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(71) Applicant: **Grundfos Holding A/S**
8850 Bjerringbro (DK)

(72) Inventors:
- **Schmitz, Rainer**
  40699 Erkrath (DE)
- **Kechler, Valeri**
  76327 Pfinztal (DK)
- **Müller, Klaus**
  76327 Pfinztal (DK)

(74) Representative: **Patentanwälte Vollmann Hemmer Lindfeld**
Partnerschaft mbB
Wallstraße 33a
23560 Lübeck (DE)

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(54) METERING PUMP SYSTEM

(57) The invention refers to a metering pump system comprising at least one metering pump (2) provided for connection to at least one exchangeable liquid container 16 via a suction line 10, and a control device 18, 24 for control of the at least one metering pump (2) wherein the control device 18, 24 is configured such that it records the total volume pumped by the metering pump (2), compares the recorded total volume with a nominal volume of said liquid container 16 and starts an action if the recorded total volume exceeds the nominal volume by more than a predefined threshold, and a method for controlling such metering pump system.

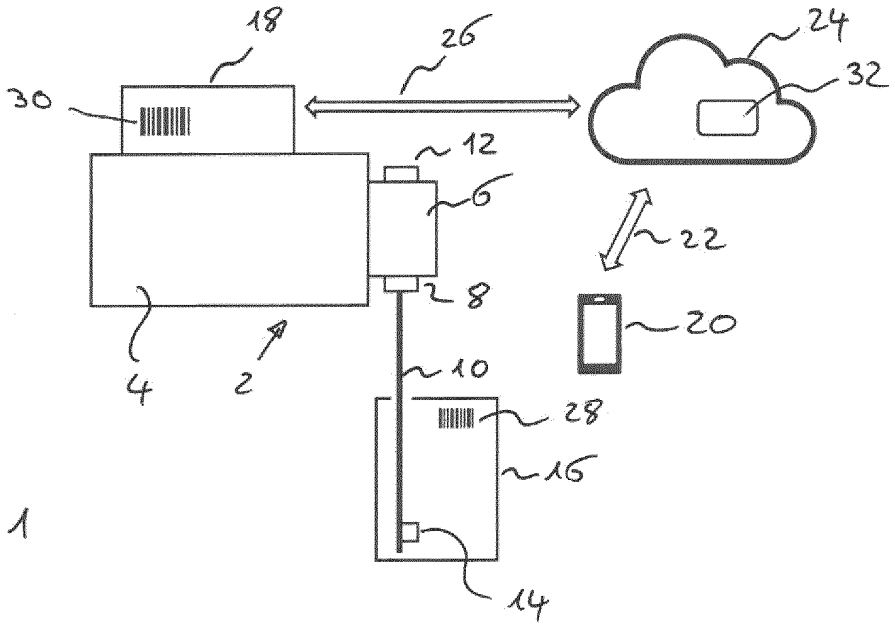

Fig. 1

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Description

[0001] The invention refers to a metering pump system and to a method for controlling such a metering pump system.

[0002] Metering pump systems are used for dosing of liquids, for example chemicals. The dosing of liquids or chemicals is needed in different applications or facilities. For example, in car wash sites different cleaning agents have to be added to water for cleaning. In many applications different chemicals are used together with several metering pumps, each metering pump for dosing a certain chemical. In those applications it is a problem that when exchanging the liquid containers, mistakes may occur so that the wrong container may be connected to a certain metering pump. Also when the containers are refilled, there is a risk that a wrong or improper chemical is refilled into a container.

[0003] In view of this, it is the object of the invention to improve a metering pump system such that the use of improper or wrong chemicals together with a certain metering pump can be prevented.

[0004] This object is achieved by a metering pump system having the features defined in claim 1 and by a method for controlling a metering pump system having the features defined in claim 19. Preferred embodiments are disclosed in the dependent subclaims, the following description and the accompanying drawings.

[0005] The metering pump system according to the invention comprises at least one metering pump, provided for connection to at least one exchangeable liquid container via a suction line, and a control device for control of the at least one metering pump. At least one exchangeable liquid container may form a part of the metering pump system. However, the liquid container is a consumable product. Thus, according to a preferred embodiment, the metering pump system according to the invention is provided or configured to be connected via a suction line with a suitable disposable liquid container. Preferably the system may comprise more than one metering pump which are connected to a central control device. In a further embodiment each metering pump may have an independent control device and the control devices may communicate with one another or with a central master control. The liquid container may comprise any suitable liquid to be pumped by the metering pump, for example a chemical used in a car wash site or in an industrial facility. Preferably the container is a container in which the respective liquids are delivered so that the entire container is replaced if a container is emptied. According to a preferred embodiment the suction line of the metering pump comprises a suction lance insertable into the liquid container through an opening of the container. For replacing the container the suction lance is pulled out of the container and inserted into a new, full container.

[0006] The invention provides an improved security when replacing the liquid container to ensure that a correct liquid container, i.e. a liquid container containing the correct liquid is connected to a certain metering pump. The control device according to the invention is configured such that it records the total volume pumped by the metering pump. This may be the total volume in a certain time period. Preferably this period starts with the connection of a full liquid container to the metering pump and the respective volume counting is reset to zero when replacing the liquid container by a new completely filled liquid container. Since metering pumps are replacement pumps, it is possible for the pump control to calculate and count the volume pumped by counting the strokes of the pump considering the stroke length and the volume of the pump chamber. Thus, the pumped volume is not directly measured but calculated on basis of the number of strokes carried out with knowledge of the pumped volume per stroke. However, it would also be possible to directly measure the fluid flow produced by the metering pump and to record the measured pumped volume on basis of such direct measurement.

