Level Measuring Device, Method for Operating a Level Measuring Device and Assembly Consisting of a Level Measuring Device and at Least one Spacer

This invention relates to a level measuring device for measuring the filling level in a container through its wall by means of ultrasound.

By a level measurement by means of ultrasound, the filling level in the container can be determined without a level meter having to be introduced into the interior of the container or the container having to be opened for measuring purposes. This is advantageous in particular in containers which are under a high pressure, for example liquefied gas bottles, or cannot be opened for other reasons.

A mobile level measuring device for measuring the filling level by means of ultrasound is known from DE 20 2011 110 687. It is designed as hand-held measuring instrument, which in case of need is pressed against the wall of the container by a user, in order to carry out a measuring process. The level measuring device then indicates whether or not a liquid is present in the interior of the container at the height at which the measuring device has been attached.

From DE 198 20 482 C1 a stationary level measuring device is known, which is integrated into a base on which a gas bottle can be placed.

The object of the invention consists in creating a level measuring device which is suitable for stationary applications over a long period and can be used with a plurality of different containers and container types.

For the solution of this object, there is provided a level measuring device according to the invention for measuring the filling level in a container through its wall by means of ultrasound, comprising an ultrasonic measuring head, a control unit and a fastening device by means of which the level measuring device can be attached to the container such that the ultrasonic measuring head is pressed against the wall of the container, wherein a communication interface for wireless communication is provided which contains a transmitting/receiving unit.

The invention is based on the fundamental idea to integrate a fastening device into the level measuring device so that it is permanently held at the container. In this way, the level measuring device can be used for long-term measurements of the filling level. It can furthermore be used for a plurality of different containers as it can flexibly be attached to the wall of the container independent of the special geometry of the container. Due to the wireless communication interface, level measurement values can be transmitted to the outside so that they can be indicated to a user. The expenditure for cabling of the level measuring device hence can be omitted.

According to a preferred embodiment of the invention it is provided that the fastening device contains magnets. This embodiment provides for mounting the level measuring device with minimum effort on all containers which are made of a ferromagnetic material, i.e. in particular on all steel bottles. The holding magnets hold the level measuring device in the desired position until it is withdrawn again.

According to an alternative embodiment of the invention it is provided that the fastening device contains an adhesive. In this embodiment, the level measuring device can be glued to the desired point on the wall of the container like a plaster, at which point it then permanently remains. To mount the level measuring device on the next container, after it has been removed from a container, the “old” adhesive layer can further be used depending on the adhesive, or a new adhesive layer is applied.

According to still another embodiment of the invention it is provided that the fastening device contains a spring clip. The spring clip is particularly useful to mount the level measuring device on protruding parts of the container, for example on a standing ring or a handle.

The fastening device can also contain a tensioning strap. The same extends around the circumference of the container and presses the level measuring device and in particular the ultrasonic measuring head against its wall.

Preferably, the transmitting/receiving unit operates in accordance with the Bluetooth standard. This provides for transmitting the level measurement values with little energy consumption over a distance which is completely sufficient for many applications (for example in the camping sector, for a grill, for terrace heaters, a gastronomic business or for roofers).

According to one embodiment it is provided that an additional communication interface in the form of a plug is provided. In this way, a cable-bound data transmission can be effected for example to a bus system (LIN bus or CAN bus).

According to one aspect of the invention it is provided that a power supply for the control unit is integrated into the communication interface. A separate energy supply of the level measuring device thereby can be omitted.

According to a preferred embodiment an energy source is integrated into the level measuring device. In this way, the level measuring device is completely self-contained.

The energy source can contain two batteries. With these batteries an energy supply can be ensured over a sufficiently long period, for example for up to one year, at low cost.

The batteries preferably are exchangeable so that the level measuring device as such can be used over a long period.

According to a preferred embodiment of the invention it is provided that the batteries are arranged at a distance from the ultrasonic measuring head. As regards the installation space, this is advantageous in applications in which the level measuring device is used at the bottom of a gas bottle. In this case, the ultrasonic measuring head usually is located at the deepest point of the bottom, i.e. at a point with the smallest distance to the ground. Laterally thereof, the distance between the ground and the bottom of the gas bottle is greater so that the batteries can be accommodated there more easily.

Preferably the two batteries are arranged diametrically opposite each other at the outer edge of the level measuring device, as most of the space is available there.

According to one aspect of the invention a housing is provided in which the components of the level measuring device are integrated. The level measuring device thereby is easy to handle, and the components are mechanically protected.

According to one aspect it is provided that the housing is formed in one part. This facilitates mounting of the level measuring device on the container.

According to one aspect it is provided that the housing is made of an elastomeric plastic material and is flexible in itself. The level measuring device thereby can flexibly be mounted on containers which differ with regard to the curvature of the wall against which the ultrasonic measuring head is to be pressed. In addition, the material provides a particularly effective protection against external mechanical loads, for example when the container is put down on uneven ground and the level measuring device is in contact with the ground.

According to an alternative aspect it is provided that the housing is designed in several parts with a joint between the parts. The level measuring device thereby can flexibly be mounted on containers which differ with regard to the curvature of the wall against which the ultrasonic measuring head is to be pressed.

