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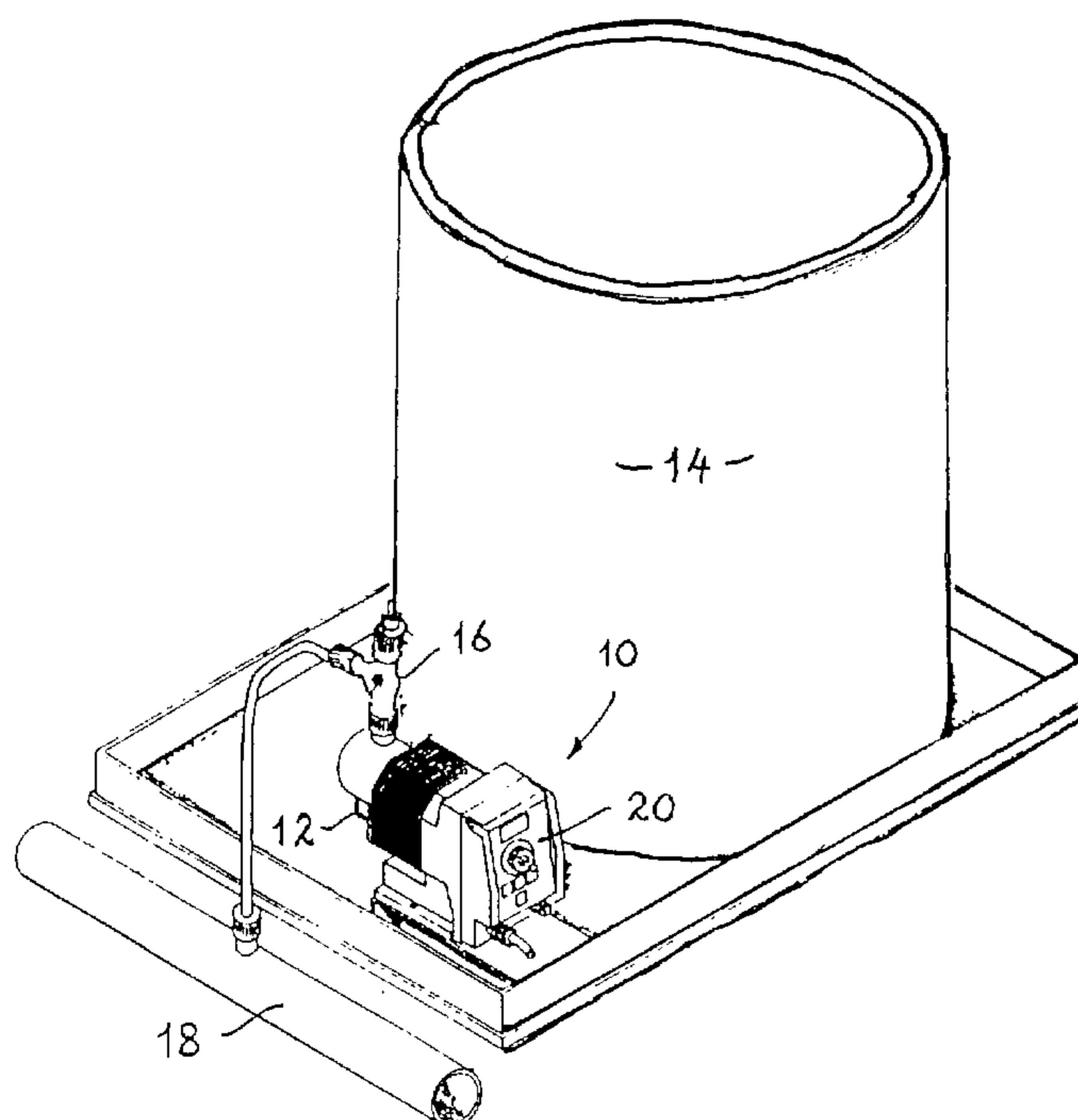
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(54) Title: CHEMICAL METERING PUMP



(57) Abrégé/Abstract:

A liquid chemical metering pump (24) is described that can be fully submerged within a hazardous liquid chemical transport/storage container (28). The pump (24) includes a discharge adaptor (30) that can be received in the outlet aperture (40) of the container (28), in which it is held in sealing relationship by a suitable screw-threaded connector. The discharge adaptor (30) is provided with an intake port (32) in fluid communication with the liquid chemical in the container (28), and a discharge port (34) which is in fluid communication with a discharge tube (36) leading to a flow stream (38). The chemical metering pump (24) is remotely controlled by an electronic controller (26) connected by cable (25) to the chemical metering pump. The chemical metering pump (24) substantially eliminates the need for "double handling" of hazardous liquid chemical, as the chemical can be metered directly from the transport/storage containers in which it is delivered to the end user. The pump (24) can be readily modified to suit different sized containers.



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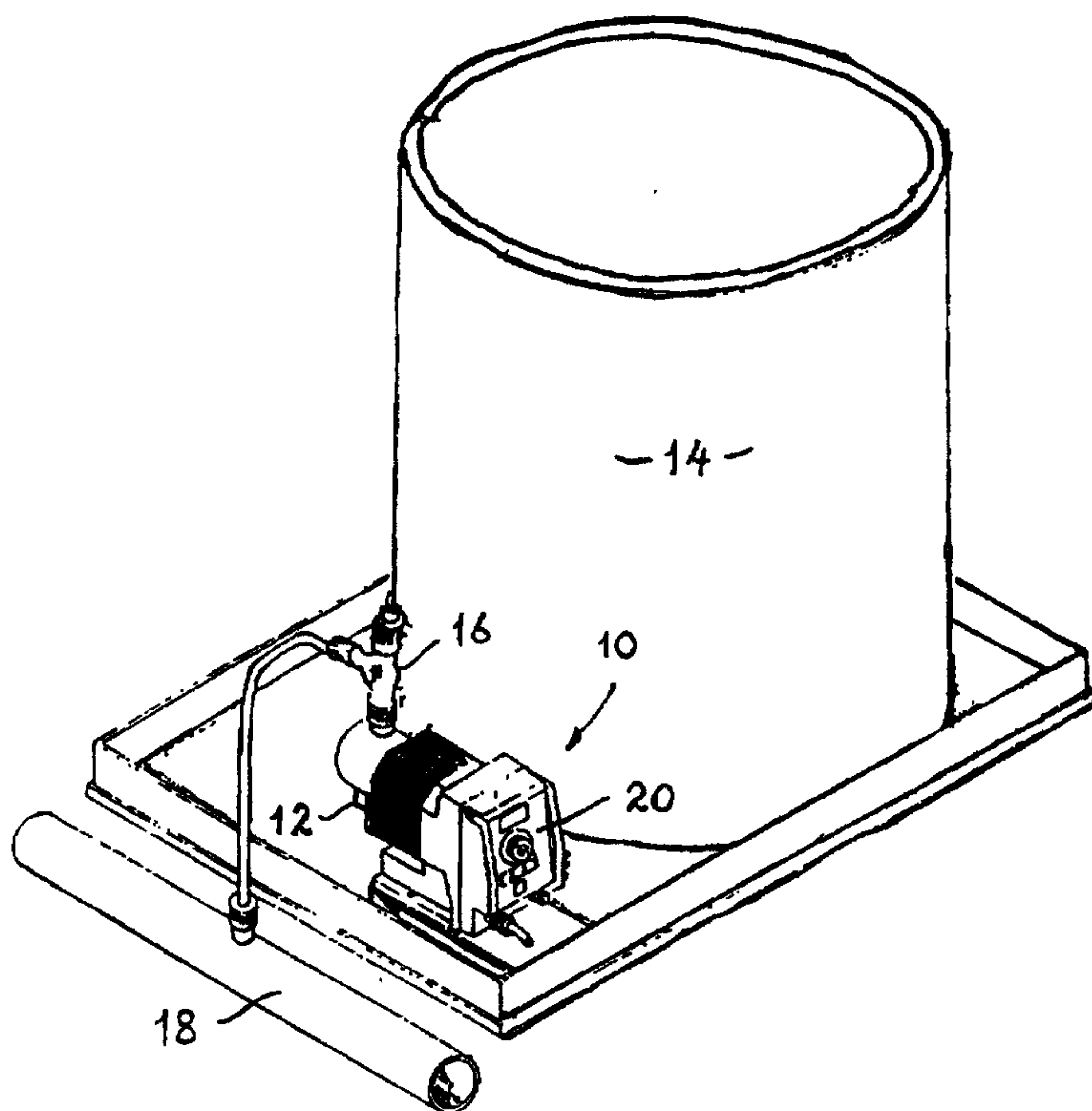
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(54) Title: **CHEMICAL METERING PUMP**