[0007] Furthermore, the control device is configured to compare the recorded total volume with a nominal volume of the liquid container which is connected to the metering pump. For this purpose the control device has knowledge of the nominal volume. For example, the nominal volume of the liquid container may be known by or input into the control device before. In case that the recorded total volume, i.e. the actual volume pumped by the metering pump exceeds the nominal volume of the liquid container by more than a predefined threshold the control device starts a desired action, for example gives an alarm and/or stops the pump. By this the control device in the metering pump system according to the invention can prevent or signalize a refilling of the container since the pump volume will exceed the nominal volume if the container is refilled. Thus, refilling of the container with a wrong chemical or liquid can be detected and preferably prevented. It can be ensured that always the entire liquid container has to be replaced. Furthermore, also a fault diagnosis is possible, since for example in case that the container is not refilled and, nevertheless, the recorded volume exceeds the nominal volume, there must be a fault in dosing.

[0008] According to a preferred embodiment the value for the nominal volume is stored in the control device. For this, the control device may comprise a suitable memory. For example, the nominal volume may be stored in the control device during set up of the system and/or input in any suitable way later when connecting a liquid container to the metering pump system, i.e. to a certain metering pump of the system. According to a further embodiment, the control device may be connected or connectable to storage means containing a value for the nominal volume and the control device may read this information from said storage means. That storage means may be an external database or for example an information carrier arranged on a liquid container.

[0009] According to a further embodiment there is provided at least one level sensor, preferably at least two

level sensors at different heights, inside the liquid container, the level sensors being connected to the control device. This means the at least one level sensor or preferably two level sensors are provided to be arranged inside an exchangeable liquid container. Preferably, the sensors can be removed and inserted into a liquid container together with a suction line or a suction lance. However, it is also possible, that respective liquid sensors are fixed inside the container and are exchangeable together with the container. In this case, there is provided a releasable data connection between the sensors in the container and the control device. According to a preferred embodiment the level sensor is provided on a suction lance which is inserted into the container for sucking the liquid out of the container. The lance has to extend close to the bottom of the container allowing to completely empty the container. The level sensor may be used to produce an empty signal showing that the container is empty or nearly empty so that the control device can give an alarm or initiate ordering a new container for replacement. For this the control device may be connected to a central control system of a facility or to an ordering system. Furthermore, two level sensors may be provided to produce a pre-empty signal and an empty signal. The pre-empty signal can signalize that a new container has to be ordered or to be supplied, since the container in use is nearly empty. The empty signal can be used to signal that the replacement is necessary. Instead of applying physical level sensors on the suction lance with an alternative embodiment it may be possible to detect an emptying of the liquid container just by recording the total volume pumped out of the container. If this total volume corresponds to the nominal volume this can be regarded as a complete emptying and the control device may signalize that the liquid container has to be exchanged. Additionally, the metering pump may stop its operation as described before and in the following.

[0010] According to a further embodiment said nominal volume may be defined as a total capacity of the liquid container or as a volume defined by the height of at least one of the level sensors. For example, the nominal volume may be defined as the volume above the position of a level sensor, for example the empty sensor. In case that two level sensors are used as described before, it would also be possible that the nominal volume is the volume above the vertical position of the upper level sensor providing a pre-empty signal. This allows a fault detection before the container is completely empty.

[0011] According to a further preferred embodiment, the control device is configured to generate an alarm or signal and/or to stop the metering pump as an action if the recorded total volume exceeds the nominal volume by more than the predefined threshold. This allows to stop a further malfunction of the metering in case that a fault is detected by the control device. Furthermore, by this the pumping of a wrong or not suitable liquid can be signalized or prevented, since in case that the control device detects a re-filling of the container, which may be the case if the recorded volume exceeds the nominal volume, a further dosing can be prohibited preventing that an unknown liquid is introduced into a facility or process. Additionally or alternatively, other actions can be taken by the control device if the recorded pumped volume exceeds the nominal volume. For example, an alarm or signal can be sent to a further control system or output to an operator. Furthermore, this detection may automatically be logged in a log file inside the control device or output to a further control system.

[0012] According to a further preferred embodiment said at least one liquid container is provided with a container identification means containing at least a container identifier identifying the liquid container and the control device is connected to an input or reading device which is configured for reading the container identifier. Preferably, said container identifier is unique and identifies just one certain container. In the simplest case there is an input device allowing an operator to input the container identifier read from a label on the liquid container. Alternatively, it may be possible to provide an input device in form of a scanner for scanning the information on a label of the liquid container, for example a bar code or QR-code. In a further alternative embodiment an electronic data transfer between the container and the control device may be possible, as described in more detail below.

[0013] Furthermore, preferably the metering pump may be provided with a pump identification means containing at least a pump identifier identifying the metering pump and the control device may be connected to an input or reading device designed for reading the information contained in the pump identification means. Also for reading the pump identifier in the simplest case there may be provided an input device allowing an operator to input a pump identifier read from a label on a certain metering pump. Alternatively, there may be provided a scanner or reading device connected to the control device allowing to read the pump identifier from a label or display on a certain metering pump. In this case the label or display forms the identification means. Alternatively, it may be possible to provide an electronic transfer of the identification, i.e. the pump identifier by an electronic connection between the metering pump and the control device, as described in more detail below.

[0014] Preferably, the container identification means and/or the pump identification means comprise an optical code or an electronic tag or storage means, preferably provided for wireless communication with the reading device, i.e. the control device. The optical code, for example, may be a QR-code or barcode which can be scanned by a scanner acting as a reading device. The code may be printed onto a label or shown on a display. Furthermore, the identification means may, for example, be realized as an electronic tag or an electronic storage means allowing a data communication with the reading device, either by direct contact or preferably wireless. This may be realized, for example, as an RFID-tag on the liquid container and/or the metering pump which can be read

by a respective reading device. A pump identifier according to a further possible solution may directly be stored in the control electronics of the metering pump and output for example via a communication interface, a display etc. Furthermore, storage means connected via a Bluetooth low energy module may be used, for example, like a beacon. A wireless reading can be provided by a radio communication or, for example, an inductive or optical coupling. Also a direct electric connection may be possible.