According to one embodiment a spring clip is provided between the parts of the housing. The desired pressing force of the ultrasonic measuring head against the wall of the container thereby can be produced with little effort.

The ultrasonic measuring head also can resiliently be arranged in the housing, so that it rests against the wall of the container with the desired pressing force, when the level measuring device is mounted on the wall of the container.

According to one embodiment springs are provided, which urge the ultrasonic measuring head against the wall of the container. With such springs, the desired pressing force can be produced over a long period.

According to one aspect of the invention it is provided that the springs are made of plastics integrally with the housing. The expenditure for the assembly of separate springs thereby is avoided.

When the fastening device contains one or more magnets, a receptacle for the magnet(s) preferably is provided, wherein the receptacle is closed by a housing wall on its side towards the container. Expressed in other words: the magnet(s) is(are) separated from the wall of the container by the housing wall. This has two advantages: on the one hand, a corrosion protection is obtained for the magnets as the housing seals the magnets on the side facing the container. On the other hand, the magnetic forces acting when the housing is mounted on a container are absorbed by the housing without any additional measures being necessary, with which it is ensured that the magnet(s) also reliably remains(remain) in the receptacle over a long service life.

According to one embodiment of the invention, a temperature sensor is provided. With the temperature sensor the measurement accuracy can be increased as the sound velocity in liquids among other things depends on the temperature. Moreover, the liquid level in the container likewise is temperature-dependent due to the thermal expansion of the liquid. When liquefied gas is regarded as liquid, it is to be noted that the two effects contradirectionally and non-linearly act on the running time of the sound signal with otherwise unchanged gas quantity, so that a temperature-dependent compensation is necessary for determining the correct liquefied gas quantity. It is sufficient when the temperature in the level measuring device and thus in the vicinity of the container is measured, as it can be assumed that the temperature measured outside the container for example on its underside approximately corresponds with the temperature of the liquid in the interior of the container, at least when extreme cases such as unilateral solar radiation or strong changes in temperature are excluded.

Preferably, the housing is provided with a load transmission portion which is arranged in the vicinity of the coupling cushion. The load transmission portion either rests against the bottom of the container or is located at a small distance from the bottom. When the level measuring device is extremely strongly pressed against the container, for example because a protruding object is disposed below the housing, the loads are transmitted directly to the container via the load transmission portion so that the coupling cushion and the measuring head are protected against high forces. At the same time, the housing is protected against high loads.

The temperature sensor can be integrated into a coupling cushion which is arranged on the side of the ultrasonic measuring head facing the wall of the container. The temperature sensor thereby is located in the vicinity of the wall of the container while at the same time it is protected well against environmental influences

The coupling cushion consists of an elastomer and ensures the good sound transmission between the ultrasonic measuring head (in particular an ultrasonic generator used there, such as a piezoceramic) and the wall of the container while the ultrasonic measuring head at the same time is protected against a direct contact. When the coupling cushion is designed compressible enough, it furthermore can compensate different bulges of the wall of the container and also certain tolerances and thereby each ensure a good sound transmission. The elastomer is designed such that at the usual pressing forces the yield point of the elastomer is not reached so that the pressing force against the wall of the container also is maintained with long constant pressure.

Preferably, the elasticity of the coupling cushion is chosen such that the cushion solely (i.e. without springs being necessary in the housing) generates the necessary pressing force of the ultrasonic measuring head against the wall of the container when the level measuring device is pressed against the wall of the container by action of the fastening device. This pressing force deforms the coupling cushion to such an extent that it conforms well to the wall of the container and the ultrasonic waves are well coupled into the wall of the container by the piezoceramic, and vice versa.

According to one embodiment of the invention it is provided that the control unit includes a forecast module with a memory. This provides for supplying a user with an estimated value on the basis of the consumption in the past, until when the supply in the container will last.

The control unit also can contain a characteristics module in which the course of a filling height in dependence on the liquid volume present in the container is stored. With the characteristics module the accuracy of the level measurement can be increased, in particular when the cross-section of the container varies above the filling height. One example of this is the bulged shape of a gas bottle in its lower region.

In operation of the level measuring device it is advantageous when a situation-dependent sampling rate is used. Expressed in general terms, a high sampling rate, i.e. a comparatively fast sequence of individual measuring operations, is used when the control unit recognizes due to external influences that this is advantageous. Conversely, the sampling rate is reduced when it is recognizable for the control unit that a high sampling rate does not make sense. With these measures the operating time to be achieved with a set of batteries can be increased.

When the control unit detects that the level measuring device is mounted on a new container, a number of measurements preferably is initiated, whose result is averaged, in order to determine a starting level. As a result, a reliable level measurement value is available to a user after a comparatively short time.

After the starting level has been determined, the control unit preferably reduces the sampling rate. This is easily possible without the accuracy of the determined filling level being reduced, as even with maximum consumption the filling level for example in a gas bottle does not change so much that a measurement for example every minute would not be sufficient.

The sampling rate can be further reduced when the control unit determines a constant filling level over an extended period. This can be interpreted by the control unit such that currently no liquid is removed from the container so that a measurement for example once per hour is sufficient. As soon as a decrease of the filling level again is detected, the control unit also can again increase the sampling rate.

