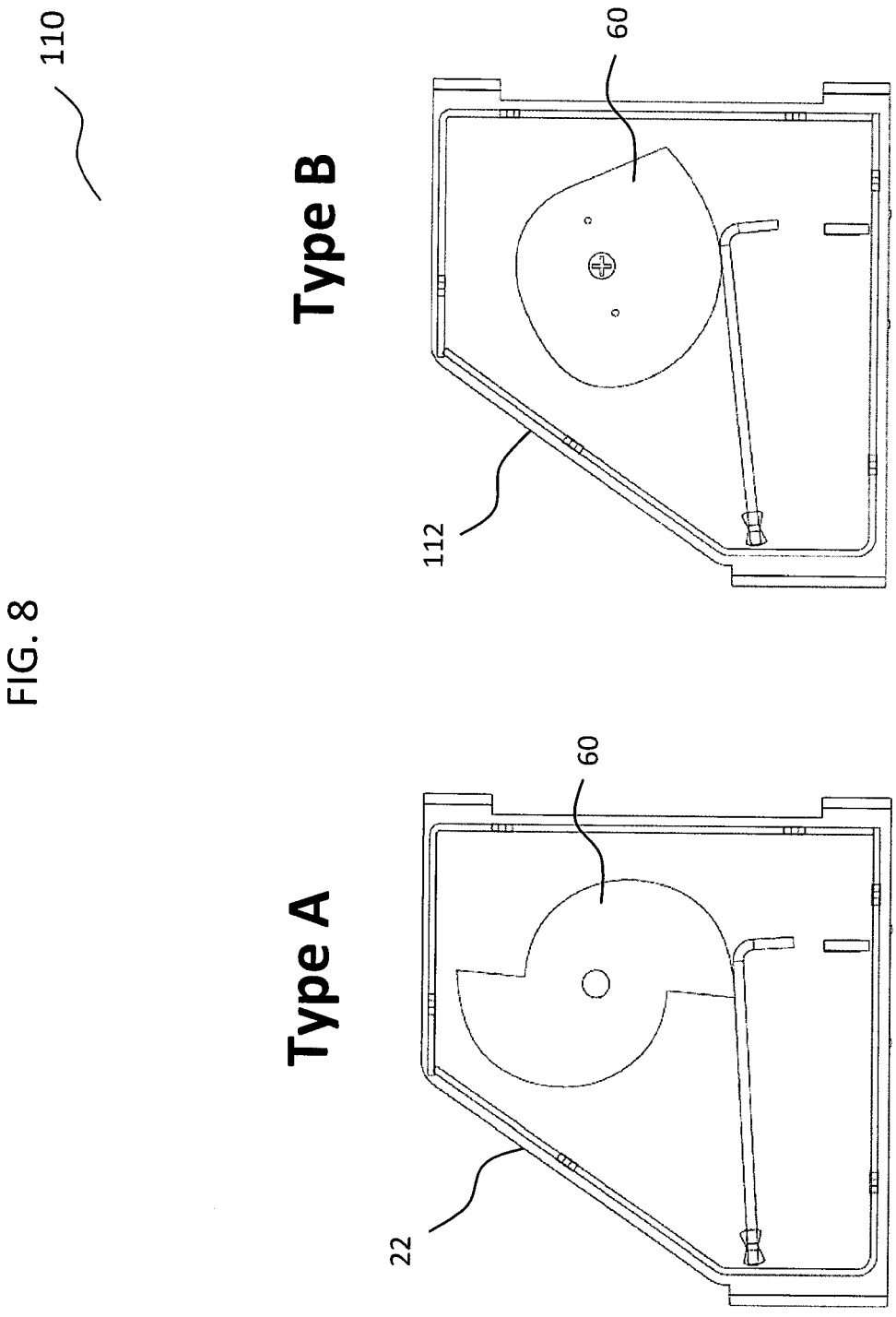

100
p254=0,6
p252=0,9
p250=0,8
p248=1,5
p246=2,3
p244=3,2
p242=2,6
Δr radius changes
p164=g
p163=f
p162=e