[0015] According to a further preferred embodiment the input or reading device may be provided by a mobile communication device, preferably a mobile phone or smartphone. This mobile communication device is connected to the control device via a communication network, preferably a telecommunication network and/or the internet. Such mobile communication device provides the required interface for reading the data from the container identification means and/or the pump identification means. This may be for example a Bluetooth interface, a near field communication interface and/or a camera for identifying an optical code like a barcode or QR-code. Those interfaces/cameras are parts of common mobile phones or smartphones. Therefore, those devices can be used as an input or reading device without the need for special hardware. If necessary, required software can be added to such a device, for example in form of an app for the smartphone. For example, a QR-code as a container or a pump identification means can be captured by the camera of a mobile phone and the data from the code can be read by a suitable software application on the mobile phone and then transferred to the control device via the communication network.

[0016] Furthermore, the control device may be configured such that it receives a container identifier read by the input or reading device, checks the received container identifier with information stored in a database, assigns the container identifier to a certain metering pump and allows an activation of this metering pump only if the received container identifier fits to the stored information. The database may contain information concerning containers which are allowed to be connected with a certain metering pump. Thereby the container identifiers can be stored in this database, preferably together with a status of the container showing whether it is new, partly emptied or completely emptied. Furthermore, it may be possible to delete container identifiers for containers which have been used from the database so that they could not be allowed for connection with a metering pump anymore. The control device is connected to the database in a suitable way or the database is stored in the control device itself. The control device makes a comparison or matching with the data in the database to check whether the container with the received container identifier is allowed to be used together with a certain metering pump, which preferably is identified by a pump identifier before. Only if the control device can match the received information with the information in the database and preferably with a certain status belonging to a container identifier the pump is activated. By this, a mismatch of a container, i. e. of a certain chemical with the need in the facility can be avoided since only containers with chemicals allowed or suitable for a certain purpose can be activated together with a predefined metering pump.

[0017] Furthermore, the control device may be configured to adjust a pump control of the metering pump on basis of the information stored in said database. For example, the database may contain information about a program according to which the metering pump should operate for the identified container or the liquid contained in this container. For example, the dosing amount can be adjusted on basis of the concentration of the liquid contained in the container. The database may contain for example information about the concentration. As another example the speed of the pump may be adjusted, for example the suction speed to avoid cavitation.

[0018] According to a further preferred embodiment the control device is configured such that it assigns the container identifier to a metering pump identified by a pump identifier, preferably read by the input or reading device. According to this solution, the user first has to read or input the pump identifier so that the pump control gets information about or identifies the metering pump concerned. In the next step, the user inputs or reads the container identifier of a container which he wants to connect to this metering pump. By this, the control device gets knowledge about or identifies the container to be connected. It has to be understood that this information may be transferred to the control device also in opposite order, i.e. first the container identifier and then the pump identifier. In the following, the control device verifies or checks, for example by use of a database, whether the container identifier is allowed to be connected to the certain metering pump. If yes, it updates the database and assigns the container identifier to this special metering pump. I.e. it is stored in the database that the respective container is used with a certain metering pump. Furthermore, preferably the control device can activate the metering pump only if it can find a match in the database that the certain container identifier is allowed to be used with the metering pump.

[0019] Preferably, said control device is configured such that it updates the information stored in the database for a certain liquid container dependent on the use or emptying of the container. For example, the control device may change the status of the data in the database for a certain liquid container. In particular, the control device may be configured to update the information in the database to a used status, if the recorded total volume reaches the nominal volume of the respective container. However, alternatively or additionally it would be possible to store the current emptying degree of the container in the database. This would allow for example to partly empty a container, replace it by another container and to connect it to a metering pump again later to empty the remaining portion of liquid inside the container. Further preferably, the control device is configured such that it

generates an alarm and/or does not allow the start of the metering pump in connection with a liquid container having the used status in the stored information or in the database, respectively. By this, a possible refilling of the container can be detected. If an emptied container is used again, it must have been refilled. This maybe signalized to a use or a control. In a further preferred embodiment the activation of pump may be prohibited if such a condition is recognized to securely prevent a refilling to avoid the use of a wrong chemical or liquid in a certain application.

[0020] According to a further embodiment of the invention, the control device comprises a storage means or is connected to storage means or a database and is configured such that it stores in the storage means the recorded total volume pumped by the metering pump out of a liquid container which is assigned to the metering pump. Thus, according to this solution there is not just changed a status but a value representing the pumped volume is stored in a database or a storage means. The control device may, furthermore, be configured such that it generates an alarm and/or blocks the activation of the metering pump if a container identifier is assigned to the metering pump for which the stored total volume corresponds to or exceeds the nominal volume of the liquid container identified by this container identifier. This in particular allows to partly empty containers and to later reconnect them to a metering pump, as described above.

[0021] The container identification means according to a further possible embodiment may contain information about the nominal volume and/or the content of the liquid container. Alternatively, the control device may have access to a database comprising information about the nominal volume and/or the content of the liquid container with a certain container identifier. This means the nominal volume is not directly defined in the container identifier but can be received from a database by use of the container identifier. Furthermore, further information concerning the content may be in this database, for example, the kind of chemical, parameters for the pump setting, date of expiry, production date etc. For example, the control device may receive information about the use-by date and signalizes or blocks the activation of the pump if the use-by date has passed. By this, the metering of liquids not having a required quality can be prevented.

[0022] According to a further possible embodiment of the invention, the at least one metering pump and the control device comprise communication means connected to a data network enabling data communication between the metering pump and the control device. This allows to arrange the control device remotely from the metering pump. Furthermore, a single control device may control several metering pumps, in particular several metering pumps not placed close to each other. Furthermore, the control device and the metering pump preferably are connected to one another via the internet. Thus, the control device can be provided as a cloud computing solution. The metering pump may comprise a local controller or pump control for controlling the motion of the metering pump and executing commands received from the control device via the network. Furthermore, the local controller may transfer sensor information to the control device, for example, sensor information from a level sensor placed in the liquid container. Such a level sensor may be connected to a local controller inside the pump so that the local controller can transfer the received data or parameters derived from these data to the remote-control device.