(57) Abstract: A liquid chemical metering pump (24) is described that can be fully submerged within a hazardous liquid chemical transport/storage container (28). The pump (24) includes a discharge adaptor (30) that can be received in the outlet aperture (40) of the container (28), in which it is held in sealing relationship by a suitable screw-threaded connector. The discharge adaptor (30) is provided with an intake port (32) in fluid communication with the liquid chemical in the container (28), and a discharge port (34) which is in fluid communication with a discharge tube (36) leading to a flow stream (38). The chemical metering pump (24) is remotely controlled by an electronic controller (26) connected by cable (25) to the chemical metering pump. The chemical metering pump (24) substantially eliminates the need for "double handling" of hazardous liquid chemical, as the chemical can be metered directly from the transport/storage containers in which it is delivered to the end user. The pump (24) can be readily modified to suit different sized containers.

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- 1 -

"Liquid Delivery Means"**Field of the Invention**

The present invention relates to the delivery of liquids and includes a liquid delivery means, a liquid delivery and calibration arrangement, a liquid delivery
5 system and a cradle for supporting containers from which the liquid is to be delivered.

Background

In many regional country town water supplies the only economical way that hazardous chemicals can be delivered to water treatment plants is by portable
10 chemical containers (20 to 40 litre capacity). More often than not, a chemical metering pump, which accurately meters the required amount of chemical into the water, needs many times the capacity of a single container and therefore a vat is used in which the chemical is stored. The main problems associated with manually handling the chemical from the portable containers to the vats is that it
15 is a slow, laborious and hazardous task for treatment plant operators. Whilst a number of methods have been introduced to reduce the time and risks involved, the exercise of "double handling" of the liquid chemical still remains a significant problem.

Other users of hazardous liquid chemicals, such as farmers, who also have a
20 need to accurately meter a wide range of chemicals into water, also have major problems with this "double handling" process. Here again, a number of initiatives have been proposed to reduce the time and risks involved in transferring hazardous chemicals from portable containers into vats and tanks. These initiatives include battery-operated transfer pumps, purpose-built stands with
25 special chemical syphons and innovative vortex systems, all of which improve the process, but do not remove the "double handling" problem.

- 2 -

Disclosure of the Invention

Accordingly the invention resides in a liquid delivery means intended for the delivery of liquid from a storage container having an outlet, the delivery means comprising an adaptor which is adapted to sealingly close the outlet, the adaptor supporting a housing, said housing having a pumping chamber which is at least in part defined by a flexible diaphragm, the space defined by face of the diaphragm and which is remote from the pumping chamber being vented to atmosphere, an inlet providing communication between the interior of the container and the pumping chamber and an outlet providing communication between the pumping chamber and a delivery line, wherein in use said pumping chamber is located in relation to the inlet to be constantly filled with said liquid, the housing supporting an actuator operatively connected to the diaphragm through said space and adapted to reciprocate to cause flexing of the diaphragm in the pumping chamber to induce liquid flow from the inlet to the pumping chamber and from the pumping chamber to the outlet, a control means located remote from the container and adapted to control the actuator,.

According to a preferred feature of the invention the adaptor comprises a closure which is adapted to close the outlet and a support which when in position extends from the outlet into the container to terminate proximate a wall of the container which in use is to be lowermost the housing supported from the innermost end of the support, said support accommodating the delivery line.

According to a preferred feature of the invention the adaptor comprises a closure which is adapted to close the outlet, the housing supported from the external face of the closure, the inlet opening to the internal face of the closure.

According to a preferred feature of the invention the adaptor comprises a closure which is adapted to close the inlet, the housing supported from the closure to extend inwardly into the interior of the container from the closure, the external face of the closure being adapted to support the delivery line.

According to a preferred feature of the invention the housing is formed of a material which is chemically resistant to the liquid.

- 3 -

According to a preferred feature of the invention the actuator comprises a solenoid having a core operatively connected to the diaphragm, the control adapted to cause periodic activation of the solenoid and consequent reciprocation of the core.

- 5 According to a preferred feature of the invention there is space associated with a vent duct which extends between the exterior of the container and the space.

According to a preferred feature of the invention the vent duct accommodates electrical conductors providing connection between the control and actuator.

- 10 According to a preferred feature of the invention the housing defines a cavity, said inlet and outlet located to one side of the cavity, the actuator located to another side of the cavity, an insert receivable in the cavity, said insert accommodating the diaphragm and providing the pumping chamber and space. According to a preferred feature of the invention the insert is capable of being replaced by other inserts defining a pumping chamber of differing volumes.

- 15 According to a preferred feature of the invention the insert comprises a first portion accommodating the diaphragm and defining the space and a second portion having a recess which is receivable over the diaphragm to define the pumping chamber.

- 20 According to a preferred feature of the invention in use the inlet is located below the pumping chamber and the outlet is located above the pumping chamber.

According to a preferred feature of the invention the inlet is connected to a pumping chamber by a first duct and the pumping chamber is connected to the outlet by a second duct wherein when in use the first and second ducts are upwardly inclined.

- 25 According to a preferred feature of the invention a reservoir is located intermediate the inlet and pumping chamber and an inlet port is provided between the reservoir and pumping chamber at a position which in use is to be located in the lower portion of the reservoir, the upper portion of the reservoir, being vented to atmosphere.

- 4 -

According to a preferred feature of the invention in use the inlet port is downwardly inclined from the reservoir to the pumping chamber

Accordingly the invention also resides in a liquid delivery and calibration arrangement for use with a pump having a pump inlet, connected to a liquid
5 source and a pump outlet, the arrangement having an inlet connected to the pump outlet, the arrangement further comprising an outlet and a bypass duct connected to the inlet through an adjustable valve which is adapted to direct fluid flow from the inlet to the outlet and/or the bypass duct, a chamber connected to the bypass duct, a measuring means provided in association with the chamber to
10 enable the volume of liquid in the column to be monitored, the chamber being connected to the pump inlet, the arrangement further comprising a control valve at the pump inlet adapted to control the flow of fluid from the liquid source to the pump.