p161=d
p160=c
p159=b
p158=a
p132=a
p133=b
p134=c
p135=d
p136=e
p137=f
p139=g

FIG. 8



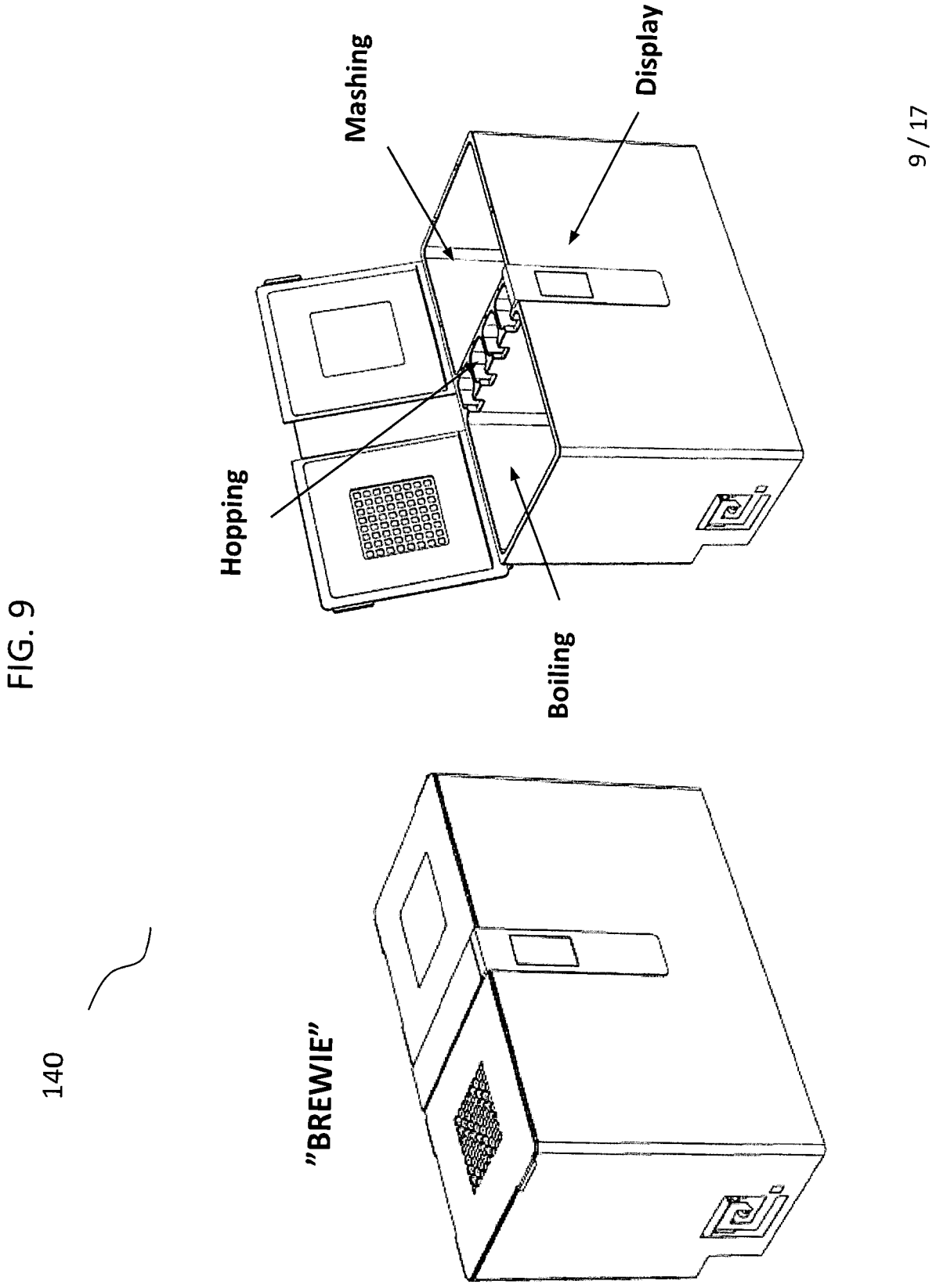


FIG. 9

FIG. 10

