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(54) SPRAYING SYSTEM DIAGNOSTICS AND METHODS THEREOF

(57) The present invention relates to spraying system diagnostics and methods thereof. In one example aspect, the present invention relates to a method for detecting malfunction of a sprinkling device (10) of a washing unit (1) by monitoring the pressure profile thereof to determine a repetitive pressure profile. The repetitive pressure profile is then monitored in real time, and wherein any variation therefrom may trigger an alert or alarm providing indication of a malfunction. The present invention also relates to a sprinkling device (10) comprising at least one spraying bar (11), said at least one spraying bar (11) comprising a pressure pipe (20), a shaft (30) rotationally mounted to the pressure pipe (20), and at least one sensor (60) connected to the pressure pipe (20).

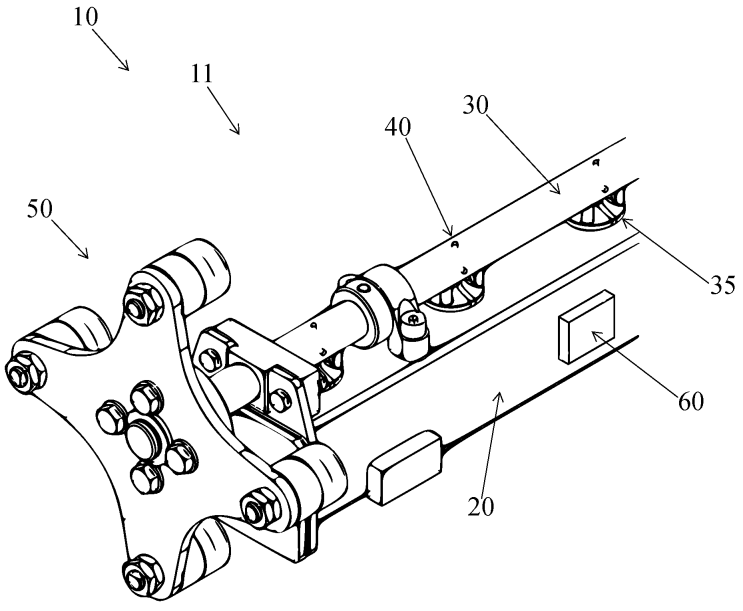

Fig. 2

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Description

FIELD OF INVENTION

[0001] The present invention relates to sprinkling devices and systems such as washing units that utilize sprinkling devices. More particularly, the invention relates to spraying system diagnostics and methods thereof.

BACKGROUND

[0002] Washing units typically include conveying tunnels to carry empty containers such as bottles. In most cases, multiple sprinkling devices are used to spray a liquid in or on containers that are typically oriented upside down and captured within pockets of a chain or conveyor that moves throughout the washing unit.

[0003] An example of a sprinkling device is known from EP3124128. Known sprinkling devices typically include at least one pump supplying the liquid through a conduit to a pressure pipe under at least some amount of pressure, and a shaft is rotatably mounted along the pressure pipe and comprises pairs of spaced-apart bores for seating against spaced-apart nozzles that are fluidly connected to the pressure pipe. Movement of the chain or conveyor throughout the washing unit causes engagement with a mechanical cam provided on the end of the shaft, thereby rotating the shaft to permit the liquid to pass through the nozzles and bores, discharging as liquid jets to reach the bottles moved by the conveyor. Further emphasis is directed to the nozzle shape to prevent excessive wear thereof from rigid particles within the liquid passing therethrough, further noting that a consequence of excessive wear is the shortening of the nozzle's usable life, leading to liquid tightness issues, either between the nozzle and the rotating shaft or even between the nozzle and the pressure pipe. Insufficient water tightness hinders a proper working condition for the sprinkling device. Also, an excessive wear leads to more frequent maintenance operations.

[0004] However, even with the most durable nozzle acting as the conduit between the pressure pipe and the rotating shaft and bores thereof, one or more other unforeseen events may occur that could be prone to substantial mechanical failure and stoppage of the machine. Indeed, other than conducting maintenance procedures, machine stoppage is most commonly attributed to mechanical failures that are typically only detected by visual inspection, most of which are realized after the failure has occurred.

[0005] Consequently, mechanical failures which are not detected immediately introduce substantial risks to the washing unit and its intended purpose, for example, to wash the bottles. This may lead to not optimal rinsing with potential caustic residuals remaining therein. Furthermore, some mechanical failures have been known to be so destructive so as to require disassembly and replacement of substantial components of the washing unit, causing major economic losses.