[0023] According to a further preferred embodiment, there may be provided container detection means connected to the control device and configured to detect the replacement of a liquid container. The container detection means for example may be a sensor detecting whether a suction pipe or suction lance is inserted into a container. The sensor, furthermore, may be configured to detect that the suction pipe or suction lance is removed from the container. Further preferably, said container detection means is configured such that it uses signals from level sensors on a suction pipe or suction lance. It may analyze those signals to detect a removing of the suction lance from or an inserting of the suction lance into the liquid container, for example by detecting the time between a signal change of two sensors or by detecting the change rate of a level sensor. A short period of time between a change of sensor signals or a fast change rate may be an indication of a removal of the suction lance out of the container. The control device, furthermore, may be configured such that it stops the metering pump if a removal of a suction lance out of the container is detected and for a reactivation requires an identification procedure and verification procedure of a new liquid container identified by a container identifier as described above.

[0024] Beside the metering pump system as described above a method for controlling a metering pump system (in particular a metering pump system as described before) is subject of the present invention. Preferred features of the metering pump system as described above have to be regarded as preferred features or embodiments of the method, too, although not described with reference to the method in detail.

[0025] The method according to the invention is provided for controlling a metering pump system which comprises at least one metering pump and at least one exchangeable liquid container to which this metering pump can be connected via a suction line. According to this method, the total volume pumped or metered by the metering pump is detected and recorded during the operation of the metering pump. The pumped or metered volume can directly be measured or in particular be calculated on basis of the countered pump strokes with knowledge of the stroke length and the volume of a metering chamber. The value of the total volume may be recorded in a memory of a pump control or control device. The recorded total volume is compared with a nominal volume of the liquid container. If the recorded total volume exceeds the nominal volume by more than a predefined

threshold an action may be started. This action may be to output a signal or an alarm. Additionally or alternatively, the metering pump may be stopped or an activation of the metering pump may be prohibited if the recorded total volume exceeds the nominal volume by more than the predefined threshold. By this, a refilling or replacement of the liquid container by a further, not registered container can be avoided. The pumped volume is always compared with the nominal volume of the container and a plausibility check is made on the basis of the recorded data. For this, it is preferred that a certain container can clearly be identified, preferably by a container identifier read or received from the container. By this, it can be guaranteed that each container can be used only once and a refilling is impossible. By this, mistakes in the use of liquids or chemicals can be avoided, since it is ensured that always the correct liquid or chemical is connected to a certain metering pump.

[0026] Therefore, preferably, a liquid container is assigned to a certain metering pump by use of a container identifier uniquely identifying this liquid container. Furthermore, preferably, an alarm is generated and/or the activation of the metering pump which is assigned or connected to this liquid container is prohibited if the recorded total volume pumped from this certain liquid container corresponds to or exceeds the nominal volume of this respective liquid container. This means according to this method a certain container identified by a container identifier is assigned to a certain metering pump. The metering pump may be identified by a respective pump identifier. Preferably, this assignment or match can be made only once until the nominal volume of the liquid container is emptied. This can be detected if the recorded total volume reaches the nominal volume. Then it can be signalized that this certain container is emptied and cannot be used anymore. Preferably, the metering pump then can only be restarted after a new container with a container identifier not recorded before is assigned to this metering pump.

[0027] In the following the invention is described with reference to the accompanying drawings. In this:

Fig. 1 shows a schematic illustration of a first embodiment of the invention,

Fig. 2 shows a schematic illustration of a second embodiment of the invention,

Fig.3 shows a schematic diagram of a third preferred embodiment of the invention, and

Fig.4 shows a schematic diagram of a fourth preferred embodiment of the invention.

[0028] All three preferred embodiments of a metering pump system according to the invention described in detail below comprise a metering pump 2 which is a positive displacement pump. The metering pump 2 according to this example comprises a drive arranged in a drive housing 4 and a dosing head 6 comprising the pump means. Inside the dosing head 6 there is a pump chamber connected via an inlet valve 8 to a suction line or a suction lance 10. Furthermore, the dosing head 6 comprises an outlet valve 12 on a pressure side which is provided for connection to an outlet line. The inlet valve 8 and the outlet valve 12 may be configured as check valves as known in the art. Inside the dosing head 6 there is a displacement element, for example in form of a membrane or plunger forming a wall of the dosing chamber. This displacement element is driven by the drive inside the drive housing 4 in a reciprocating manner. The drive in the drive housing 4 may for example be a magnetic drive or an electric drive motor, for example a stepper motor.

[0029] On the suction lance 10 there is provided a level sensor 14 which is configured to detect an empty level inside a liquid container 16. The level sensor 14 is configured to at least detect that the liquid container 16 has been emptied and must be replaced. However, it may also be possible to provide more than one level sensor or a level sensor 14 being configured to additionally detect a pre-empting level and to give a signal well in advance before the liquid container 16 is emptied. Furthermore, it would be possible to provide a level sensor 14 allowing to continuously detect the level inside the liquid container 16. The level sensor 14 is connected to pump control 18 arranged in the metering pump 2. The pump control 18 may comprise a display and input means for setting parameters of the metering pump 2 and to signalize operating conditions, for example that the liquid container 16 is emptied. Furthermore, the pump control 18 may be provided to control the drive of the metering pump 2 to achieve a desired dosing rate.

[0030] According to the invention, the metering pump system is provided with a system to reduce the risk that a wrong liquid container 16 is connected to the metering pump 2 or that a wrong chemical or liquid is filled into the liquid container 16. The metering pump system according to the invention allows to carry out a special method to detect a possible refilling or reuse of a liquid container 16. In the following three different examples are described with reference to figures 1 to 3.