According to one aspect of the invention it is provided that the control unit greatly reduces the sampling rate or entirely stops the measurements when it does not detect a communication of the level measuring device with an external receiver. Expressed in simple terms, this aspect is based on the principle that no measurement is performed when nobody asks for the level measurement value. An example for this procedure is a mobile home which is immobilized outside the holiday periods. As a result, a receiver also is shut down, which normally communicates with the level measuring device. When the control unit detects that no communication is possible, the sampling rate can be reduced to a very low value or even to zero. When the control unit detects that a communication again is built up, a higher sampling rate can again be used. It also is possible to initially use a greatly increased sampling rate in this case, as it is used when a new container is detected.

According to one aspect of the invention the control unit, when it detects a low filling level, proceeds from an evaluation of a first echo of the generated ultrasonic waves to an evaluation of a second or third echo of the ultrasonic waves. A reliable measurement thereby is possible also at a low filling level. At a low filling level in the container, the time distance between the emission of the ultrasonic signal and the reception of the echo is getting shorter and shorter. This is aggravated by the fact that after emission of the sound signal the ceramic still oscillates for a while and therefore is not immediately ready to receive. Therefore, it possibly is difficult to measure the first echo, i.e. the first reflection of the ultrasonic waves at the interface between liquid and gas. Usually, however, the wavefront is reflected several times, i.e. after a reflection at the interface liquid-gaseous again at the bottom of the container, then again at the interface, then again at the bottom, etc. These echoes are getting weaker and weaker, but in principle they are suitable for evaluation.

According to one embodiment it is provided that the transmission power of the ultrasonic measuring head is reduced when there is a low filling height. This is based on the finding that at low liquid levels the running distance of the sound waves is shorter, so that even with a low transmission power an echo reliably will arrive at the ultrasonic measuring head. A low transmission power has the advantage that the oscillation time after emission of the sound wave is getting shorter and the ceramic thus is again ready to receive more quickly. Thus, it is possible to measure lower liquid levels.

According to one aspect of the invention it is provided that the control unit, when it detects that the filling level falls below a defined value, makes sure that the user receives a specific indication. This can be an alarm message on the display device (for example on the smart phone). It thereby is ensured that the user takes suitable measures in due time, for example for the replacement of the empty liquid container.

According to one aspect of the invention it is provided that the control unit, when it detects that the filling level falls below a defined value, makes sure that a new container is procured. In a preferred embodiment this is achieved in that an application software on the smart phone makes sure that a reorder is initiated with a corresponding service provider. This can be effected for example via an Internet connection or an SMS communication. This aspect is particularly comfortable, because the process chain provides for an uninterrupted supply of the liquid to be measured, without the user himself having to become active.

A separate aspect of the invention relates to an assembly with a level measuring device as it has been described above, and at least one spacer which can be mounted on the lower edge of a container to be provided with the level measuring device. By means of the spacer the distance between the bottom of the container and the ground can be increased so that the level measuring device can be reliably mounted there also when the container is put down on an uneven ground (for example gravel). The spacers reduce the risk that the container provided with the level measuring device supports on the ground via the level measuring device, which possibly might lead to a damage of the level measuring device.

The spacer can be a base with a closed bottom. Such base is preferred particularly when the container is to be put down on a loose ground.

The base preferably includes two positioning formations for two types of containers. The positioning formations for example can be rings or clamps by means of which the base can be reliably mounted on a foot ring of the container. With different positioning formations it is possible to use one and the same base for different containers.

It can also be provided that the spacer consists of three or more spacer elements which can be clipped to the lower edge of the container. The same can then be flexibly mounted by a user, when this is advantageous in the individual case.

Preferably, each spacer element includes a slot of a first type and at least one second slot of a further type. This provides for using the same spacer elements with different containers.

Preferably, the spacer elements are constructed of an elastic plastic material so that due to the deformation the slots of further container types can be used, in that the slots flexibly adapt to the container edge.

The invention will be described below with reference to various embodiments which are illustrated in the attached drawings, in which:

- Figure 1 shows a schematic sectional view of a level measuring device according to the invention mounted on a container;
- Figure 2 shows a schematic sectional view of the level measuring device of Figure 1;
- Figure 3 shows a schematic sectional view of a level measuring device according to a second embodiment;
- Figure 4 shows the level measuring device of Figure 3 in a top view;
- Figure 5 shows a schematic sectional view of a level measuring device according to a third embodiment;
- Figure 6 schematically shows the electronic components of a level measuring device according to the invention;
- Figure 7 in a diagram shows the sampling rate used by the level measuring device over the time;
- Figure 8 shows a perspective, cut-off view of three spacer elements which are mounted on a container; and
- Figure 9 shows an enlarged, perspective view of one of the spacer elements shown in Figure 8.

Figure 1 shows a container 8 in whose interior space a liquid 3 is disposed. The liquid 3 fills the interior space of the container 2 up to a filling level F; above the liquid level a gaseous medium 4 is present. The same can be evaporated liquid 3 or air which has absorbed a certain amount of evaporated liquid 3.