[0006] Accordingly, it is to the provision of spraying system diagnostics and methods thereof meeting these and other needs that the present invention is primarily directed.

SUMMARY

[0007] The present disclosure relates to spraying system diagnostics and methods thereof.

[0008] According to the invention, there is provided a method for detecting malfunction of a sprinkling device 10 of a washing unit 1, said method comprising providing a washing unit 1 comprising at least one sprinkling device 10, at least one pump 6 configured for supplying the fluid under pressure to the sprinkling device 10, and a conduit 7 fluidly connected between the sprinkling unit 10 and the at least one pump 6, providing at least one sensor 60 for continuously measuring the pressure of the fluid within the conduit 7 or at delivery of the fluid to the sprinkling device 10, obtaining data from the at least one sensor 60, processing the data to determine a repetitive pressure profile; monitoring the repetitive pressure profile, and triggering an alarm when variation exists in the repetitive pressure profile.

[0009] In some aspects of the invention, the washing unit 1 comprises a plurality of sprinkling devices 10 and wherein each of the plurality sprinkling devices 10 comprise at least one sensor 60. According to an aspect of the invention, the method can comprise obtaining data from the plurality of sensors 60, processing the data to determine a repetitive pressure profile for each of the plurality of sensors 60, monitoring the repetitive pressure profiles for each of the plurality of sensors 60, triggering an alarm when a variation exists in one or more of the repetitive pressure profiles of the plurality of sensors 60. According to aspects of the invention, the sensor 60 comprises a pressure transducer.

[0010] According to another aspect, the present invention relates to sprinkling device 10 comprising at least one spraying bar 11, said at least one spraying bar 11 comprising a pressure pipe 20, a shaft 30 rotationally mounted to the pressure pipe 20, and at least one sensor 60 connected to the pressure pipe 20. According to aspects of the invention, the at least one sensor 60 comprises a pressure transducer. In some aspects of the present invention, the pressure transducer comprises a wired connection with a CPU 100 for collecting, processing and monitoring data being output from the pressure transducer. According to some aspects of the present invention, the pressure transducer comprises a wireless connection with a CPU 100 for collecting, processing and monitoring data being output from the pressure transducer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Further features and advantages of the present invention will be better understood from the description of possible features and preferred embodiments, which is given below by way of a non-limiting illustration, with reference to the accompanying drawings, in which:

Figure 1 is a lateral view of a washing unit comprising a spraying system according to an example embodiment of the present invention.

Figure 2 is a perspective view of a spraying bar according to an example embodiment of the present invention.

Figure 3 is a lateral view of a portion of a sprinkling device having two spraying bars that are manipulated by portions of the conveyor.

Figure 4 shows a sequence of operation of jets of fluid discharging from a shaft of the spraying bar as pockets carrying containers pass thereby.

[0012] The drawings illustrate only example embodiments and are therefore not to be considered limiting of the scope described herein, as other equally effective embodiments are within the scope and spirit of this disclosure. The elements and features shown in the drawings are not necessarily drawn to scale, emphasis instead being placed upon clearly illustrating the principles of the embodiments. Additionally, certain dimensions may be exaggerated to help visually convey certain principles. In the drawings, similar reference numerals between figures designate like or corresponding, but not necessarily the same, elements.

DETAILED DESCRIPTION

[0013] In accordance with the purpose(s) of the present disclosure, as embodied and broadly described herein, embodiments of the present disclosure, in some aspects, relate to systems and methods incorporating diagnostic improvements to tunnel machines or bottle washing units.

[0014] According to example embodiments, objects of the present invention comprise diagnostic systems and methods configured for use with a washing unit 1 comprising at least one spraying system for discharging a liquid, gas and/or combination thereof (hereinafter "fluid") to contribute to the washing process containers 4 undergo as they travel throughout the washing unit along a chain or conveyor 2.