According to a preferred feature of the invention the chamber is formed at least
15 in part to be transparent to enable the liquid level in the column to be visually observed.

According to a preferred feature of the invention the chamber is provided with graduations representative of the volume of liquid in the chamber for at least a portion of the height of the chamber.

20 According to a preferred feature of the invention the chamber accommodates a float, said float supporting an element which extends from the chamber wherein the degree of extension is representative of the volume of liquid in the chamber.

According to a preferred feature of the invention the portion of the element which is to extend from the chamber is provided with a set of graduations.

25 According to a preferred feature of the invention the element comprises an elongate element which extends from the upper end of the chamber.

According to a preferred feature of the invention the chamber is formed as an elongate tubular member having its central axis substantially upright.

According to a preferred feature of the invention the upper portion of the
30 chamber is associated with a closure which is adapted to close the outlet of a

- 5 -

container and support the chamber to extend into the container the lower end of the chamber associated with the pump.

According to a preferred feature of the invention the pump inlet is provided in the lower end of the chamber, said elongate element being movable longitudinally in the chamber into and out of sealing engagement with the pump inlet to provide
5 said control valve, a control provide to effect the longitudinal movement of the elongate element between the open and closed position.

According to a preferred feature of the invention the closure is mounted to the chamber and the chamber supports the pump.

10 According to a preferred feature of the invention the chamber is received in a tubular shroud, said closure supports the shroud and the pump is supported by the lower end of the shroud, at least a portion of the wall of the shroud providing communication between the interior and exterior of the shroud, said portion providing a filtering element

15 According to a preferred feature of the invention the arrangement is associated with a liquid delivery means of a form as claimed at any one of claims 1 to 16.

According to a preferred feature of the invention the inlet is connected directly to the pump outlet.

20 According to a preferred feature of the invention the inlet, outlet and bypass duct are contained within the housing and the chamber is mounted at its lower end to the housing.

Accordingly the invention also resides in a liquid delivery system comprising a first reservoir having first outlet and a liquid delivery means for delivery said liquid from the first reservoir the first delivery outlet located at the lower portion of the
25 first reservoir, a second reservoir located above the first reservoir and having a second outlet located in its lower portion the first reservoir having a vent at its upper portion which is open to atmosphere, a first delivery conduit connecting the second outlet to the first reservoir, the second delivery conduit interconnecting the upper portion of the interior of the first reservoir with the interior of the second
30 reservoir, a vent valve controlling communication through the second delivery

- 6 -

conduit, a level sensor provided with the first reservoir and adapted to sense the level of liquid in the first reservoir, the sensor associated with the vent valve to cause the vent valve to open the level of liquid falling below a first predetermined level and to close vent valve on the level rising above a second predetermined level where the first predetermined level is lower than the second predetermined level.

According to a preferred feature of the invention the second reservoir comprises a plurality of second reservoirs each connected to the first reservoir by a second delivery conduit.

10 According to a preferred feature of the invention the first reservoir comprises a plurality of containers each having a common upper level and each having a first outlet wherein one container has one first outlet lower than the other first outlets, the liquid delivery means being associated with the one first outlet and the other first outlets being connected to the one container.

15 According to a preferred feature of the invention each container is associated with a second reservoir.

According to a preferred feature of the invention the liquid delivery means is of the form as claimed at any one of claims 1 to 17.

20 According to a preferred feature of the invention the liquid delivery means is provided with a liquid delivery and calibration arrangement as claimed at any one of claims 18 to 31.

25 Accordingly the invention also resides in a cradle adapted to support and receive a container, said container having an outlet on one face, the container pivotally supported from a base to be movable between a first position at which the one face is uppermost and a second position at which the outlet is located towards the lower extent of the container when at the second position.

According to a preferred feature of the invention the cradle is displaced through substantially 90° in its movement between the first and second positions.

30 According to a preferred feature of the invention the cradle is adapted to support a plurality of containers in a side by side relationship.

- 7 -

Brief Description of the Drawings

In order to facilitate a more comprehensive understanding of the nature of the invention several embodiments of the chemical metering pump in accordance with the present invention will now be described in detail, by way of example
5 only, with reference to the accompanying drawings, in which:

Figure 1 illustrates a prior art electronic chemical metering pump;

Figure 2 illustrates a first embodiment of a chemical metering pump according to the present invention in situ;

Figure 3 is an enlarged section view of the chemical metering pump of Figure 2;

10 Figure 4 illustrates in section view a second embodiment of a chemical metering pump according to the present invention in situ;

Figure 5 illustrates the chemical metering pump of Figure 4 in a typical application;

15 Figure 6 illustrates in section view a third embodiment of a chemical metering pump according to the present invention;

Figure 7 illustrates the chemical metering pump of Figure 6 in a typical application;

Figure 8 illustrates in section view a fifth embodiment of a chemical metering pump incorporating a first embodiment of a calibration system;

20 Figure 9 illustrates in section view a fifth embodiment of a chemical metering pump according to the present invention;

Figure 10 is a plan view of the chemical metering pump of Figure 9;

Figure 11 is a front section view of the chemical metering pump of Figure 9 with an integrated calibration system fitted;

- 8 -

Figure 12 is a front view of the chemical metering pump of Figure 9;

Figure 13 illustrates a second embodiment of a calibration system for the chemical metering pump of Figures 6 and 7;

Figure 14 illustrates the calibration system of Figure 13 in situ;

- 5 Figure 15 illustrates another embodiment of a cradle for holding a container containing chemicals for metering;

Figure 16 illustrates a multi-head chemical metering pumping system in accordance with the present invention;

- 10 Figure 17 illustrates a preferred embodiment of an auto-refill system for use in conjunction with the chemical metering pump of the present invention;

Figure 18 illustrates banked and tiered chemical containers incorporating the auto-refill system of Figure 17, mounted in a cradle system; and,

Figures 19 (a), (b) and (c) illustrate a third embodiment of a calibration system for the chemical metering pump according to the present invention.

15 Detailed Description of Specific Embodiments

- 20 A prior art electronic chemical metering pump 10 illustrated in Figure 1 has an inlet 12 which draws liquid chemical from a vat 14 and a discharge valve 16 through which liquid chemical is metered to a flow stream 18. The pump 10 includes a built in electronic controller 20 for controlling the operation of the pump 10 so that it accurately meters the required volume of liquid chemical into the flow stream 18. The liquid chemical held in the vat 14 may be, for example, liquid chlorine (a concentrated solution of sodium hypochlorite) which is metered into the water supply flow stream 18 at the rate of between 0.05 to 10 litres/hour.

- 25 As noted above, one of the problems with this type of prior art metering system, is that the vat 14 must be periodically refilled with liquid chemical. This task is

- 9 -

done manually, and in addition to being laborious and time consuming, may also be dangerous, particularly when handling hazardous chemicals.

Figure 2 illustrates a first embodiment of a chemical metering pump 24 in accordance with the present invention. Instead of having an electronic controller built into the pump, a remote electronic controller 26 is provided (in this case shown as a wall-mounted unit), which is connected by cable to the chemical metering pump 24. The electronic controller 26 performs essentially the same function as the conventional electronic controller 20 of Figure 1, however it differs from the prior art controller in that it is capable of safely transmitting a low voltage, variable, control signal to one or more chemical metering pumps via suitably screened cable(s). Furthermore, as it is preferably mounted in a separate, wall-mounted unit, it can be positioned in a more convenient environment, such as a plant control room, where it can be viewed (at eye level) and adjusted in total safety and isolation from the pumping installation.