In the illustrated exemplary embodiment the container 2 is a liquefied gas bottle which is provided with a gas port 5, a bottom 6 and a foot ring 7. With the foot ring 7 the liquefied gas bottle is standing on a ground 8, for example the bottom of a gas bottle locker of a mobile home. The wall 9 of the liquefied gas bottle consists of a ferromagnetic steel alloy.

On the bottom 6 of the liquefied gas bottle a level measuring device 10 is mounted by means of which the filling level F within the liquefied gas bottle and hence the quantity of the liquefied gas present in the liquefied gas bottle can be determined.

Even if the level measuring device 10 in the following is described in connection with a liquefied gas bottle, it is suitable and provided in principle to be used with other types of containers 2. It is not absolutely necessary either to mount the level measuring device 10 on the bottom 6 of a container. The level measuring device 10 for example might also be arranged on the side wall or on the upper side of the container.

The level measuring device 10 operates to determine the filling level F in the container 2 by means of ultrasound. Expressed in general terms, there are generated ultrasonic waves which are coupled into the wall 9 of the container (in the illustrated exemplary embodiment concretely into the bottom 6). From there, the ultrasonic waves are running through the liquid as signal S and are reflected at the interface between liquid medium and gaseous medium, so that they run back as echo E. This echo can be detected by the level measuring device 10. From the running time of the sound waves the filling level can be inferred, and this filling level can be converted into a filling quantity (either liter or kilogram), when the geometry of the container 2 is known.

The level measuring device 10 includes an ultrasonic measuring head 12 which in particular is a piezoceramic. On the side facing the container 2, the ultrasonic measuring head 12 is provided with a coupling cushion 14 which consists of an elastomer, for example silicone. The coupling cushion 14 serves to couple the vibrations of the piezoceramic into the wall of the container 2 and conversely transmit the vibrations of the wall of the container 2 resulting from the echo E back to the piezoceramic.

The ultrasonic measuring head 12 is arranged in a housing 16 which here is designed in two parts. It consists of a housing part 16A and a housing part 16B, which are connected with each other. In the illustrated exemplary embodiment, a schematically shown hinge 18 is present.

The level measuring device 10 furthermore is provided with a control unit 20 by means of which the measurement of the filling level can be performed. Details of the control unit will be explained below with reference to Figure 5.

There is provided an energy supply in the form of two exchangeable batteries 22 which provides the electric energy necessary for the operation of the control unit 20. The batteries can be commercially available batteries of the size AA.

The batteries 22 are arranged as far as possible towards the outside in the housing parts 16A, 16B, i.e. with a large distance from the hinge 18.

To be able to fasten the level measuring device 10 at the container 2, a fastening device 24 is provided which here consists of two magnets. In each housing part 16A, 16B a magnet 24 is arranged, namely on the side facing away from the hinge 18.

The ultrasonic measuring head 12 is arranged in the housing 16 in an elastically resilient way, namely such that it is urged towards the side on which the magnets 24 are arranged, out of the housing 16.

For resiliently mounting the ultrasonic measuring head, two springs 26 are provided here.

The springs 26 can be separate springs which are mounted in the housing parts 16A, 16B. Preferably, however, the springs 26 are made integrally with the housing parts 16A, 16B, namely as injection-molded elements of the housing parts 16A, 16B.

The housing 16 is provided with a spring clip 28 which is active between the two housing parts 16A, 16B. The spring clip 28 urges the two housing parts relative to each other in direction of the arrows P shown in Figure 2, i.e. the magnets 24 away from an “upper side” which is defined by the side on which the coupling cushion 14 is disposed.

To mount the level measuring device 10 on the container 2, it is attached to the bottom 6 such that the ultrasonic measuring head 12 is located at the deepest point of the bottom. Then, the two housing parts 16A, 16B are pressed against the ground 6 against the action of the spring clip 28 such that the magnets 24 magnetically adhere to the bottom 6. Due to the action of the spring clip 28, the housing 16 is pressed against the curved bottom 6 of the container 2 in the region of the hinge 18, whereby the ultrasonic measuring head 12 with its coupling cushion 14 is pressed against the bottom 6 of the container 2. The springs 26 provide the desired pressing force (necessary with regard to the transmission of ultrasonic waves) and also a tolerance compensation.

In Figures 3 and 4, a second embodiment of the level measuring device 10 is shown. For the components known from the first embodiment the same reference numerals are used, and in so far reference is made to the above explanations.

The difference between the first and the second embodiment consists in that in the second embodiment the two housing parts 16A, 16B are not mounted on each other, but on opposite sides of a central housing part 16C. In the housing part 16C the ultrasonic measuring head 12 is mounted. For this purpose, springs can be used like in the first embodiment.

As hinge 18 between the first housing part 16A and the third housing part 16C or between the third housing part 16C and the second housing part 16B, other than in the first embodiment, no fixed hinge is used, but an elastomer joint which provides for the desired movability between the housing parts.

Into the housing parts 16A, 16B, 16C a spring clip 28 also is integrated in the second embodiment, which urges the housing parts 16A, 16B, 16C into a starting position. In the starting position, the undersides of the three housing parts can extend in one plane (see Figure 3).

Another difference between the first and the second embodiment consists in that in the second embodiment the energy supply (batteries 22 also are used here) is not split up on two housing parts, but that two batteries 22 are arranged one beside the other in one housing part (here the second housing part 16B). In the same way as in the first embodiment, the batteries 22 however are arranged far on the outside.