[0015] Figure 1 shows the washing unit 1 comprising the conveyor 2 for conveying containers 4 along an endless path W through a plurality of treatment zones as the containers move from an inlet station to an outlet station. In example embodiments, the washing unit 1 comprises the spraying system 5 comprising a plurality of sprinkling devices 10. In example embodiments, each of the treatment zones may comprise one or more sprinkling devices 10 positioned below the conveyor for discharging jets of the fluid for cleaning and further rinsing of the containers 4 as they are handled by the conveyor 2. In example embodiments, each sprinkling device 10 comprises a pump for moving the fluid under low or high pressure to the sprinkling device 10, only one of which is shown in Figure 1. Thus, the pump 6 is configured to service a single sprinkling device 10 whereby a conduit 7 fluidly connects the pump 6 to the sprinkling device 10.

[0016] Still referring to Figure 1, a showering apparatus 80 may be provided and positioned above the conveyor 2 near some of the sprinkling devices 10, said showering apparatus 80 being generally fluidly connected to the conduit 7 and supplied with the fluid by the pump 6. Accordingly, in example embodiments, the pump 6 can be configured to supply fluid to a single sprinkling device 10, or for example, may be configured to supply fluid to both the single sprinkling device 10 and a single showering apparatus 80. In other example embodiments, one or more sprinkling devices 10 and/or showering apparatuses 80 may be supplied with fluid by a desired number of pumps, for example, by a single pump or by multiple pumps.

[0017] Figure 2 shows the sprinkling device 10 is greater detail. In example embodiments, the sprinkling device 10 comprises at least one spraying bar 11, said spraying bar 11 comprising a pressure pipe 20 in which fluid flows, a rotating shaft 30 extending along the pressure pipe 20, and at least one sprinkling means comprised of an aperture of the pressure pipe 20, a nozzle 35 positioned in said aperture, between said pressure pipe 20 and said rotating shaft 30, and at least one radial bore 40 in the rotating shaft 30, located at the level of the nozzle 35, for receiving the fluid from the nozzle 35. According to example embodiments, the sprinkling device 10 may comprise 2, 3, 4 or more spraying bars 11 arranged generally parallel relative to each other in a spaced-apart arrangement. For example, the sprinkling device 10 shown in Figure 3 comprises two spraying bars 11 which are at least partially spaced apart from each other.

[0018] With reference to Figures 2-3, a mechanical cam 50 is provided at an end of the rotating shaft 30, said cam 50 being engaged directly or indirectly by the conveyor, in order to ensure that the jets of fluid, coming from the radial bores 40 and directed thereby, reaches the bottles moved by said conveyor. According to example embodiments, the conveyor 2 comprises pockets 3, each dedicated to receive a container 4. Furthermore, at least a portion of one or more pockets 3 can be provided for engagement with the mechanical cam 50 so as to provide for manipulation thereof to directly cause rotation of the shaft 30. In example embodiments, the speed of the conveyor 2 and rotation of the mechanical cam 50 are synchronized so as to permit maximum engagement of the jets of fluid discharged from the bores 40 onto the containers 4. For example, Figure 4 shows a sequence of operation of the shaft 30 synchronized to rotate with the movement of the conveyor, showing the jets of fluid

following the pocket 3 and a mouth of the container 4 as the conveyor 2 passes by the spraying bar 11.

[0019] According to example embodiments, jets of fluid are discharged from the bores 40 for about 90 degrees of rotation of the shaft 30, for example about 45 degrees in either direction with respect to a vertical axis. According to other example embodiments, the range of rotation for which jets of fluid may be discharged may be greater than or less than 90 degrees. In example embodiments, the shaft 30 comprises pairs of spaced-apart bores 40 with one of the bores of the pair being generally oriented perpendicular relative to the other bore of the pair. Accordingly, still referring to Figure 4, as one of the bores of the pair reaches the ending of the range of rotation for which the jet of fluid is spraying therefrom (see far right of Figure 4), the other bore of the pair is entering the range of rotation, and thus defining a patterned discharge of jets of fluid.

[0020] As shown in Figure 2 and Figure 4, at least a portion of the sprinkling device 10 comprises at least one pressure sensor 60 connected therewith for monitoring a local pressure of the fluid that is delivered from the pump 6 to the sprinkling device 10 and one or more spraying bars 11 thereof. In example embodiments, the at least one pressure sensor 60 may be in the form of a pressure transducer or other hardware component capable thereof.

[0021] In example embodiments, each spraying bar 11 can comprise a pressure sensor 60 connected thereto for monitoring the pressure of the fluid within the pressure pipe 20, or for example, near the delivery of the fluid to the pressure pipe 20. According to example embodiments, as a result of the arrangement of the rotating bar 30 and bores 40 thereof defining the pattered discharge of jets of fluid, a pressure curve profile of the fluid at its delivery to the pressure pipe 20 of each spraying bar 11 is obtainable and can be monitored in real time as the washing unit is in operation.