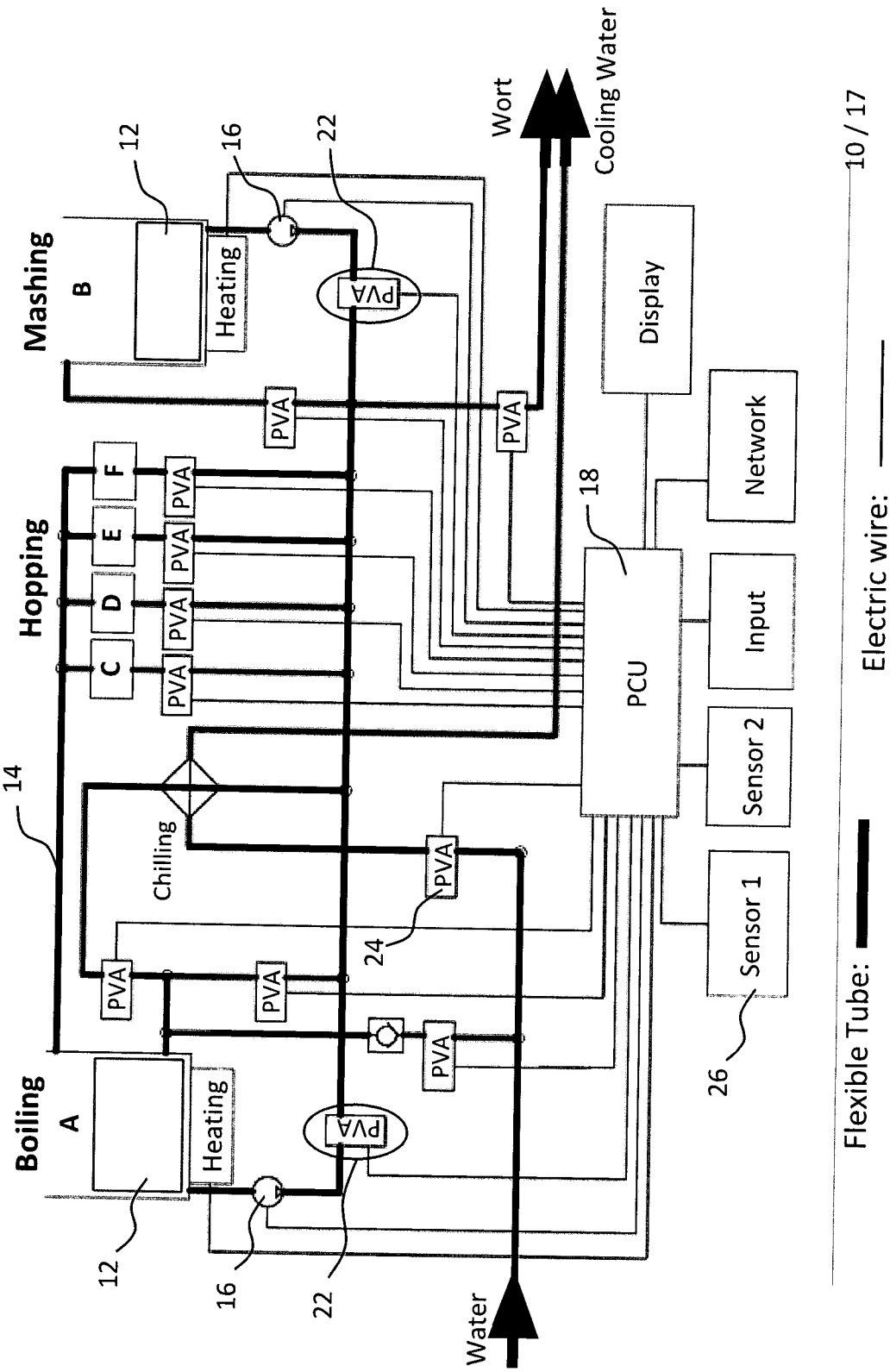

150
Mashing
B
Heating
12
16
22
PVA
Wort
Cooling Water
Display
Network
Hopping
F
E
D
C
PVA
18
PCU
Input
Sensor 2