The level measuring device 10 according to the second embodiment is mounted on the container in the same way as it has been explained for the first embodiment. When the two housing parts 16A, 16B are moved towards the wall of the container 2 such that the magnets 24 adhere to the wall 9 of the container, the desired pretension between the ultrasonic measuring head 12 and the wall of the container is generated automatically.

Figure 5 shows a level measuring device according to a third embodiment. For the components known from the preceding embodiments the same reference numerals are used, and in so far reference is made to the above explanations.

In the third embodiment a rigid housing 16 is used which consists of an upper part 16A and a lower part 16B. The two parts 16A, 16B can be clipped to each other so that a user can exchange the batteries 22 accommodated therein with little effort.

Alternatively, it is also possible to provide two small lids for one battery compartment each on the underside so that a user can exchange the batteries without separating the two parts 16A, 16B from each other.

The difference between the third embodiment and the first two embodiments consists in that in the third embodiment the ultrasonic measuring head 12 is rigidly mounted in the housing.

The necessary pretension between the wall of the container 2 and the ultrasonic measuring head 12 here solely is achieved by the dimensioning of the coupling cushion 14 and its material.

The coupling cushion 14 slightly protrudes from the side of the housing 16 facing the container 2. The protrusion s can lie in the order of magnitude of 1 to 2 mm.

When the level measuring device 10 is attached to a container (see the bottom wall 6 of a container indicated in broken lines in Figure 5), its wall compresses the coupling cushion 14 under the effect of the force of attraction of the fastening device 24, so that the desired pretension is obtained. The coupling cushion 14 can back away laterally as an annular clearance 50 is provided between the housing 16 and the coupling cushion.

The protrusion s of the coupling cushion defines how far the coupling cushion 14 can maximally be compressed (in a wall of a container with the smallest radius of curvature).

Another difference between the third embodiment and the first two embodiments consists in that in the third embodiment a load transmission portion 52 is provided in the housing. The same serves to transmit loads which act on the side of the housing 16 facing away from the container 2 directly onto the side of the housing 16 facing the container 2 and from there to the wall of the container 2.

The load transmission portion here is designed as a material portion extending continuously from the upper side to the underside of the housing 16. It is ring-shaped and surrounds the ultrasonic measuring head 12 and the coupling cushion 14 so that the clearance 50 is present. Alternatively, several separate load transmission portions designed for example like posts also might be used.

When excessively high loads act on the level measuring device 10 (for example when the container 2 provided with the level measuring device 10 is put down on a gravelly soil and a stone presses against the housing 16), these loads are transmitted through the housing and introduced into the wall of the container 2. The housing cannot be damaged in the process, as the load transmission portion extends directly from the bottom (here: from the lower part 16B) to the upper side of the housing 16 (here: to the upper part 16A).

At the same time, the coupling cushion is protected against excessively high loads, as at a certain load the upper side of the housing 16 supports on the container and the coupling cushion 14 cannot be compressed further.

As fastening device a ring-shaped magnet 24 can be used which is arranged in a ring-shaped receptacle 60. The bottom of the receptacle 60 (in the orientation of the housing as shown in Figure 5: the upper side of the receptacle) is formed by a wall of the housing. The radially inner side of the receptacle here is formed by the load receiving portion 52.

When the level measuring device 10 is mounted on a container, the magnet pulls the housing 16 against the container, so that the level measuring device 10 is fixed at the wall of the container. At the same time, the holding forces pull the magnet 24 against the wall which defines the receptacle 60. Hence, it is sufficient to merely secure the magnet 24 such that it does not fall out of the receptacle 60.

The radially outer side of the receptacle (material portion 53) here extends down to the lower part 16B of the housing 16 and thus acts as part of the load transmission portion 52.

As an alternative to a ring-shaped magnet 24 a plurality of individual magnets can also be used. The same then are arranged around the ultrasonic measuring head 12. For example, three magnets can be used, which in separate receptacles are concentrically arranged around the ultrasonic measuring head 12 at a distance of 120°.

The features of a load transmission portion 52 and a receptacle for the magnets, which on the side of the container is closed by a wall of the housing 16, can also be used individually or in combination in the first or the second embodiment.

In all embodiments of the housing the control unit 20 (see Figure 6) can suitably actuate the ultrasonic measuring head 12, in order to generate and detect ultrasonic sound waves when an ultrasound echo impinges on the ultrasonic measuring head 12.

To increase the accuracy of the level measurement, there is preferably provided a temperature sensor 30 which provides for the control unit 20 to take account of the (approximated) temperature of the liquid 3 in the container 2 in the evaluation of the runtime signal. The temperature sensor 30 for example can be cast into the coupling cushion 14, so that the temperature measured by the same at least for a certain part depends on the temperature of the wall 9 against which the coupling cushion 14 is pressed during a measurement. Alternatively, it is possible to arrange the temperature sensor 30 within the housing 16.

The control unit 20 furthermore is provided with a forecast module with which in dependence on the currently existing filling level and in dependence on consumption values the control unit 20 can extrapolate from the past how long the supply of liquid 3 in the bottle 2 will last (on the assumption that the consumption values do not change significantly).