[0022] According to example embodiments of the present invention, a computing device such as a computer or other electronic device (e.g., programmable logic controller (PLC), etc.), for example a central processing unit (CPU) 100, which typically comprises a hard drive, a processor, random access memory, and hardware and software is configured to communicate with the pressure sensors 60 in real time as the washing unit 1 is operating. In example embodiments, data obtained by the pressure sensors 60 is continuously output to the CPU 100 in real time by a wired connection, or for example, wirelessly. The data received by the CPU 100 is then processed.

[0023] According to example embodiments, the data is processed by the CPU 100 to determine a repetitive or repeating pressure profile over a span of time, for example, to understand the pressure of the fluid at its delivery to the spray bar 11 during normal operating conditions. Thereafter, once the repeating pressure profile is identified over a particular span of time, the CPU 100 continues to receive and process the data provided from the pressure sensor 60 while monitoring the repetitive profile. For example, according to example embodiments, it is during the monitoring of the repeating pressure profile that a variation of the profile is instantly recognizable, and an alert or alarm can be triggered when the variation is recognized to alert and inform an operator of the washing unit that a problem exists. Accordingly, problems or incidents may be attended to much sooner, making it less likely for an incident to result in a substantial repair and leading to less machine downtime with greater efficiency, while also mitigating risks linked to quality of washing or rinsing.

[0024] According to some example embodiments, said CPU 100 or other electronic device(s) receiving and processing the data obtained from the one or more sensors 60 of the plurality of sprinkling devices 10 of the washing machine 1 as described herein can be adapted for use with artificial intelligence (AI) or other AI driven software or capabilities to further improve, automate and streamline diagnostic capabilities. For example, an AI module can be implemented with the methods and systems as described herein so as to receive, process, learn, and exploit the data received from the one or more sensors 60. And thus, over time, the AI module can become more knowledgeable with respect to the data so as to understand, recognize and make aware of not only current but also future potential failures.

[0025] According to another example embodiment of the present invention, the present invention relates to a method for detecting malfunction of a sprinkling device 10 of a washing unit 1, said method comprising providing a washing unit 1 comprising at least one sprinkling device 10, at least one pump 6 configured for supplying the fluid under pressure to the sprinkling device 10, and a conduit 7 fluidly connected between the sprinkling unit 10 and the at least one pump 6, said method further comprising providing at least one sensor 60 for continuously measuring the pressure of the fluid within the conduit 7 or at delivery or the fluid to the sprinkling device 10, obtaining data from the sensor 60, processing the data to determine a repetitive pressure profile, monitoring the repetitive pressure profile, and triggering an alarm when variation exists in the repetitive pressure profile. In example embodiments, said at least one pump is configured for supplying the fluid under pressure to the sprinkling device 10, and more specifically one or more spray bars 11 thereof. As described above, the sensor 60 can be installed for fluid communication with the fluid within the pressure pipe 20, to obtain a more proximal pressure relative to the fluid's output, and thus obtain more credible and accurate readings of the pressure within the pressure pipe 20, continuously and in real time, as the shaft 30 rotates atop the nozzles 35 to permit a patterned discharge of jets of fluid from the pressure pipe 20, through the nozzles 35 and through the bores 40.

[0026] In example embodiments, the washing unit 1 can comprise a plurality of sprinkling devices 10 and wherein the method can further comprise equipping each

sprinkling device 10 with at least one sensor 60 so as to obtain and process the data thereof, continuously, so as to determine and monitor the repetitive pressure profile of each sensor 60. According to example embodiments, the method as described herein can further comprise providing a plurality of sprinkling devices 10, said method further providing an indication of possible mechanical errors associated with the variations found in the repetitive pressure profiles of one or more sensors 60 of the plurality of sprinkling devices 10. According to example embodiments, variations remaining specific to data obtained from a single sprinkling device 10 indicates failure of the sprinkling device 10 itself and wherein variations of data moving between two or more of the plurality of sprinkling devices 10 indicates a failure of the conveyor or components thereof such as a triggering arm according to one example embodiment. For example, when a variation occurs in a repetitive pressure profile and the variation does not disappear, then the behavior is likely indicative of a failure of the sprinkling device 10 for which the data is obtained. Whereas, when a variation in the repetitive pressure profile only occurs for a period of time, and wherein said variation is moving from one repetitive pressure profile to the next, from one sprinkling device 10 to the next sprinkling device 10, then the behavior is likely indicative of a failure of the conveyor or one or more trigger arms, for example wherein the variation is typically coinciding with the damaged portion thereof as it moves along throughout the washing machine 1.