[0031] In the first embodiment shown in fig. 1 a mobile communication device like a mobile phone 20 is used. The mobile communication device 20 is connected to an external control device 24 via a data network 22. In this embodiment the external control device 24 is provided by a cloud computing system. The control device 24 communicates with the pump control 18 via a data network 26. The data networks 22, 26 may be an internet connection which may be provided by wired or wireless connection, for example Wi-Fi or a telecommunication network.

[0032] The mobile communication device 20 comprises a scanner, preferably in form of the usual camera, provided for scanning optical codes. In this example a bar code 28 on the liquid container 16 and a bar code 30

on the metering pump 2 are shown. The bar code 28 may be printed on a label on the liquid container 16 and form a container identifier. The bar code 30 may be printed on the housing of the metering pump 2 or shown in a display of the pump control 18. The bar code 30 forms a pump identifier. The container identifier 18 clearly defines a single container and allows to distinguish between different containers. This means, the container identifier 28 is a unique identifier identifying exactly one container. The bar code 30 of the metering pump 2 forms a pump identifier being unique and allowing to distinguish between different metering pumps, since the pump identifier 30 identifies just one single metering pump 2. The control device 24 contains a database 32 containing information of the different metering pumps 2, i.e. containing the pump identifiers 30 identifying metering pumps 2 which are used in the system. Furthermore, the database 32 contains information about liquid containers 16 which may be used in the system, i.e. the container identifiers 28 are also stored in the database 32.

[0033] According to this example the system is configured such that for connecting a liquid container 16 with a metering pump 2 an allocation of the metering pump 2 and the liquid container 16 must be made by the control device 24. For this, a software application on the mobile communication device 20 is used. By scanning the bar code 30 forming the pump identifier the software application on the mobile phone 20 receives the pump identifier from the bar code 30 and transfers the pump identifier via the data network 22 to the control device 24. In the next step the user scans the bar code 28 on the liquid container 16 which is connected to the metering pump 2 by inserting the suction lance 10 into the liquid container 16. The software application on the mobile phone 20 receives the container identifier from the bar code 28 and transfers the container identifier via the data network 22 to the control device 24. The control device 24 checks the received pump identifier 30 and container identifier 28 with the database 32. For example, database 32 may contain information whether the metering pump 2 is ready for use and whether the liquid container 16 identified by the container identifier 28 is a liquid container 16 not used before and containing the correct content to be connected to the metering pump 2 identified by pump identifier 30. If the received data fit with the data inside the database 32 the control device 24 sends an activation signal via the data network connection 26 to the pump control 18 allowing the pump control 18 to start the operation of the metering pump 2. During the operation the pump control 18 records the metered volume, i.e. the total volume pumped by the pump since it received the activation signal from the control device 24. For this, the pump control 18 may count the strokes of the displacement element inside the pump head 6 and may calculate in knowledge of the displaced volume the metered total volume. The value of the pumped total volume is transferred from the pump control 18 via the data network 26 to the control device 24. The control device 24 compares the received value with a value for the nominal volume of the liquid container 16 which is stored in the database 32 for the pump identifier 30. If the value for the recorded total pumped volume exceeds the nominal volume stored in the database 32 by a predefined amount the control device 24 may transfer an alarm signal to the pump control 18. The pump control 18 may display this alarm signal and/or in response to the alarm signal stop the operation of the metering pump 2. If the pumped total volume exceeds the nominal volume this is an indication that the liquid container 16 has been refilled. This should be avoided, since refilling involves the risk that a wrong liquid or chemical is refilled into the container 16. In view of this it is preferred that always new original containers 16 are used. Instead of or in addition to transferring the alarm signal to the pump control 18 the alarm signal may be transferred via the data network 22 to the mobile phone 20 and displayed to a user on the mobile phone.

[0034] If during the operation the level sensor 14 detects that the liquid container 16 is emptied this may be displayed to the user via the pump control 18 or the mobile phone 20 by data communication via the data network 22, 26 and the control device 24. Then the user may exchange the liquid container 16 and again start the initialization procedure, i.e. scanning the bar code 30 of the metering pump 2 and the bar code 28 of the new liquid container 16. In response the control device 24 sends an activation or an approval signal via the data network 26 to the pump control 18 allowing the metering pump 2 to start operation with the new liquid container 16. Furthermore, the control device 24 updates the database 32 for the emptied liquid container 16 by, for example, setting the container identifier 28 of the emptied liquid container 16 to a used status or by deleting the identifier from the database 32 so that a reuse of the same container 16 is prohibited. This means, preferably, the control device 24 is configured such that each liquid container 16 can be used only once.

[0035] Furthermore, also other verifications can be made by the control device 24, for example the database 32 may contain an use-by date for different liquid containers 16 and the control device 24 may prevent the start of the metering pump 2 in connection with a liquid container 16 for which an use-by date has expired.

[0036] It has to be understood that several variations of this method can be made. For example, the database 32 can at least partly be stored in the mobile device 20 and/or in the pump control 18. Furthermore, the required information concerning the liquid container 16 may also be contained in the container identifier 28. The container identifier 28, for example, may be a QR-code containing more information. Furthermore, instead of an optical code the container identifier 28 may be realized in form of electronic memory means containing the container identifier and allowing to store or update data contained in the container identifier 28. This would allow for example to change the status of a liquid container 16 to a used status directly in the container identifier 28. The respec-

tive communication may for example be realized by a Bluetooth connection between the container identifier 28 and the mobile device 20.