Sensor 1
26
14
Chilling
24
Boiling
A
Heating
12
16
22
Water
Flexible Tube:
Electric wire:

FIG. 11

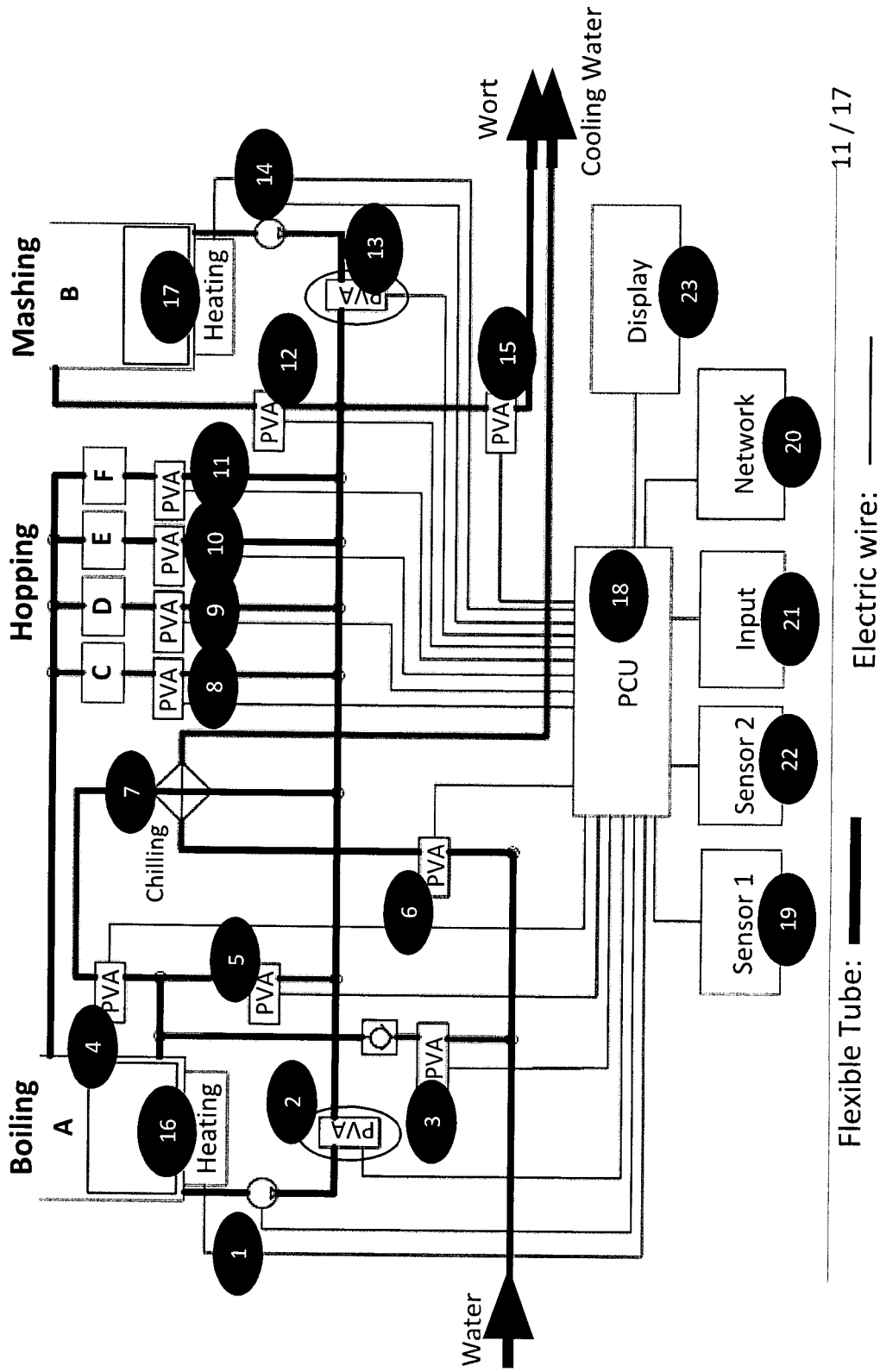