[0027] While specific embodiments of the invention have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details, in addition to those discussed above, could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only, and not limiting as to the scope of the invention which is to be given the full breadth of the claims appended in any and all equivalents thereof, including any combination of their features.

Claims

1. A method for detecting malfunction of a sprinkling device 10 of a washing unit 1, the method comprising:

providing a washing unit 1 comprising at least one sprinkling device 10, at least one pump 6 configured for supplying the fluid under pressure to the sprinkling device 10, and a conduit 7 fluidly connected between the sprinkling unit 10 and the at least one pump 6;
providing at least one sensor 60 for continuously measuring the pressure of the fluid within the conduit 7 or at delivery of the fluid to the sprinkling device 10;
obtaining data from the at least one sensor 60;
processing the data to determine a repetitive pressure profile;
monitoring the repetitive pressure profile; and
triggering an alarm when variation exists in the repetitive pressure profile.

2. The method of Claim 1, wherein the at least one pump is configured for supplying the fluid under pressure to one or more spray bars 11 of the sprinkling device 10.

3. The method of Claim 1, wherein each of the one or more spray bars 11 comprises at least one sensor 60 connected thereto and in communication with the pressurized fluid contained therein.

4. The method of Claim 3, wherein each spray bar 11 comprises a pressure pipe 20, and wherein the at least on sensor 60 is connected thereto and in communication with the pressurized fluid contained therein.

5. The method of Claim 1, wherein the washing unit 1 comprises a plurality of sprinkling devices 10 and wherein each of the plurality sprinkling devices 10 comprise at least one sensor 60.

6. The method of Claim 5, further comprising obtaining data from the plurality of sensors 60.

7. The method of Claim 6, further comprising processing the data to determine a repetitive pressure profile for each of the plurality of sensors 60.

8. The method of Claim 7, further comprising monitoring the repetitive pressure profiles for each of the plurality of sensors 60.

9. The method of Claim 8, further comprising triggering an alarm when a variation exists in one or more of the repetitive pressure profiles of the plurality of sensors 60.

10. The method according to any of Claim 1-9, wherein the sensor 60 comprises a pressure transducer.

11. The method according to any of Claim 1-9, wherein the washing unit 1 comprises a plurality of sprinkling devices 10, and wherein the method further comprises providing indication of possible mechanical errors associated with the variations found in the repetitive pressure profile.

12. The method of Claim 11, wherein variations remaining specific to data obtained from a single sprinkling device 10 indicates failure of the sprinkling device 10 itself and wherein variations of data moving between

two or more of the plurality of sprinkling devices 10 indicates a failure of the conveyor or components thereof.

13. A sprinkling device 10 according to the method of Claim 1, said sprinkling device comprising:

at least one spraying bar 11, said at least one spraying bar 11 comprising a pressure pipe 20 and a shaft 30 rotationally mounted to the pressure pipe 20; and
at least one sensor 60 connected to the pressure pipe 20.

14. The sprinkling device of Claim 13, wherein the at least one sensor 60 comprises a pressure transducer.

15. The sprinkling device of Claim 14, wherein the pressure transducer comprises a wired connection with a CPU 100 for collecting, processing and monitoring data that is output from the pressure transducer.

16. The sprinkling device of Claim 14, wherein the pressure transducer comprises a wireless connection with a CPU 100 for collecting, processing and monitoring data that is output from the pressure transducer.