[0037] A second preferred embodiment is shown in fig. 2. According to this embodiment, there is not provided an external control device 24. The functionality of the control device 24, however, in this embodiment is carried out by the pump control 18. Thus, the database 32 is provided in the control device in form of the pump control 18. Furthermore, the pump control 18 may contain an electronic pump identifier 36 in form of data which may be transferred to the mobile device 20. There is a direct data connection 34 between the pump control 18 and the mobile communication device 20, for example via Wi-Fi, the internet, a telecommunication network, a Bluetooth connection or any other suitable data connection. This embodiment for starting the use of the metering pump 2 the mobile device 20 connects to the pump control 18 via the data connection 34. For example, an identifier of the mobile device 20 is transferred to the pump control 18. The mobile device 20 may read a bar code 28 forming a container identifier 28 as described in the first embodiment according to fig. 1. The verification process by use of the database 32 as described above, then, may be carried out by the pump control 18. This means, the pump control 18 checks with the database 32 whether the received container identifier 28 is allowed to be connected to the metering pump 2 and after the verification the control 18 starts the operation of the metering pump 2. During the operation the total metered volume is recorded as described above and in case that the recorded total pumped volume exceeds the nominal volume of the liquid container 16 which is defined in the database 32 the pump control 18 may stop the operation of the metering pump 2 and/or signalize this to the operator or user. Thus, also in this embodiment a refilling of the container can be prohibited. If the level sensor 14 detects that the liquid container 16 is emptied the control device (pump control 18) may change a status of the respective container identified by a certain container identifier 28 in the database 32 to prevent a restart of the metering pump 2 with the same liquid container 16 or to signalize a possible reuse of the same liquid container 16. When a new container 16 is connected to the metering pump 2 the initialization process is started again, i.e. the bar code 28 of the new liquid container 16 is scanned by the mobile device 20, transferred via the data connection 34 to the pump control 18 and checked with the database 32 by the pump control 18. A counter for recording the pumped volume is preferably set to zero.

[0038] In the third embodiment shown in fig. 3 there is provided a direct communication between the liquid container 16 and the pump control 18 forming a control device. In this embodiment, the container identifier identifying a liquid container 16 is realized in form of an electronic tag like a RFID-tag 38. The electronic tag 38 contains the container identifier and possible further information regarding the liquid container 16 and its content. The electronic tag 38 is readable by a communication or reading device 40 provided on or in the metering pump 2. The reading device 40 is connected to the pump control 18. When a new container 16 is connected to the metering pump 2 by inserting the suction lance 10 into the liquid container 16 an initialization process may for example be started by a command given to the pump control 18. Then, the reading device 40 reads information from the electronic tag 38 and transfers this information to the control device (pump control 18), in particular a container identifier received from the electronic tag 38. Then, the control device checks the received container identifier with the database 32 to verify whether the respective liquid container 16 identified by this identifier is ready to be used together with the metering pump 2. If there is a positive match, the metering pump 2 may be activated. In the following, the total pumped or metered volume is recorded by the pump control 18 as described before with reference to the first and second embodiment. In case that the recorded total volume, starting with connecting the liquid container 16 to the metering pump 2, exceeds the nominal volume of this liquid container 16 this may be signalized to a user by the pump control 18 or the pump control 18 may stop the operation of the metering pump 2. Instead of storing the nominal volume in the database 32 the respective information may also be stored in the electronic tag 38 and read by the reading device 40. Furthermore, in this embodiment it may be possible that the reading device 40 allows to write information into the electronic tag 38, for example to change a status for the respective liquid container 16, for example, to a used status which prevents the reuse with the metering pump 2 again. For example, if the control device receives information together with the container identifier, that the respective container has been used before, it may block the start of the metering pump 2 and/or signalize this to the user, since this is an indication that the respective liquid container 16 has been refilled.

[0039] The fourth embodiment of the invention shown in fig. 4 is similar to the embodiment as shown in fig. 3 and described above. Differing from the third embodiment in the fourth embodiment the reading device 40' is attached to the suction lance 10 and connected for communication with the control device formed by pump control 18. The reading device 40' communicates with the electronic tag 38 arranged on the liquid container or in the liquid container 16 to read the container identifier and/or write information into the electronic tag 38. This embodiment has the advantage that the risk to mix up different suction lances 10 in an application with several liquid supply systems can be reduced.

[0040] It has to be understood, that also combinations of these four embodiments may be realized. For example, an electronic tag 38 can also be used together with a mobile phone 20 or an external control device 24 as shown in fig. 1. It would also be possible to replace the bar code 30 as shown in fig. 1 by an electronic tag containing a pump identifier, for example an electronic pump

identifier as described with reference to fig. 2.

[0041] The essential method step in all embodiments is that the total volume pumped or metered by the metering pump 2 is recorded over a certain period of time and compared with the nominal volume of the liquid container 16 connected to the metering pump 2. The period of time for recording the pumped volume is re-started with the connection with a new full liquid container 16. However, it may also be possible to store the emptied volume, i.e. the pumped volume for a liquid container 16 in the database 32 or an electronic tag 38 allowing to reconnect partly emptied liquid container 16 to a metering pump 2 later. Then, the recording of the pumped volume is continued with the reconnection of the respective liquid container 16 so that in the result also the total pumped volume for a certain liquid container 16 can be compared with the nominal volume of the same liquid container 16 to prevent that more than the nominal volume can be sucked out of a certain liquid container 16. By this, a refilling can be detected or prevented.

List of reference numerals

[0042]

2	metering pump
4	drive housing
6	dosing head
8	inlet valve
10	suction line / suction lance
12	outlet valve
14	level sensor
16	liquid container
18	pump control
20	mobile communication device / mobile phone
22	data network
24	control device
26	data network
28, 30	bar code / identifier
32	database
34	data connection
36	pump identifier / tag
38	electronic tag / container identifier
40, 40’	reading device

Claims

1. Metering pump system comprising at least one metering pump (2) provided for connection to at least one exchangeable liquid container (16) via a suction line (10), and a control device (18, 24) for control of the at least one metering pump (2)
characterized in that
the control device (18, 24) is configured such that it records the total volume pumped by the metering pump (2), compares the recorded total volume with a nominal volume of said liquid container (16) and starts an action if the recorded total volume exceeds the nominal volume by more than a predefined threshold.