The chemical metering pump 24 of the first embodiment overcomes the problem of "double handling" by being itself adapted to be connected directly to an outlet of a chemical transport/storage container 28. For this purpose, the pump 24 comprises a discharge adaptor 30 for connecting the pump to an outlet of the container 28 and providing a closure for the container. The discharge adaptor 30 has an intake port 32 (see Figure 3) adapted to be in fluid communication with the interior of the container 28, and a discharge port 34 adapted to be in fluid communication with a discharge tube 36 leading to a flow stream 38.

As can be seen more clearly in Figure 3, the chemical metering pump 24 of the first embodiment is in the form of a submersible pump capable of being submerged in the liquid chemical within the container 28. As shown in Figure 3, the discharge adaptor 30 has a substantially cylindrical body adapted to be received in the outlet aperture 40 of the container 20, and it is held in sealing relationship with the aperture by a suitable screw-threaded connector 42. Once the cable 25 from controller 26 and the discharge tube 36 are connected, the container 28 is laid on its side as shown in Figure 3. The pump 24 further comprises a housing 44 connected to the discharge adaptor 30 to define a

- 10 -

pumping chamber defined in part by a diaphragm 46 provided therein for alternately drawing liquid by suction into the intake port 32 and pushing the liquid by compression out through the discharge port 34. The diaphragm 46 is driven by a connecting member 48 which is coupled to an actuator 50. In the first
5 embodiment, the actuator 50 is an electrical solenoid actuator, having a core connected to the connector where a solenoid 52 causes the connecting member 48 to move in a reciprocating motion in response to a control signal from the controller 26. A coil spring 54 provided within the housing of the electrical
10 actuator 50 pushes the diaphragm 46 via a connecting member 48 to a normally closed 25 position in which it forces liquid from the pumping chamber through the discharge port 34 and a discharge valve 56. However, when an electrical pulse activates the solenoid 52, the reciprocating member 48 is drawn backwards against the force of the spring 54 to move the diaphragm 46 to the open position in which it simultaneously draws fresh liquid chemical into the pumping chamber
15 through an intake valve 58, which is in fluid communication with the liquid chemical in the container 30 28, and into the intake port 32. With each cycle of movement of the diaphragm 46, a precise volume of liquid chemical is metered from the container 28 to the discharge tube 36. The flow rate can be controlled by adjusting the rate at which electrical pulses are transmitted to the solenoid -
20 7actuator 50 from the controller 26.

The discharge valve 56 and intake valve 58 are one way valves for controlling the flow of liquid out through the discharge port 34 and into the intake port 32 respectively. In the first embodiment both the intake valve 58 and discharge valve 56 are ball valves, in which a small ball bearing is normally held in the
25 closed position by gravity or by a small spring. Discharge valve 56 prevents the liquid chemical from being drawn back into the discharge port 34 when the diaphragm 46 moves backwards, and intake valve 58 prevents the liquid chemical from flowing back out through the intake port 32 when the diaphragm 46 moves forward. Clearly, other suitable one way valves may be used to control
30 the flow of liquid chemical through the intake and discharge ports.

The discharge adaptor 30 also includes a vent port 60 which extends into the diaphragm housing 44 for venting a space behind the diaphragm 46 to

- 11 -

atmosphere. This allows the free movement of the diaphragm 46 under the influence of the connecting member. Preferably the vent port 60 also extends through the diaphragm housing 44 to the electrical actuator 50 and provides a path through which an electrical connector for connecting the actuator 50 to the remote controller 26 can pass. A wire 62 which passes through the vent port 60 connects the solenoid 52 to the cable 25. If the diaphragm 46 ruptures the vent port 60 allows the fluid to be vented to atmosphere, so that fluid does not flow into the actuator 50 and its flow from the vent port 60 provides an indication that the diaphragm 46 has failed.

10 As can be seen in Figure 3, the discharge adaptor 30, diaphragm housing 44 and electrical actuator 50 are all arranged end to end in an elongate, cylindrical configuration having an outer diameter sufficiently small to allow the whole pump 24 to be inserted through the outlet aperture 40 of the container 28. The whole of the submersible pump assembly is encased in a chemically resistant shroud so
15 as to be protected from the corrosive properties of the liquid chemical. In this manner, liquid chemical solution can be pumped directly from within the container 28 and metered through the discharge tube 36 to a flow stream in a most efficient manner. Furthermore the intake port 32 is located below the discharge port 34 and the flow path between the intake and outlet is constantly
20 directed upwardly. This presents a significant advantage especially when the pump is in use with liquid chlorine since it is a characteristic of liquid chlorine, that chlorine gas will be generated to form bubbles in its liquid. The collection of the bubbles in the pumping chamber will inhibit the action of the pump. The configuration of the inlet port and discharge port enable such bubbles to move to
25 the discharge port 34 and away from the pumping chamber.

Figure 4 illustrates in section view a second embodiment of the chemical metering pump which is similar to the first embodiment illustrated in Figure 3 except in this case the pump is not submerged in the chemical solution within the container 28 but is supported from the outlet to lie outside of the container. The
30 like parts in the pump 64 of this embodiment have been identified with the same reference numerals as in the pump 24 of Figure 3 and will not be described in detail again. The principal difference in this embodiment is that the discharge

- 12 -

adaptor 30 is provided with a secondary location adaptor 66 for connecting the pump to the outlet aperture 40 of the container 28. The secondary location adaptor 66 is formed with an inlet port 68 for connecting the intake port 32 in the discharge adaptor 30 in fluid communication with the liquid chemical in the
5 container 28.

The secondary location adaptor 66 is also provided with a vent tube 70 adapted to extend from the exterior of the second adaptor and into the container to extend upwards into the container 28 to a point above the level of liquid chemical within the container 28 (when inverted). Vent tube 70 allows air from the atmosphere to
10 enter the container 28 so as to avoid the formation of a vacuum within the container during metering of chemical solution via pump 64. Optionally, a filter member 72 may be provided in the inlet port 68 so as to prevent any sediment which may settle to the bottom of the container 28 from entering the flow stream via the chemical metering pump 64. A handle bracket 74 is provided for
15 supporting the pump 64 from the handle of the container 28 when the container is in its inverted position.

Figure 5 illustrates the chemical metering pump 64 of Figure 4 in a typical application in which liquid chemical is metered from the container 28 to a flow stream 38 under the control of a remote electronic controller 26. In this case, the
20 container 28 is held in a specially designed cradle 76 with built-in bunding tray. Cradle 76 enables the container 28 to be rotated from an upright position, in which the pump 64 can be fitted to the outlet aperture of the container in the manner illustrated in Figure 4, to an inverted position as shown in Figures 4 and 5 ready for metering. Cradle 76 reduces the time and labour involved in replacing
25 an empty container with a full container of liquid chemical, since the full weight of the container 28 is at all times supported in the cradle 76 while the pump 64 is being fitted to the outlet aperture.