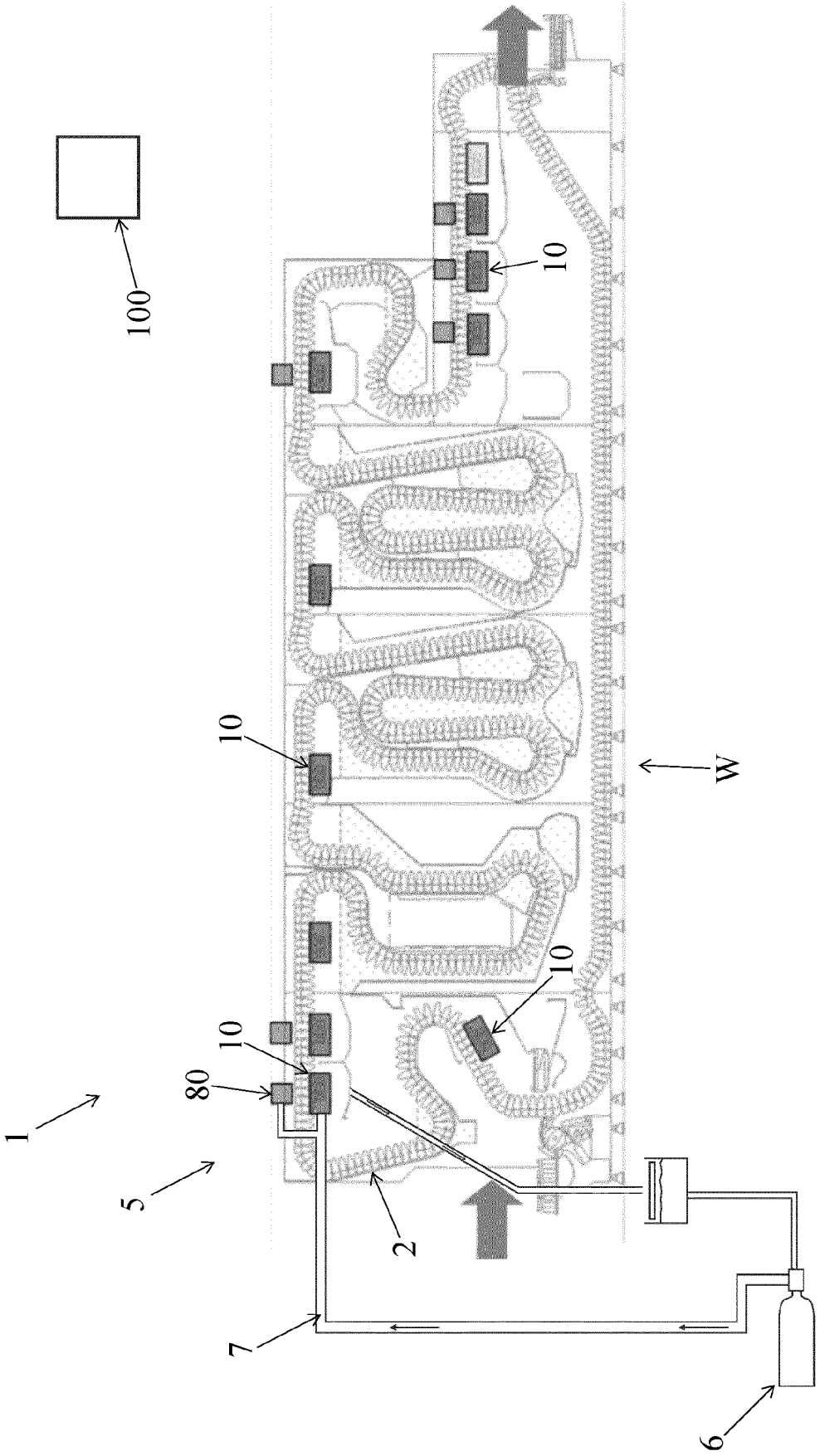

Fig. 1

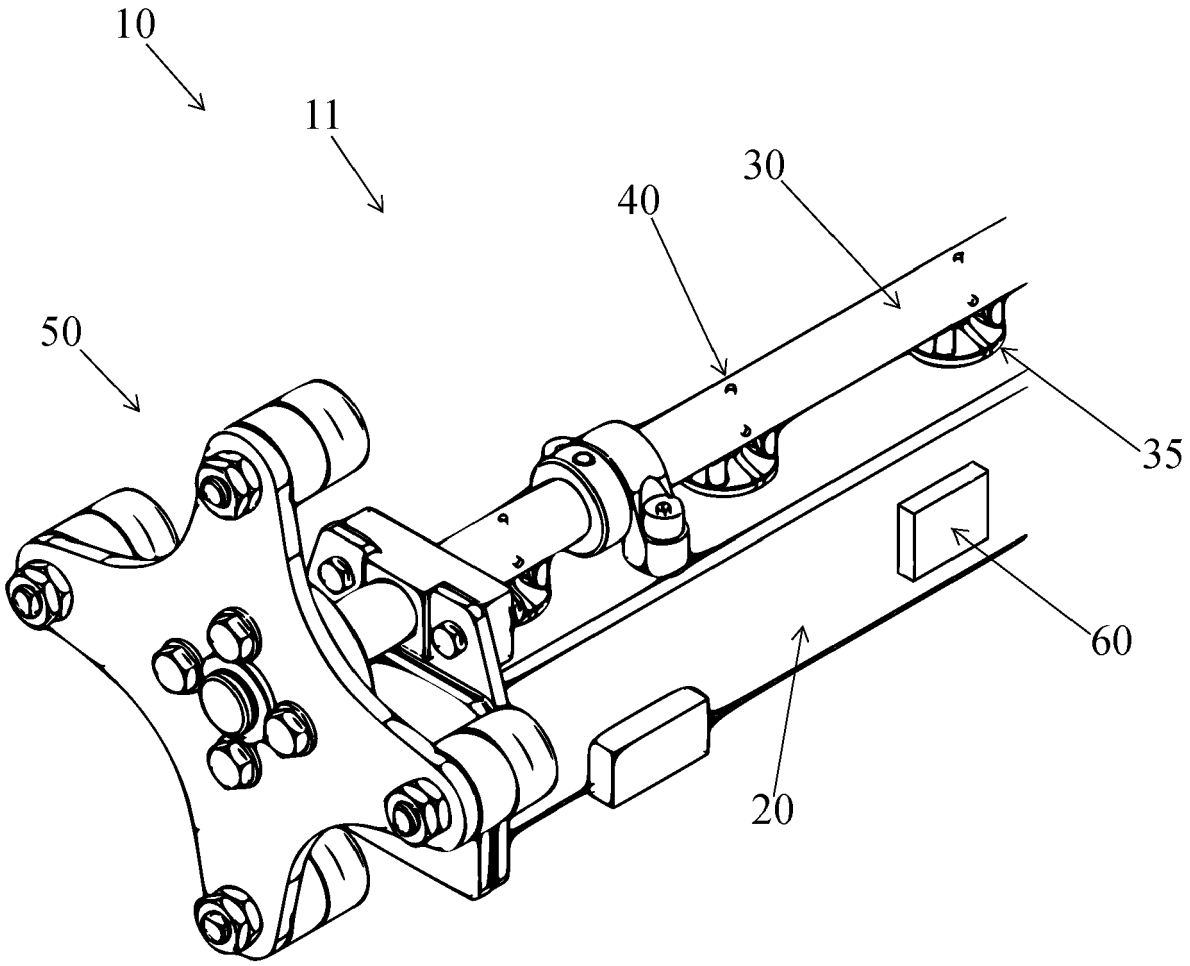

Fig. 2

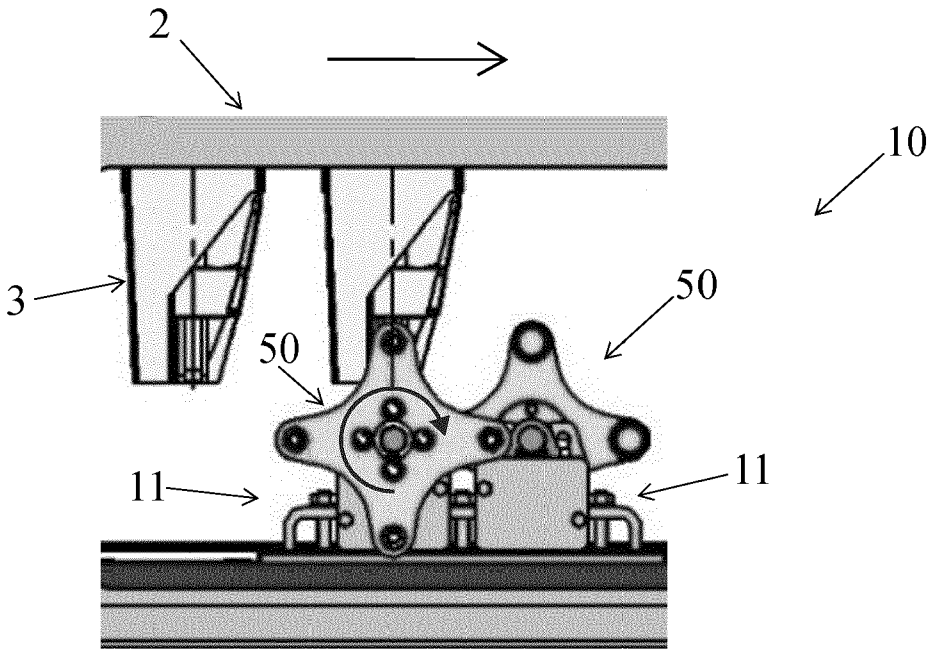

Fig. 3

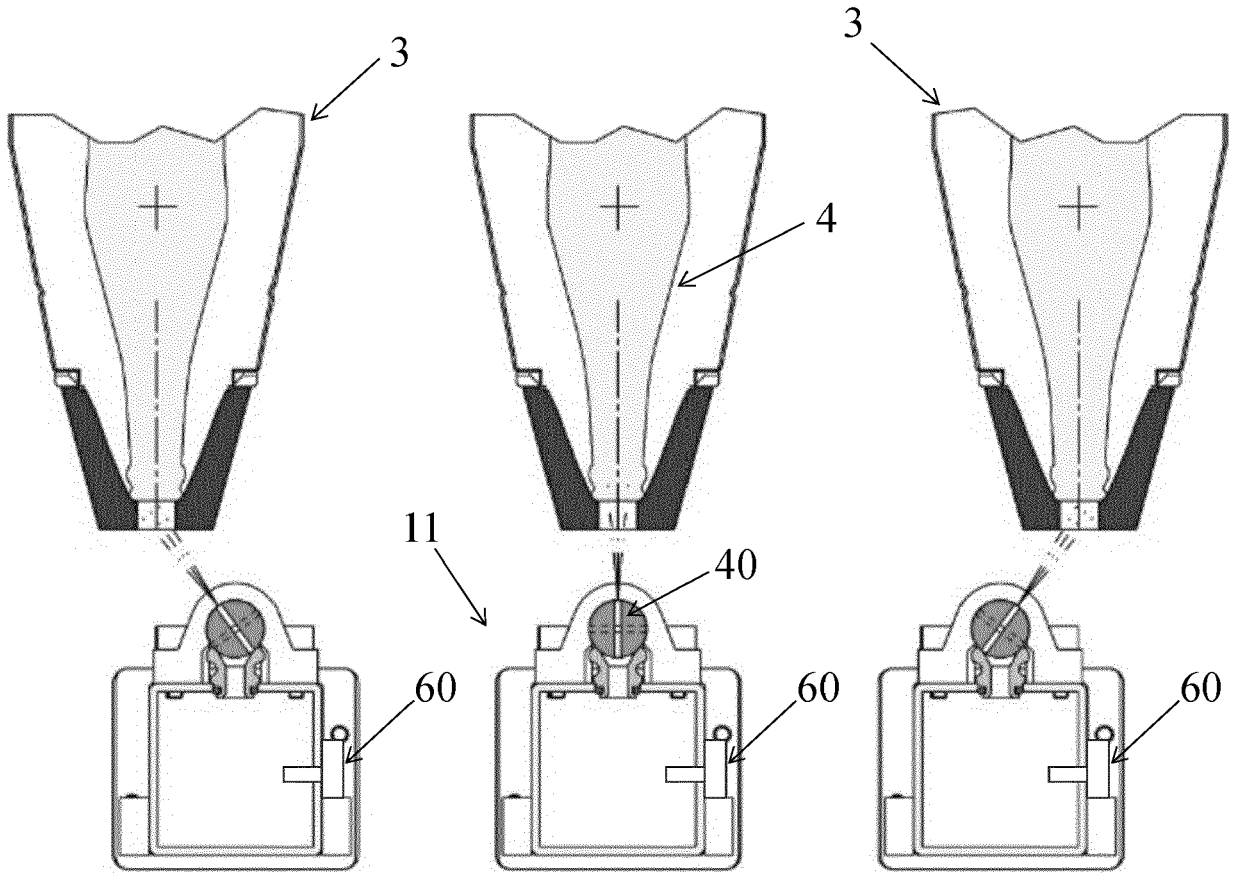

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 23 22 0446

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	28 May 2024	van der Zee, Willem

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EUROPEAN SEARCH REPORT

Application Number
EP 23 22 0446

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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