2. Metering pump system according to claim 1, **characterized by** at least one exchangeable liquid container (16) connectable to said metering pump (2) via a suction line (10).

3. Metering pump system according to claim 1 or 2, **characterized in that** a value for the nominal volume is stored in the control device (18, 24) or in storage means (32) readable by the control device (18, 24).

4. Metering pump system according to one of the preceding claims, **characterized in that** there is provided at least one level sensor (14), preferably at least two level sensors at different heights, inside the liquid container (16), the level sensors being connected to the control device (18, 24).

5. Metering pump system according to one of the preceding claims, **characterized in that** said nominal volume is defined as the total capacity of the liquid container (16) or a volume defined by the height of at least one of the level sensors (14).

6. Metering pump system according to one of the preceding claims, **characterized in that** the control device (18, 24) is configured to generate an alarm and/or to stop the metering pump (2) as an action if the recorded total volume exceeds the nominal volume by more than a predefined threshold.

7. Metering pump system according to one of the preceding claims, **characterized in that** the liquid container (16) is provided with a container identification means (28, 38) containing at least a container identifier identifying the liquid container (16) and that the control device (18, 24) is connected to an input or reading device (20, 40) which is designed for reading the container identifier, wherein preferably said container identifier is unique and identifying just one certain container (16).

8. Metering pump system according to one of the preceding claims, **characterized in that** the metering pump (2) is provided with a pump identification means (30, 36) containing at least a pump identifier identifying the metering pump (2) and that the control device (18, 24) is connected to a reading device (20) designed for reading the information contained in the pump identification means (30, 36).

9. Metering pump system according to claim 7 or 8, **characterized in that** the container identification means (28, 38) and/or the pump identification means (30, 36) comprise an optical code or an electronic

tag or storage means, preferably provided for wireless communication with the reading device (20, 40).

10. Metering pump system according to one of the claims 8 to 9, **characterized in that** the input or reading device (20) is provided by a mobile communication device (20), preferably a mobile phone, which is connected to the control device (18, 20) via a communication network (22, 26, 34).

11. Metering pump system according to one of the claims 7 to 10, **characterized in that** the control device (18, 24) is configured such that it receives the container identifier read by the input or reading device (20, 40), checks the received container identifier with information stored in a database (32), assigns the container identifier to a certain metering pump (2) and allows an activation of this metering pump (2) only if the received container identifier fits to the stored information.

12. Metering pump system according to claim 11, **characterized in that** the control device (18, 24) is configured to adjust a pump control (18) of the metering pump (2) on basis of the information stored in said database (32).

13. Metering pump system according to claim 11 or 12 **characterized in that** the control device (18, 24) is configured such that it assigns the container identifier (28, 38) to a metering pump (2) identified by a pump identifier (30, 36), preferably read by the input or reading device.

14. Metering pump system according to claim 13, **characterized in that** the control device (18, 24) is configured such that it updates the information stored in the database (32) for a certain liquid container (16) to a used status, if the recorded total volume reaches the nominal volume of the respective container (16), and wherein the control device (18, 24) preferably is configured such that it generates an alarm and/or does not allow the start of the metering pump (2) in connection with a liquid container (16) having the used status in the stored information.

15. Metering pump system according to one of the claims 13 or 14, **characterized in that** the control device (18, 24) comprises storage means or is connected to storage means and is configured such that it stores in the storage means the recorded total volume pumped by the metering pump (2) out of a liquid container (16) assigned to the metering pump (2) and generates an alarm and/or blocks the activation of the metering pump (2) if a container identifier (28, 38) is assigned to the metering pump (2) for which the stored total volume corresponds to or exceeds the nominal volume of the liquid container (16) identified by this container identifier (28, 38).

16. Metering pump system according to one of the claims 7 to 15, **characterized in that** the container identification means contains information about the nominal volume and/or the content of the liquid container (16) or the control device (18, 24) has access to a database (32) comprising information about the nominal volume and/or content of the liquid container (16) with a certain container identifier (28, 38).

17. Metering pump system according to one of the preceding claims, **characterized in that** the at least one metering pump (2) and the control device (24) comprise communication means connected to a data network (22, 26) enabling data communication between the metering pump (2) and the control device (24).

18. Metering pump system according to one of the preceding claims, **characterized by** container detection means connected to the control device (18, 24) and configured to detect the replacement of a liquid container (16), wherein preferably said container detection means is configured such that it analyses signals of level sensors (14) on a suction lance 10, when removing the suction lance (10) from or inserting the suction lance (10) into the liquid container (16).

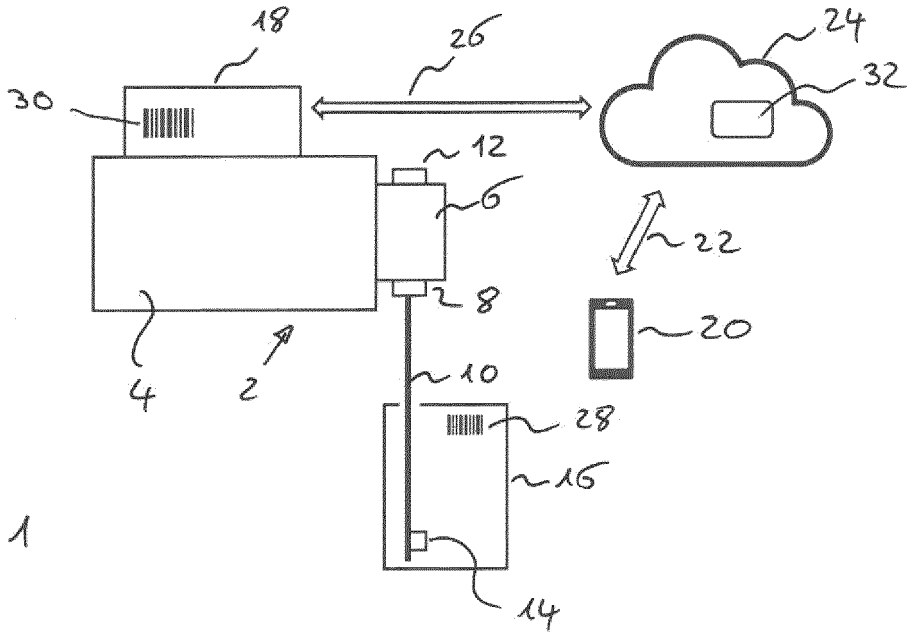
19. Method for controlling a metering pump system comprising at least one metering pump (2) and at least one exchangeable liquid container (16) to which this metering pump (2) can be connected via a suction line (10), **characterized in that**