Figure 6 illustrates in section view a third embodiment of the chemical metering pump 80. The third embodiment is substantially identical in construction to the
30 first embodiment illustrated in Figure 3, and therefore the like parts have been identified with identical reference numerals as in Figure 3, and will not be

- 13 -

described again in detail. The third embodiment of the pump 80 is also designed to be fully submersible but in this case it is suspended by means of a support member 82 within a large chemical storage container, (for example, a 200 litre drum) as illustrated in Figure 7. The support member 82 is adapted to hold the pump assembly 80 within close proximity to a floor of the drum 84 and is fixed at its top end to the outlet aperture of the drum 84.

The support member 82 may be, for example, a hollow PVC conduit, and the discharge tube 36 from the discharge port 34 of the pump is accommodated within the conduit 82. The cable 25 is also supported by the support member 82 and is lead out through the outlet aperture to the controller 26. In other respects, the operation of the submersible chemical metering pump 80 of this embodiment is substantially identical to that of Figure 3.

Figure 8 illustrates in sectional view, a fourth embodiment of a chemical metering pump 150 in accordance with the present invention. The fourth embodiment of the chemical metering pump 150 is of more compact construction and incorporates several additional innovative features compared to the previous embodiment. As in the previous embodiment, a reciprocating member 152 is adapted to be driven by a solenoid 154 which causes the reciprocating member 152 to move in a reciprocating motion in response to a control signal from the remote controller (not illustrated). A diaphragm 156, driven by the reciprocating member 152, is provided within a diaphragm housing 158.

In the fourth embodiment, the diaphragm housing is formed by a pair of removable diaphragm housing inserts 160A and 160B that are held in sealing relationship in a chamber formed partly within the discharge adaptor 162 and partly within the solenoid housing 164. The removable inserts 160A and 160B together define the internal volume of the diaphragm housing 158, and thereby the capacity of the pumping chamber of the pump and the space to the rear of the diaphragm. Furthermore, inserts 160A and 160B can also be formed with a variety of configurations of inlet and outlet ports pumping chamber volumes depending on the particular application of the pump and discharge capacity of the pump. Thus, for example, in the embodiment of Figure 8, insert 160B is

- 14 -

formed with a discharge port 166 that aligns with a discharge port 168 provided in the discharge adaptor 162. Insert 160B is also formed with an intake port that is in fluid communication with a pump reservoir 172 via one-way ball valve 174. The pump reservoir 172 is in fluid communication with liquid chemical in the container via a transfer port 176 (suction). The transfer port 176 can be closed off by means of a transfer valve 178, which is slidably moveable between an open position (as shown in Figure 8) and a closed position. The pump reservoir 172 is also in fluid communication with a sight tube 180 (see Figure 11) of the calibration system via sight tube connecting port 182. A by-pass port 184 is provided within the body of the discharge adaptor 162 and is provided with a by-pass control valve 186. By-pass port 184 provides fluid communication between the discharge port 168 and the bottom of the sight tube by-pass tube 188 (see Figure 11). The sight tube by-pass tube 188 is open to atmosphere at its upper end and overflows into the sight tube 180.

The pump is configured to accommodate for the generation of the bubbles in the liquid being pumped. This is achieved in the reservoir by the intake port from the reservoir of the pumping chamber being lower in the reservoir reducing the likelihood of bubbles being carried to the intake port. In addition the intake port is located lower than the discharge port and both are generally upwardly directed which facilitates the movement of bubbles from the pumping chamber. In addition the reservoir is vented to atmosphere through the sight tube connecting port 182 and the sight tube 180 and the connection to the sight tube connecting port is located at the upper portion of the reservoir.

As can be seen most clearly in Figure 10, the discharge adaptor is provided with a screw threaded connector 190 adapted to screw onto the threaded outlet aperture in the wall of liquid container 192. The operation of this embodiment of the pump 150 is similar to that of the previous embodiments, and will not be described again.

Figure 9 illustrates a fifth embodiment of the chemical metering pump 200 which in many respects is similar to the pump 150 of the previous embodiment. However, pump 200 is also provided with a stroke adjuster 202 for adjusting the

- 15 -

stroke of the reciprocating member 152, and thereby providing another means for adjusting the volume of liquid metered by the pump 200. Stroke adjuster 202 comprises a solenoid stroke limiter 204 which is pivotally mounted at the rear of the solenoid 154. The position of the solenoid stroke limiter can be varied by
5 turning a stroke adjuster knob 206 provided on the front face of the pump 200. In other respects, the pump 200 is substantially identical to the pump 150 of the previous embodiment, and the similar parts have been identified with the same reference numerals.

In order to determine the rate at which chemical solution is metered from the
10 container 28 to a flow stream 38, an integrated calibration system 90 has been developed for use in connection with the chemical metering pumps 150 and 200 illustrated in Figures 8 and 9.

As can be seen most clearly in Figures 8, 9 and 12, the calibration system 90 includes the transfer valve 178, (shown in Figure 8 in the open position). When
15 the transfer valve 178 is in the open position, the pump reservoir 172 is flooded with liquid chemical from the container 28. The calibration system 90 operates in the following manner. With both transfer valve 178 and bypass control valve 186 fully open (maximum), chemical solution transfers from the container into the calibration system via transfer port 176 and into the reservoir 172, filling the
20 calibrated sight tube 180 via the sight tube connecting port 182 (see Figure 11). The level of the chemical solution in the sight tube 180 will be the same as the level of chemical solution within the container 28 (sight tube 180 extends the full height of the container 28). The electronic controller 26 is then switched on and the pulse rate set to maximum so that the pump 150 or 200 will commence
25 circulating liquid chemical into the sight tube 180 via by-pass tube 188.

The transfer valve 178 is then moved to the fully closed position, (and where additional containers are connected, an auxiliary valve is also closed), and by-pass control valve 186 is partially closed until the product level in sight tube
30 begins to fall. This indicates that liquid chemical is now being discharged into the flow stream 38 via discharge tube 36. To determine the rate at which product is being discharged into the flow stream, the rate at which the level of product in the

- 16 -

sight tube 180 descends is timed against the calibration scale (millilitres per minute). If the discharge rate is lower than the rate required, the bypass control valve 186 can be adjusted and calibration repeated until the desired rate is achieved. Once the desired rate is achieved, the transfer valve 178 is opened
5 and the pump is ready for operation.

The above described calibration system can be readily adapted to conventional forms of metering pumps. It is ideal for either multiple chemical or single control use and also has the facility to eliminate vapour lock (where gaseous chemicals such as liquid chlorine are used). The reason for such is that the bypass valve is
10 located at the upper end of the discharge outlet and the bypass line is vented to atmosphere through the bypass tube 188. Therefore any gaseous phase that is generated and is delivered to the bypass valve will tend to flow to the bypass line rather than the pressurised discharge line.

Figures 13 and 14 illustrate a second embodiment of the container calibration system 110, which can be used in connection with the submersible pump 80 according to the third embodiment illustrated in Figure 6. The calibration system 110 replaces the support member 82 of Figures 6 and 7 and includes a tube 112 which is linked to the intake port 32 of the pump 80 and which supports the pump from the outer casing 116. The calibration system 110 comprises three
15 concentric members, a hollow outer casing 116, a hollow inner valve stem 118 and a calibration indicator rod 120. The pump is supported by the lower end of the casing 116.