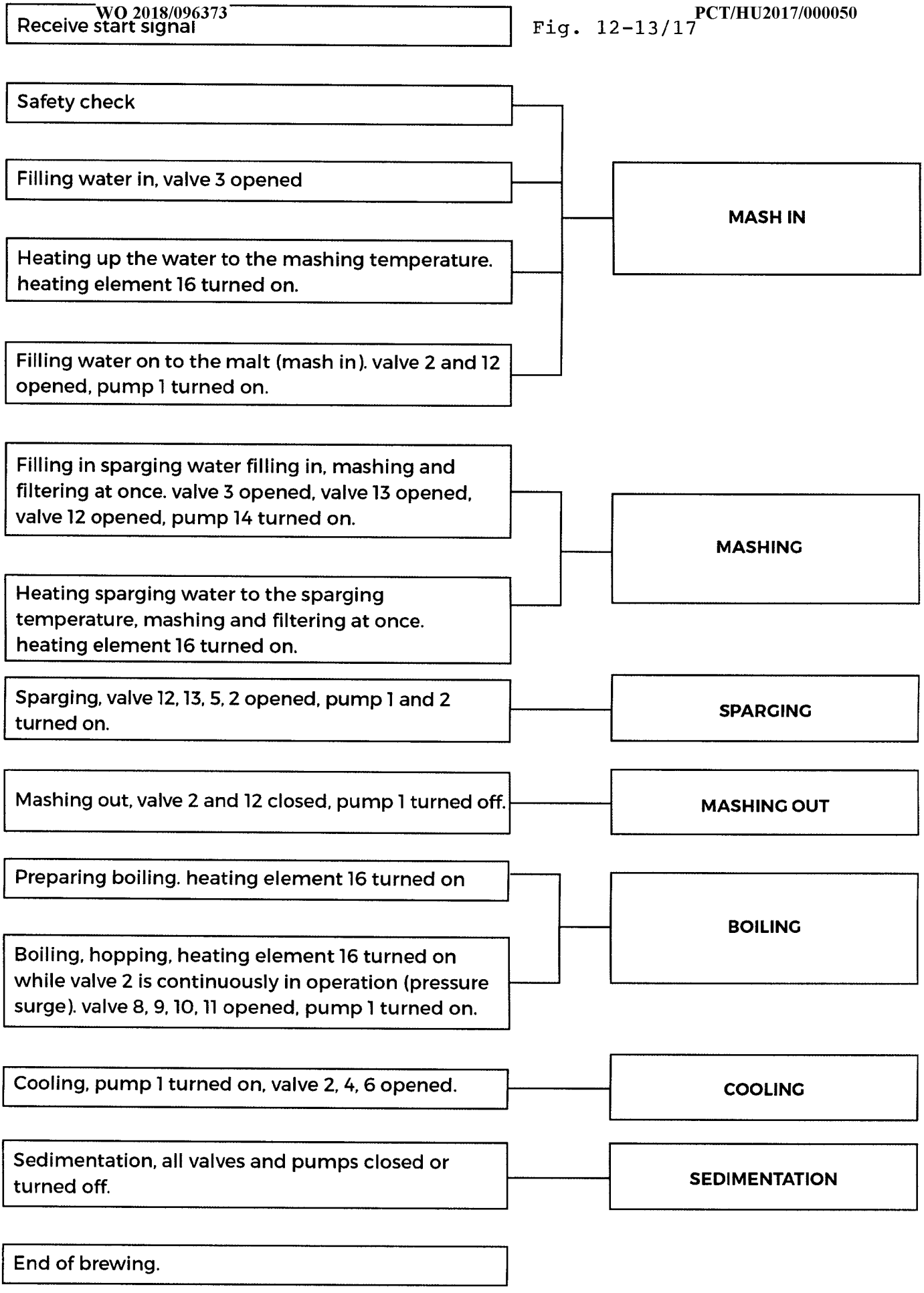
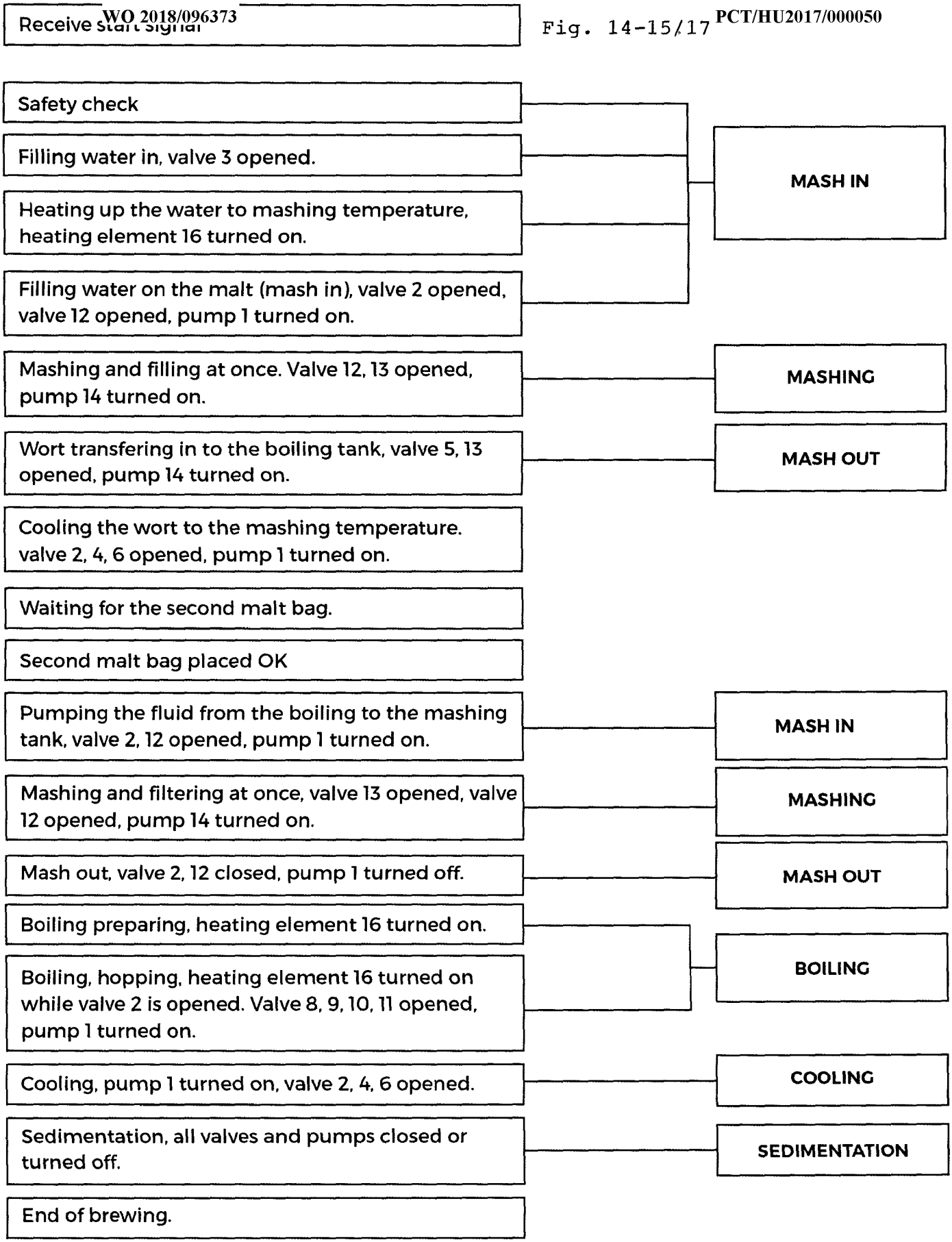
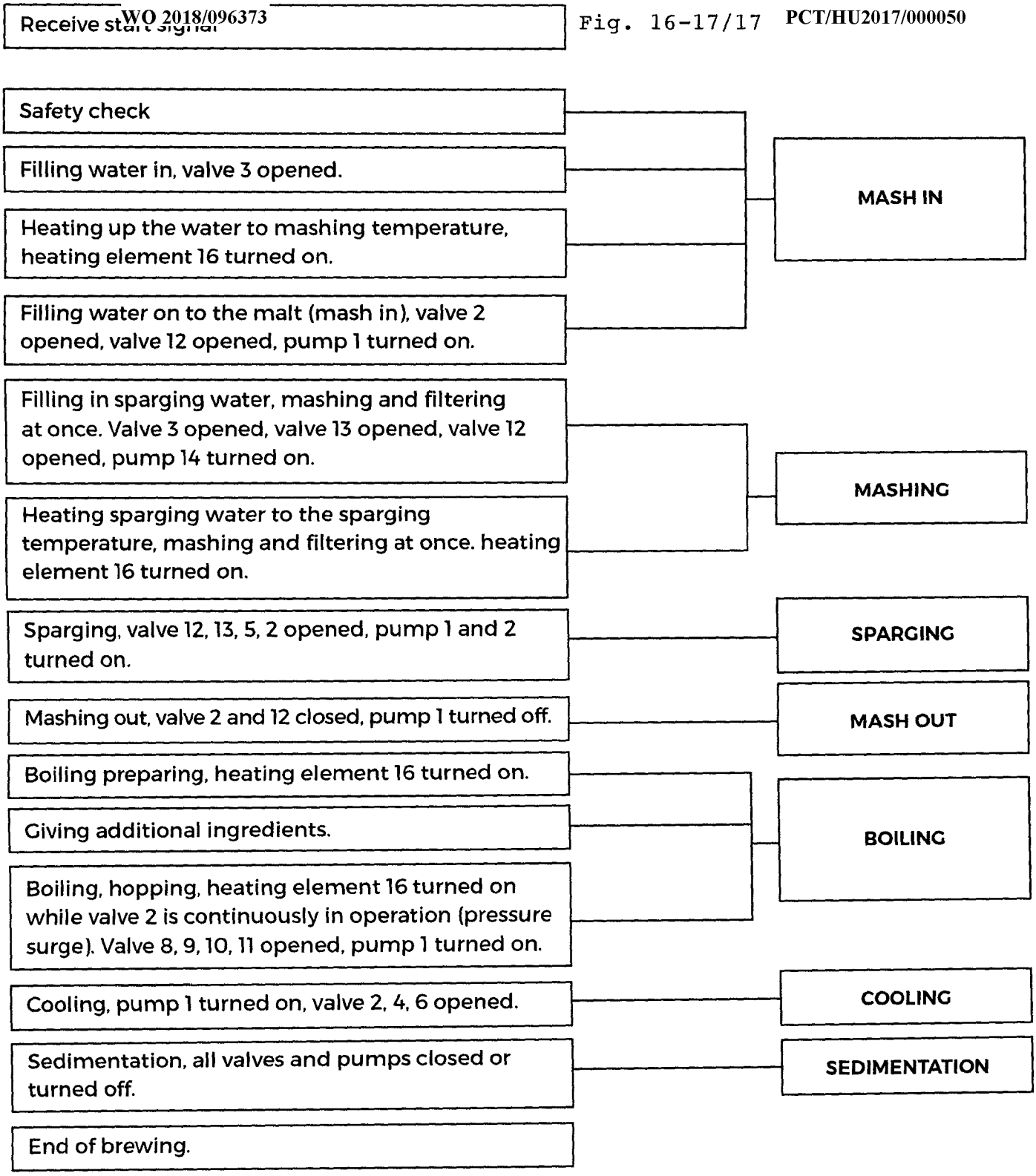

180
Boiling
A
Mashing
B
Hopping
C
D
E
F
Heating
Chilling
PVA
Water
Wort
Cooling Water
PCU
Display
Network
Input
Sensor 2
Sensor 1
Flexible Tube:
Electric wire:
11 / 17

Fig. 12-13/17


Receive start signal
Safety check
Filling water in, valve 3 opened
Heating up the water to the mashing temperature. heating element 16 turned on.