Furthermore, a characteristics module 34 is provided in which the quantity (or the volume) of liquid 3 present in the container 2 is deposited in dependence on the filling level F. In the characteristics module 34 it can also be deposited what kind of liquid 3 is present in the container 2. This is relevant when the level measuring device 10 is to be universally used for the level measurement in quite different containers as different liquids have different sound velocities which must be taken into account in the level measurement.

To the control unit 20 a communication interface 36 is associated via which the result of the level measurement is provided to a user.

In the illustrated exemplary embodiment the communication interface 36 is a wireless communication interface which operates in accordance with the Bluetooth standard. Via this interface the measurement result can be sent to a receiver 38 (see Figure 1).

The receiver 38 for example can be a smart phone of a user. Said smart phone can couple with the level measuring device 10 and either trigger a measuring process or retrieve a level measurement value which is deposited in a measurement value memory 40 of the control unit 20.

The receiver 38 can also be a superordinate appliance controller, for example in a mobile home. By means of the same various appliances such as a refrigerator, an air-conditioning system or a water supply system can be actuated and monitored centrally. To this appliance controller the control unit 20 of the level measuring device 10 can provide a level measurement value, so that it can be indicated to a user on a central control panel.

The measurement value memory 40 also ensures that there is no data loss when the communication with a receiver 38 gets lost in the meantime; nevertheless, for example forecast data again are available at any time. In addition, measurement values can easily be provided to several receivers 38 even if some of them only recently have been connected with the communication interface 36.

When the level measuring device 10 is newly mounted on a container 2, a high sampling rate can be used at the beginning (see the area I in Figure 7). For example, measurements of the filling level can be performed in intervals of one second. The measurement values determined thereby are averaged, so that after a relatively short time (for example not more than 1 minute) the current filling level is determined quite reliably. Subsequently, the sampling rate is reduced (either in a time-controlled way or when the control unit detects that the determined filling levels sufficiently stably fluctuate around a mean value) (see the area 2 in Figure 7). For example, the sampling rate is reduced to one measurement per minute. This sampling rate is sufficient to cover a change of the filling level F of the container 2 and also to provide a forecast as to the reach of the remaining filling level.

When the control unit 20 for a certain period (possibly specifiable by the user) detects that the filling level F does not change, the sampling rate can further be reduced (see the area III in Figure 7). For example, only one measurement per hour is then performed.

When the control unit 20 detects that no more receiver 38 is coupled with the communication interface 36, the sampling rate also can be decreased to zero.

In response to an external signal (either in response to a change of the filling level or to coupling of a receiver 38 with the communication interface 36), the sampling rate is increased again (see the area IV in Figure 7). It either is possible, as is shown here, to perform measurements with a high sampling rate (this is recommendable in particular when in the meantime a sampling rate of zero has been used) in order to be able to reliably determine a starting level of a possibly exchanged container. Alternatively, the process can continue with a mean sampling rate (corresponding to the area V of Figure 7), in order to be able to again reliably continue to record the consumption and the correspondingly changing filling level.

Due to the variable sampling rate and in particular due to the fact that the sampling rate largely is lowered when this is possible without sacrificing the measurement accuracy, a service life of up to one year can be obtained with one set of batteries 22.

In various applications it may be advantageous to provide a spacer 50 between the container 2 and the ground 8. By using a spacer 50, when the same is made of plastics, a clearance between the foot ring 7 and the possibly metallic bottom of a gas bottle locker can be produced, whereby the wireless communication between the communication interface 36 and the receiver 38 is improved.

A spacer 50 also can be advantageous when the container 2 with the level measuring device 10 mounted thereon is to be put down on a loose ground such as gravel. There is a risk that the foot ring 7 digs itself into the ground 8 and under the weight of the container 2 the level measuring device 10 is pressed against protruding areas of the ground 8.

The spacer 50 for example can be a circumferential ring (see Figure 1) which is adapted to the diameter of the foot ring 7 and can be provided with several smaller magnets, so that it adheres to the foot ring 7. Handling is facilitated thereby.

The spacer 50 also can be formed by several spacer elements 50A, 50B, 50C, as they are shown in Figures 8 and 9. The spacer elements 50A, 50B, 50C here are clip-like plastic parts which are provided with a slot 52 of a first type and a slot 54 of a second type. The slots 52, 54 are adapted to different foot rings 7, so that the spacer elements can be used with different containers 2. Depending on the type of container, the spacer elements are clipped to the foot ring 7 in one or the other orientation.

The level measuring device 10 also can be mounted on containers 2 with other types of fastening devices 24. For example, there can be used a spring clip with which the level measuring device 10 is mounted within a foot ring 7. This spring clip then can support on a flanged edge portion of the foot ring 7.

It also is possible to use a tensioning strap, in order to mount the level measuring device 10 on the circumference of the wall 9.

The level measuring device 10 also can be glued onto the wall 9 of the container.