A float 122 is provided at the lower end of the calibration indicator rod 120 which is free to slide up and down within the inner valve stem 118. A series of
25 connecting ports 124 are provided adjacent to the lower end of the inner valve stem 118 to allow the transfer of liquid chemical from within the outer casing 116 to within the inner valve stem 118. The lower end face of the casing is formed with an aperture 127 which is associated with a valve seat at its inner end. The lower force of the inner valve stem 118 is intended to be able to operate with the
30 valve seat to close the aperture. The upper end of the inner tube stem cooperates with an annular nut 126 which is threadably engaged with the upper

- 17 -

end of the outer casing 116. With rotation of this nut in one direction and the opposite direction the lower end of the inner valve stem 118 can be moved axially into and out of sealing engagement with the valve seat to control the flow of liquid to the pump from the container through the aperture 127. Attached to
5 and supported by the outer casing 116 is the pump discharge tube 36, a pump vent tube 128 and the pump power supply/control signal cable 25 which are mounted to the pump. The pump discharge tube 36 is in fluid communication with the chamber formed within the outer casing 116 through a by-pass control valve 130 and a discharge line 132 via a T-junction.

10 The calibration system 110 operates as follows. With the inner valve stem 118 out of sealing engagement with the valve seat, liquid chemical product flows into the outer casing from the container through the aperture 127 and then to the pump. Both the outer casing 116 and the chamber within the inner valve stem 118 are flooded with liquid chemical product to the level of the liquid within the
15 container. This causes the calibration indicator rod 120 to rise upwards within the valve stem chamber 118 to the same level as the liquid content of the container. By reading the calibrated scale marked on the rod 120 the volume of liquid chemical in the container can be measured.

To calibrate the pump, the by-pass control valve 130 is turned to the fully open
20 position, and the electronic controller 26 is set with the pulse rate to maximum. The pump will then commence circulating liquid chemical product through the calibration system. The inner valve stem is then sealingly engaged with the valve seat associated with the aperture and the by-pass control valve 130 is partially closed until the indicator rod 120 starts to fall. The liquid chemical product is now
25 being discharged into the flow stream. In order to determine the rate at which the product is being discharged, the rate at which the rod 120 descends is timed using the left calibrated scale in the rod in millilitres per minute. If the discharge rate is lower than the rate required, the setting of the by-pass control valve 130 is adjusted and the calibration process is repeated until the precise rate required is
30 achieved. Once the desired discharge rate is achieved, the calibration flow valve is fully opened and the system is ready for normal operation.

Amended sheet IPEA/AU

- 18 -

Figure 15 illustrates an alternative embodiment of a cradle for holding a liquid chemical container that may be used in conjunction with the chemical metering pump 24 as illustrated in Figures 2 and 3. The cradle 136 has a first pivotable support frame 138 that is pivotably connected to a base 140 by means of hinges 142. With the support frame 138 in the upright position (as shown), two containers 28 can be loaded into the support frame (only one container illustrated). The container may be held in place by a spring loaded bracket 144 or other suitable retaining means. When the pump, 24 is fitted in the outlet aperture of the container 28, the whole support frame 138 is pivoted to its horizontal position on the base 140 and the product is then ready for metering from the containers 28.

Figure 16 illustrates a multi-head chemical metering pumping station which employs all three embodiments of the chemical metering pump in accordance with the invention. The two different types of cradle for supporting the liquid chemical container 28 are also illustrated. All four chemical metering pumps illustrated are controlled by a single electronic controller 26 which is remotely located as a wall-mounted unit. The cradle 136 is shown holding two containers connected to the one pump to operate in bank fashion to increase the capacity of liquid that can be pumped by the pump.

Figure 17 illustrates a preferred embodiment of an auto-refill system for use in conjunction with the chemical metering pump of the present invention. The auto-refill system comprises a container drain tap 210 adapted to be fitted to the spout of any chemical container 212, which enables the container to be safely laid on its side to facilitate the syphoning of its contents. The drain tap 210 comprises a scavenger tube 214 that extends into the container 212 with its opening close to the bottom of the volume of liquid in the container when laid on its side. Scavenger tube 214 ensures maximum fluid drainage during syphoning. A lever 215 can be manually operated to open and close the drain tap 210. An expandable spout attachment 216 is provided to connect the other end of the -14 scavenger tube 214, external to the container 212. Spout attachment 216 extends into the top of the sight tube 180, fitted to the pump 200 provided in connection with a liquid chemical container 218 provided below the container

- 19 -

212. The drain tap 210 also comprises an air-inducer outlet 220 which passes through the drain tap into the liquid chemical in container 212, and permits air to be induced into the container 212 under certain conditions (to be described below).

- 5 Container 218 is fitted with an auto-refill valve 222 adapted to be fitted into a purpose built aperture in the side of the chemical container 218. Auto-refill valve 222 comprises a level signalling device 224 at its upper end, an upper chamber 226 and a lower chamber 228. A spindle 230 extends from the level signalling device 224 down through the upper chamber 228 into the lower chamber 228
10 where it connects to a float 232 provided within the lower chamber 228. A ball float 234 is provided adjacent the lower chamber 228. A plurality of fluid ports 227 are provided near the top of the upper chamber 226 where liquid enters of the auto-refill valve. The auto-fill system operates as follows.

With container 18 already laid on its side in its cradle 236, the liquid chemical in
15 the container will be at the high mark 238. The chemical metering pump 200 is connected to a controller 240 ready to operate, and the auto-refill valve 222 is installed into the threaded aperture in the side of container 218. A 4mm connecting tube 242 is attached at one end to the level signalling device 224, and at its other end to the air inducer outlet 220 of the drain tap 210 for the back-
20 up container 212. The drain tap 210 is fitted to the outlet of the container 212 before the container 212 is laid on its side on the upper tier of the cradle 236. Spout attachment 216 is arranged so that liquid chemical drawn from container 212 via the scavenger tube 214 drains directly into the sight tube 180 of container 218.

- 25 Because the only source of air into the interior of container 212 (via air inducer outlet 220) is closed by the level signalling device 224, no liquid chemical will drain from container 212 at this stage.

Until the liquid within container 218 reaches the low mark 244, chemical metering pump draws liquid exclusively from the lower container 218. Both the upper

- 20 -

chamber 226 and lower chamber 228 of the auto-refill valve 222 are filled with liquid at this stage.

However, when the liquid chemical reaches the low mark 244, the ball float 234 in the auto-refill valve 222 drops from its seat allowing the fluid within the upper
5 chamber 226 and lower chamber 228 to escape from the auto-refill valve 222. As pump 200 continues to discharge liquid from the container 218, the level of liquid within the auto-refill valve 222 will gradually fall until it reaches the lower chamber 228. At that point, float 232 begins to fall whereupon the level signalling device 224 is caused to pivot by means of spindle 230, allowing the free flow of
10 air into the connecting tube 242. The flow of air via air inducer outlet 220 into container 212 releases the air lock within that container, and liquid begins to drain out by the scavenger tube 214, spout attachment 216 and sight tube 180 into the lower container 218, where the liquid gradually accumulates until the upper container 212 is completely empty.

15 Because the volume of liquid (between the high mark and the low mark) in container 218 is already known, liquid from the upper 20 litre refill container 212 should never fill to the fluid ports 227 where liquid enters the upper chamber 226 of the auto- refill valve.