Filling water on to the malt (mash in). valve 2 and 12 opened, pump 1 turned on.
MASH IN
Filling in sparging water filling in, mashing and filtering at once. valve 3 opened, valve 13 opened, valve 12 opened, pump 14 turned on.
Heating sparging water to the sparging temperature, mashing and filtering at once. heating element 16 turned on.
MASHING
Sparging, valve 12, 13, 5, 2 opened, pump 1 and 2 turned on.
SPARGING
Mashing out, valve 2 and 12 closed, pump 1 turned off.
MASHING OUT
Preparing boiling. heating element 16 turned on
Boiling, hopping, heating element 16 turned on while valve 2 is continuously in operation (pressure surge). valve 8, 9, 10, 11 opened, pump 1 turned on.
BOILING
Cooling, pump 1 turned on, valve 2, 4, 6 opened.
COOLING
Sedimentation, all valves and pumps closed or turned off.
SEDIMENTATION
End of brewing.


Receive start signal
Safety check
Filling water in, valve 3 opened.
Heating up the water to mashing temperature, heating element 16 turned on.
Filling water on the malt (mash in), valve 2 opened, valve 12 opened, pump 1 turned on.
MASH IN
Mashing and filling at once. Valve 12, 13 opened, pump 14 turned on.
MASHING
Wort transfering in to the boiling tank, valve 5, 13 opened, pump 14 turned on.
MASH OUT
Cooling the wort to the mashing temperature. valve 2, 4, 6 opened, pump 1 turned on.
Waiting for the second malt bag.
Second malt bag placed OK
Pumping the fluid from the boiling to the mashing tank, valve 2, 12 opened, pump 1 turned on.
MASH IN
Mashing and filtering at once, valve 13 opened, valve 12 opened, pump 14 turned on.
MASHING
Mash out, valve 2, 12 closed, pump 1 turned off.
MASH OUT
Boiling preparing, heating element 16 turned on.
Boiling, hopping, heating element 16 turned on while valve 2 is opened. Valve 8, 9, 10, 11 opened, pump 1 turned on.
BOILING
Cooling, pump 1 turned on, valve 2, 4, 6 opened.
COOLING
Sedimentation, all valves and pumps closed or turned off.
SEDIMENTATION
End of brewing.


Receive start signal
Safety check
Filling water in, valve 3 opened.
Heating up the water to mashing temperature, heating element 16 turned on.
Filling water on to the malt (mash in), valve 2 opened, valve 12 opened, pump 1 turned on.
MASH IN
Filling in sparging water, mashing and filtering at once. Valve 3 opened, valve 13 opened, valve 12 opened, pump 14 turned on.
Heating sparging water to the sparging temperature, mashing and filtering at once. heating element 16 turned on.
MASHING
Sparging, valve 12, 13, 5, 2 opened, pump 1 and 2 turned on.
SPARGING
Mashing out, valve 2 and 12 closed, pump 1 turned off.
MASH OUT
Boiling preparing, heating element 16 turned on.
Giving additional ingredients.
Boiling, hopping, heating element 16 turned on while valve 2 is continuously in operation (pressure surge). Valve 8, 9, 10, 11 opened, pump 1 turned on.
BOILING
Cooling, pump 1 turned on, valve 2, 4, 6 opened.
COOLING
Sedimentation, all valves and pumps closed or turned off.
SEDIMENTATION
End of brewing.