the total volume pumped by the metering pump (2) is recorded during the operation of the metering pump (2),
the recorded total volume is compared with a nominal volume of the liquid container (16),
and an action is started if the recorded total volume exceeds the nominal volume by more than a predefined threshold.

20. Method according to claim 19, **characterized in that** an alarm is generates and/or the metering pump (2) is stopped or an activation of the metering pump (2) is prohibited if the recorded total volume exceeds the nominal volume by more than a predefined threshold.

21. Method according to claims 19 and 20, **characterized in that** a liquid container (16) is assigned to a certain metering pump (2) by use of a container identifier (28, 38) uniquely identifying this liquid container (16) and that an alarm is generated and/or the activation of the metering pump (2) assigned to this liquid container (16) is prohibited if the recorded total volume pumped from this liquid container (16) corre-

sponds to or exceeds the nominal volume of this respective liquid container (16).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24
32
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12
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2
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16
14

Fig. 1

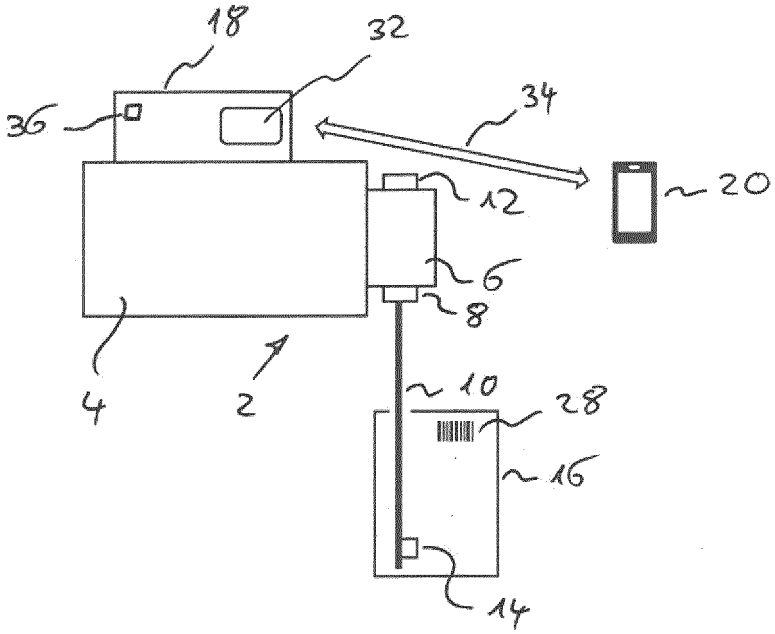
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Fig. 2

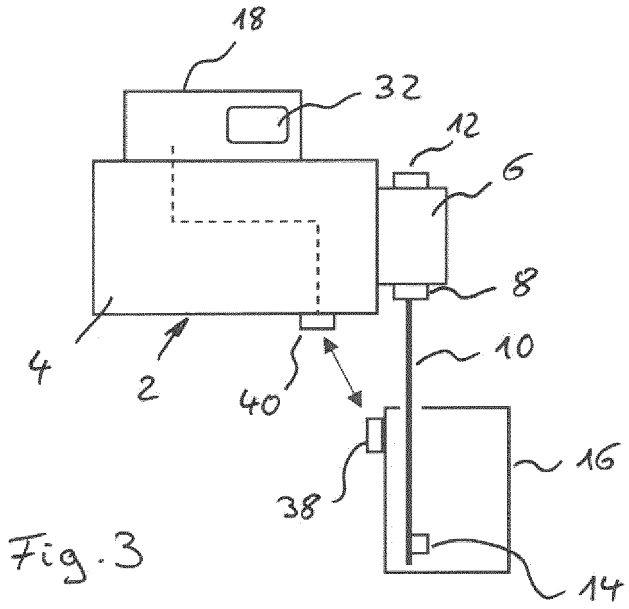

Fig. 3

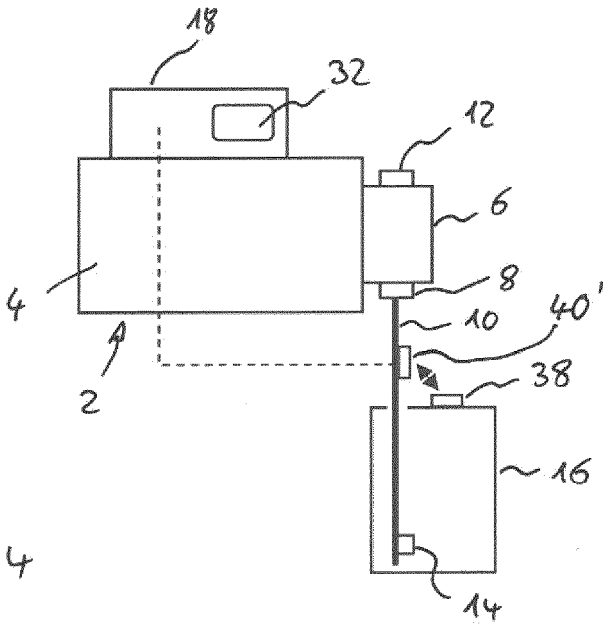

Fig. 4