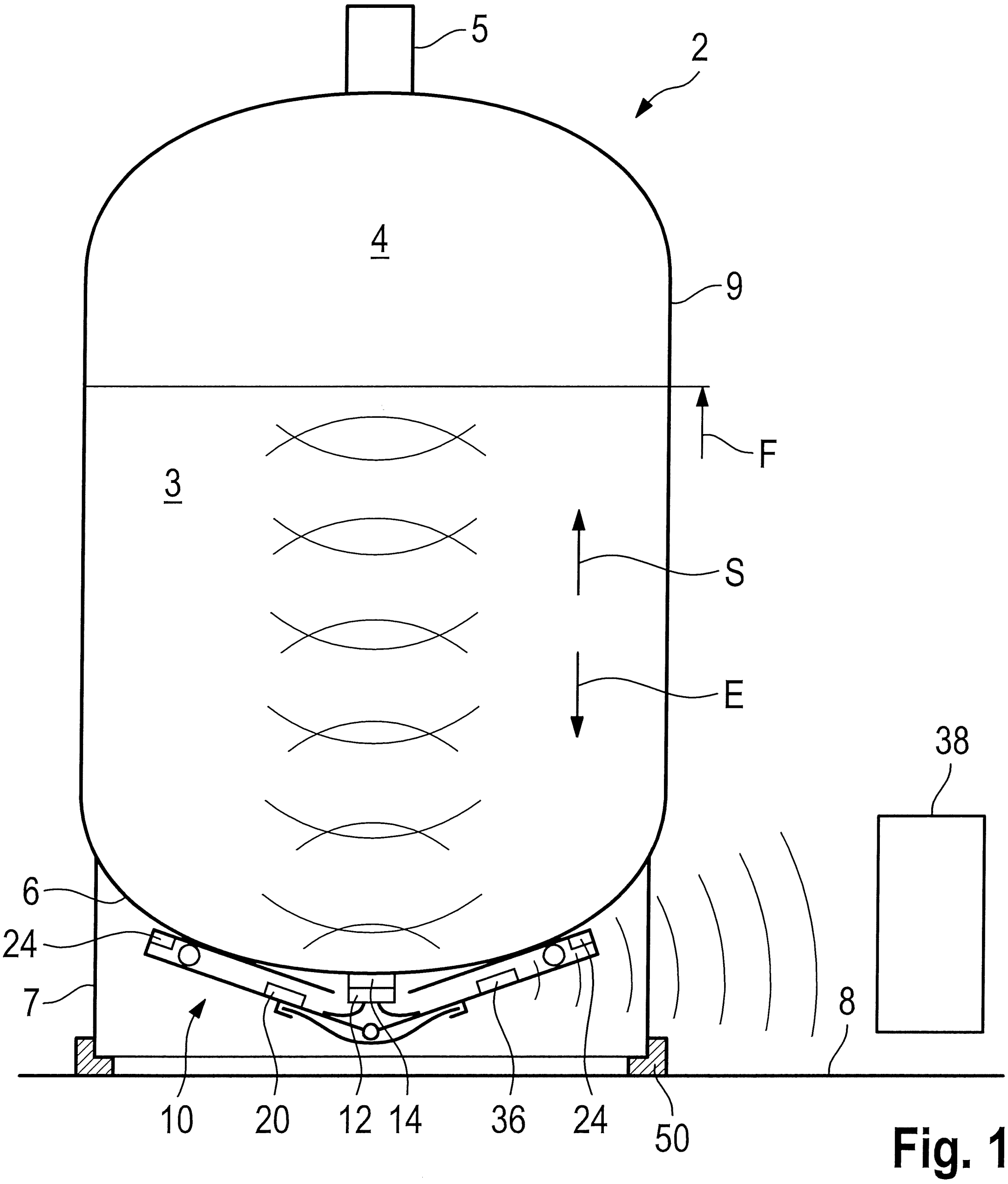
According to one design variant the level measuring device 10 is provided with current limitation diodes which ensure that the energy provided to the control unit 20 remains below certain limits. It therefore is not necessary to pot the components of the control unit in an explosion-proof way, in order to be able to use the level measuring device in explosion-hazardous regions without any problem.

Claims

1. An assembly comprising a level measuring device for measuring the filling level in a container through its wall by means of ultrasound, comprising an ultrasonic measuring head, a control unit and a fastening device by means of which the level measuring device can be attached to the container such that the ultrasonic measuring head is pressed against the wall of the container, wherein a wireless communication interface is provided which contains a transmitting/receiving unit, the fastening device containing at least one magnet, an energy source being integrated, a housing being provided, into which the components of the level measuring device are integrated, a coupling cushion being provided which is arranged on a side of the ultrasonic measuring head facing the wall of the container, the magnet being arranged in a receptacle which on the side towards the container is closed by a housing wall, the housing being provided with a load transmission portion which is arranged in the vicinity of the coupling cushion, the control unit containing a characteristics module in which the course of a filling height is deposited in dependence on the liquid volume present in the container, and at least one spacer which can be mounted on the lower edge of a container to be provided with the level measuring device, the spacer being a base with closed bottom, the base being provided with at least two positioning formations for two types of containers.