However, should the liquid level rise about the fluid ports 227, the auto- refill
20 valve will fill with liquid, causing the float 232 to rise and closing off the air supply to the upper container 212 via connecting tube 242. When the contents of the upper container 212 have fully drained, it can be replaced, whilst the pump continues to operate from the now refilled lower container 218.

Advantageously, a bank of 20 litre refill containers 212 can be provided in a
25 cradle system as illustrated in Figure 18. Only the refill containers 212 on the upper level of the cradle need ever be replaced, on a rotating system.

In Figure 19, a third embodiment of a calibration system for the chemical
metering pump according to the present invention is illustrated. Figure 19(a)
illustrates a manual calibration system, whereas Figure 19(b) illustrates an auto
30 calibration system. In both cases, the calibration system is designed to suit the

- 21 -

application of the pump to a 200 litre drum, similar to that described above and illustrated in Figures 6 and 7. The manual calibration system shown in Figure 19(a) is therefore similar to the second embodiment of the calibration system 10 illustrated in Figures 13 and 14, and therefore the similar parts shown in Figure 5 19 are identified with the same reference numerals.

Both the auto and manual versions of the calibration system 250 shown in Figures 19(a) and (b) respectively, are in cartridge form and are housed in a shroud 252 having a flange 254 to which a chemical metering pump in accordance with the present invention is mounted. Both the manual and auto 10 calibration options are provided in a cartridge housing 256, that is similar to the outer casing 116 of the second embodiment illustrated in Figure 13. Within the cartridge housing 256 of the manual option, there is provided a hollow inner valve stem 118 and a calibration indicator rod 120 similar to that of the system illustrated in Figure 13. A float 122 is provided at the lower-end of the calibration 15 indicator rod 120, which is free to slide up and down within the inner valve stem 118. A valve 258 provided at the lower end of the valve stem 118 seats on a drum connector port 260 in its close position. With valve 258 in its open position (as shown in Figure 19(a)), liquid chemical floods both the interior of the hollow inner valve stem 118 and the annular is volume between the cartridge housing 20 256 and the valve stem 118. However, when the valve stem 118 is lowered manually so that valve 258 seats against the drum connector port 260, liquid chemical can be drawn from within the hollow valve stem 118 only. The manual calibration system 250 illustrated in Figure 19(a) is operated in a similar manner to the system 10 illustrated in Figures 13 and 14 and will not be described again 25 here. As with the embodiment illustrated in Figures 13 and 14, the main function of the manual calibration system is to enable a user to measure the rate at which the chemical metering pump discharges liquid chemical into a flow stream. It also allows the user to see the volume of liquid remaining in the drum from which the pump is discharging, ie a 200 litre dangerous goods drum - commonly known as 30 a Mousser.

Advantageously, a simple wrap-around removable filter screen 262 is incorporated into the base of the cartridge housing 256. When the cartridge

- 22 -

housing is inserted into the shroud 252 the screen 262 is received within a screen chamber 264 provided within the bottom of the shroud 262 adjacent the pump flange 254. Filter screen 262 prevents any contaminants from entering into the pump suction port, thus ensuring that the chemical metering pump can
5 remain submerged in the drum at all times and minimising operator contact with hazardous liquid chemicals.

In the auto calibration option illustrated in Figure 19(b), a solenoid actuator 266 operates a valve 268 via a valve connecting rod 270. When an actuating signal is received by the solenoid actuator 266 from controller 240, connecting rod 270
10 moves the valve 268 downwards so that it seats against and seals off the drum connector port 260. A slidable float 272 is provided on the valve connecting rod 270 and is free to move up and down depending on the liquid level within the cartridge housing 256. An optical detector 274 is provided near the bottom of the cartridge housing 256 for detecting the position of the float 272. The auto
15 calibration system 250 operates as follows.

During normal operation when the chemical metering pump is running, the connecting rod 270 remains in its up position and liquid is drawn into the system through the drum connector port 26. However, when a signal is transmitted from the controller 240 to commence the calibration cycle, solenoid actuator 266 is
20 activated and connecting rod 270 forces valve 268 to seal off the drum connector port 260. In this position, the chemical metering pump will draw liquid directly from within the cartridge housing 256. As the liquid level descends, the float 272 also moves downwards and will eventually interrupt the light beam of optical detector 274. At the same time that solenoid actuator 266 is actuated, a first
25 timer within the controller 240 is activated. When the float 272 is detected by the detector 274, a detection signal is transmitted to the controller 240 which stops the first timer and records the total time elapsed from commencement. It also triggers a second timer. Once the float 272 drops below the light beam of detector 274, the second timer also stops and controller 240 records the time
30 elapsed from its commencement. At this point, solenoid actuator 266 is deactivated, causing the valve 268 to be lifted from the drum connector port 260.

PCT/AU01/00269
Received 14 June 2002

- 25 -

Claims

The claims defining the invention are as follows:

1. A liquid delivery means intended for the delivery of liquid from a storage container having an outlet, the delivery means comprising an adaptor which is adapted to sealingly close the outlet, the adaptor supporting a housing, said housing having an inlet, an outlet and a pumping chamber which is at least in part defined by a flexible diaphragm, the space defined by face of the diaphragm and which is remote from the pumping chamber being vented to atmosphere, an inlet which in use is to open directly into the interior of the container and the pumping chamber and an outlet providing communication between the pumping chamber and a delivery line, wherein in use the housing is located such that it is below the intended lowermost level of liquid in the container and the outlet is located above the inlet, the housing supporting an actuator operatively connected to the diaphragm through said space and adapted to reciprocate to cause flexing of the diaphragm in the pumping chamber to induce liquid flow from the inlet to the pumping chamber and from the pumping chamber to the outlet, a control means located remote from the container and adapted to control the actuator.
2. A liquid delivery means as claimed at claim 1 wherein the adaptor comprises a closure which is adapted to close the outlet and a support which when in position extends from the outlet into the container to terminate proximate a wall of the container which in use is to be lowermost the housing supported from the innermost end of the support, said support accommodating the delivery line.
3. A liquid delivery means as claimed at claim 1 wherein the adaptor comprises a closure which is adapted to close the outlet, the housing supported from the external face of the closure, the inlet opening to the internal face of the closure.

AMENDED SHEET
IPEA/AU

PCT/AU01/00269
Received 14 June 2002

- 26 -

4. A liquid delivery means as claimed at claim 1 wherein the adaptor comprises a closure which is adapted to close the inlet, the housing supported from the closure to extend inwardly into the interior of the container from the closure, the external face of the closure being adapted to support the delivery line.
5. A delivery means as claimed at claim 2 or 4 wherein the housing is formed of a material which is chemically resistant to the liquid.
6. A liquid delivery means as claimed at any one of the proceeding claims wherein the actuator comprises a solenoid having a core operatively connected to the diaphragm, the control adapted to cause periodic activation of the solenoid and consequent reciprocation of the core.
7. A liquid delivery means as claimed at anyone of the proceeding claims wherein there is space associated with a vent duct which extends between the exterior of the container and the space.
8. A liquid delivery means as claimed at claim 7 wherein the vent duct accommodates electrical conductors providing connection between the control and actuator.
9. A liquid delivery means as claimed at one of the proceeding claims wherein the housing defines a cavity, said inlet and outlet located to one side of the cavity, the actuator located to another side of the cavity, an insert receivable in the cavity, said insert accommodating the diaphragm and providing the pumping chamber and space.
10. A liquid delivery means as claimed at claim 9 wherein the insert is capable of being replaced by other inserts defining a pumping chamber of differing volumes.
11. A liquid delivery means as claimed at any one of claims 9 or 10 wherein the insert comprises a first portion accommodating the diaphragm and

AMENDED SHEET
IPE/AU

PCT/AU01/00269
Received 14 June 2002

- 27 -

defining the space and a second portion having a recess which is receivable over the diaphragm to define the pumping chamber.

12. A liquid delivery means as claimed at any one of the proceeding claims wherein in use the inlet is located below the pumping chamber and the outlet is located above the pumping chamber.
13. A liquid delivery means as claimed at claim 12 where the inlet is connected to a pumping chamber by a first duct and the pumping chamber is connected to the outlet by a second duct wherein when in use the first and second ducts are upwardly inclined.
14. A liquid delivery means as claimed at any one of the proceeding claims wherein a reservoir is located intermediate the inlet and pumping chamber and an inlet port is provided between the reservoir and pumping chamber at a position which in use is to be located in the lower portion of the reservoir, the upper portion of the reservoir, being vented to atmosphere.
15. A liquid delivery means as claimed at claim 14 wherein in use the inlet port is downwardly inclined from the reservoir to the pumping chamber
16. A liquid delivery means substantially as herein described with reference to the accompanying drawings.
17. A liquid delivery and calibration arrangement for use with a pump having a pump inlet, connected to a liquid source and a pump outlet, the arrangement having an inlet connected to the pump outlet, the arrangement further comprising an outlet and a bypass duct connected to the inlet through an adjustable valve which is adapted to direct fluid flow from the inlet to the outlet and/or the bypass duct, a chamber connected to the bypass duct, a measuring means provided in association with the chamber to enable the volume of liquid in the column

AMENDED SHEET
IPEA/AU

PCT/AU01/00269
Received 14 June 2002

- 28 -

to be monitored, the chamber being connected to the pump inlet, the arrangement further comprising a control valve at the pump inlet adapted to control the flow of fluid from the liquid source to the pump.

18. A liquid delivery and calibration arrangement as claimed at claim 1 wherein the chamber is formed at least in part to be transparent to enable the liquid level in the column to be visually observed.
19. A liquid delivery and calibration arrangement as claimed at claim 18 wherein the chamber is provided with graduations representative of the volume of liquid in the chamber for at least a portion of the height of the chamber.
20. A liquid delivery and calibration arrangement as claimed at any one of claims 17 to 19 wherein the chamber accommodates a float, said float supporting an element which extends from the chamber wherein the degree of extension is representative of the volume of liquid in the chamber.
21. A liquid delivery and calibration arrangement as claimed at claim 20 wherein the portion of the element which is to extend from the chamber is provided with a set of graduations.
22. A liquid delivery and calibration arrangement as claimed at claim 20 or 21 wherein the element comprises an elongate element which extends from the upper end of the chamber.
23. A liquid delivery and calibration arrangement as claimed at any one of claims 19 to 22 wherein the chamber is formed as an elongate tubular member having its central axis substantially upright.
24. A liquid delivery and calibration arrangement as claimed at claim 23 wherein the upper portion of the chamber is associated with a closure which is adapted to close the outlet of a container and support the

AMENDED SHEET
IPEA/AU

PCT/AU01/00269
Received 14 June 2002

- 29 -

chamber to extend into the container the lower end of the chamber associated with the pump.

25. A liquid delivery and calibration arrangement as claimed at claim 24 as dependant from claim 22 wherein the pump inlet is provided in the lower end of the chamber, said elongate element being movable longitudinally in the chamber into and out of sealing engagement with the pump inlet to provide said control valve, a control provide to effect the longitudinal movement of the elongate element between the open and closed position.
26. A liquid delivery and calibration arrangement as claimed at claim 24 or 25 wherein the closure is mounted to the chamber and the chamber supports the pump.
27. A liquid delivery and calibration arrangement as claimed at claim 24 or 25 wherein the chamber is received in a tubular shroud, said closure supports the shroud and the pump is supported by the lower end of the shroud, at least a portion of the wall of the shroud providing communication between the interior and exterior of the shroud, said portion providing a filtering element
28. A liquid delivery and calibration arrangement as claimed at any one of claims 17 to 27 wherein the arrangement is associated with a liquid delivery means of a form as claimed at any one of claims 1 to 16.
29. A liquid delivery and calibration arrangement as claimed at claim 28 wherein the inlet is connected directly to the pump outlet.
30. A liquid delivery and calibration arrangement as claimed at claim 29 wherein the inlet, outlet and bypass duct are contained within the housing and the chamber is mounted at its lower end to the housing.

AMENDED SHEET
IPE/AU

PCT/AU01/00269
Received 14 June 2002

- 30 -

31. A liquid delivery and calibration arrangement as herein described with reference to the accompanying drawings.
32. A liquid delivery system comprising a first reservoir having first outlet and a liquid delivery means for delivery said liquid from the first reservoir the first delivery outlet located at the lower portion of the first reservoir, a second reservoir located above the first reservoir and having a second outlet located in its lower portion the first reservoir having a vent at its upper portion which is open to atmosphere, a first delivery conduit connecting the second outlet to the first reservoir, the second delivery conduit interconnecting the upper portion of the interior of the first reservoir with the interior of the second reservoir, a vent valve controlling communication through the second delivery conduit, a level sensor provided with the first reservoir and adapted to sense the level of liquid in the first reservoir, the sensor associated with the vent valve to cause the vent valve to open the level of liquid falling below a first predetermined level and to close vent valve on the level rising above a second predetermined level where the first predetermined level is lower than the second predetermined level.
33. A liquid delivery system as claimed at claim 32 wherein the second reservoir comprises a plurality of second reservoirs each connected to the first reservoir by a second delivery conduit.
34. A liquid delivery system as claimed claim 32 or 33 wherein the first reservoir comprises a plurality of containers each having a common upper level and each having a first outlet wherein one container has one first outlet lower than the other first outlets, the liquid delivery means being associated with the one first outlet and the other first outlets being connected to the one container.
35. A liquid delivery system as claimed at any one of claims 32 to 34 wherein each container is associated with a second reservoir.

AMENDED SHEET
IPE/AU

PCT/AU01/00269
Received 14 June 2002

- 31 -

36. A liquid delivery system as claimed at any one of claims 32 to 35 wherein the liquid delivery means is of the form as claimed at any one of claims 1 to 17.
37. A liquid delivery system as claimed at claim 32 to 36 wherein the liquid delivery means is provided with a liquid delivery and calibration arrangement as claimed at any one of claims 18 to 31.
38. A liquid delivery system substantially as herein described.
39. A cradle adapted to support and receive a container, said container having an outlet on one face, the container pivotally supported from a base to be movable between a first position at which the one face is uppermost and a second position at which the outlet is located towards the lower extent of the container when at the second position.
40. A cradle as claimed at claim 39 wherein the cradle is displaced through substantially 90° in its movement between the first and second positions.
41. A cradle as claimed at claim 39 or 40 wherein the cradle is adapted to support a plurality of containers in a side by side relationship.
42. A cradle substantially as herein described.

AMENDED SHEET
IPE/AU