2. An assembly comprising a level measuring device for measuring the filling level in a container through its wall by means of ultrasound, comprising an ultrasonic measuring head, a control unit and a fastening device by means of which the level measuring device can be attached to the container such that the ultrasonic measuring head is pressed against the wall of the container, wherein a wireless communication interface is provided which contains a transmitting/receiving unit, the fastening device containing at least one magnet, an energy source being integrated, a housing being provided, into which the components of the level measuring device are integrated, a coupling cushion being provided which is arranged on a side of the ultrasonic measuring head facing the wall of the container, the magnet being arranged in a receptacle which on the side towards the container is closed by a housing wall, the housing being provided with a load transmission portion which is arranged in the vicinity of the coupling cushion, the control unit containing a characteristics module in which the course of a filling height is deposited in dependence on the liquid volume present in the container, and at least one spacer which can be mounted on the lower edge of a container to be provided with the level measuring device, the spacer consist of three or more spacer elements which can be

clipped to the lower edge of the container, each spacer element being provided with a slot of a first type and at least one second slot of a further type.


5
2
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9
F
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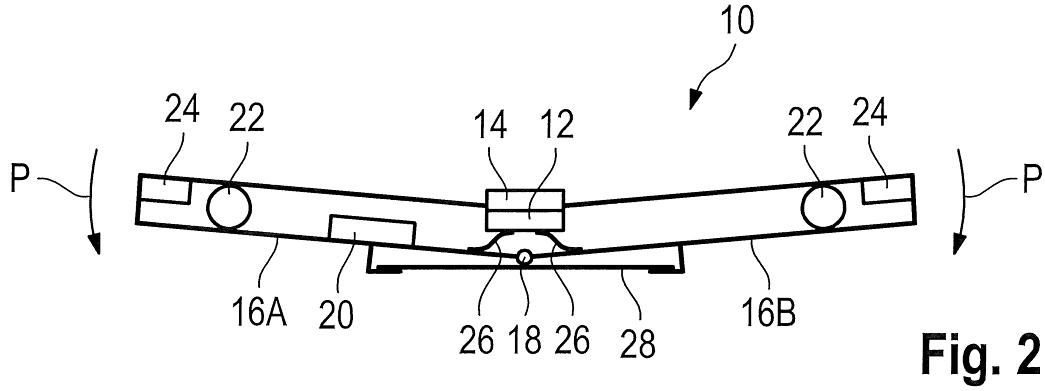
Fig. 1


10
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22
14
12
22
24
P
P
16A
20
26
18
26
28
16B

Fig. 2

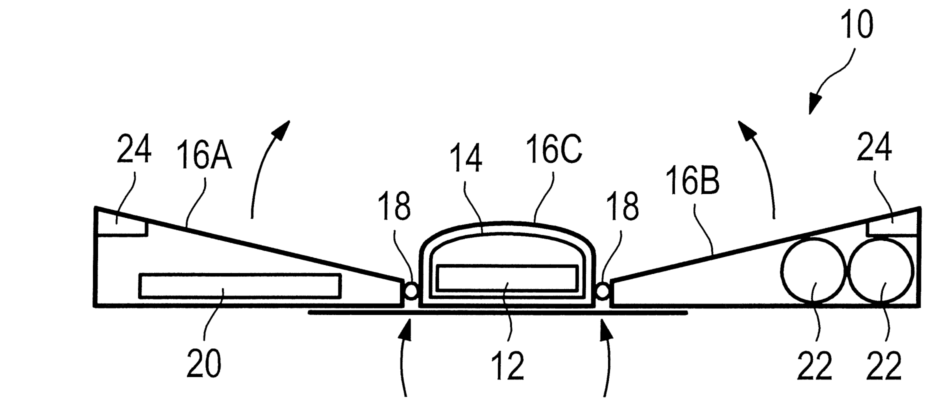

Fig. 3

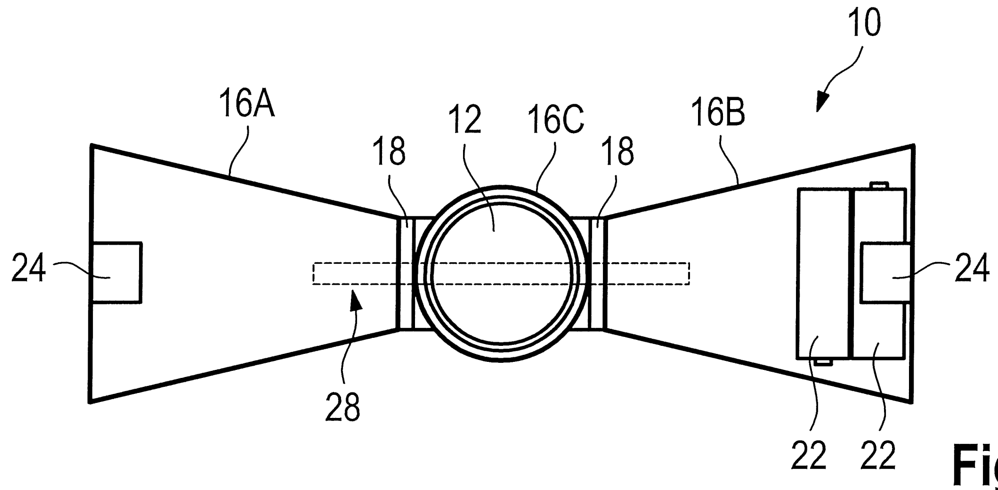

Fig. 4

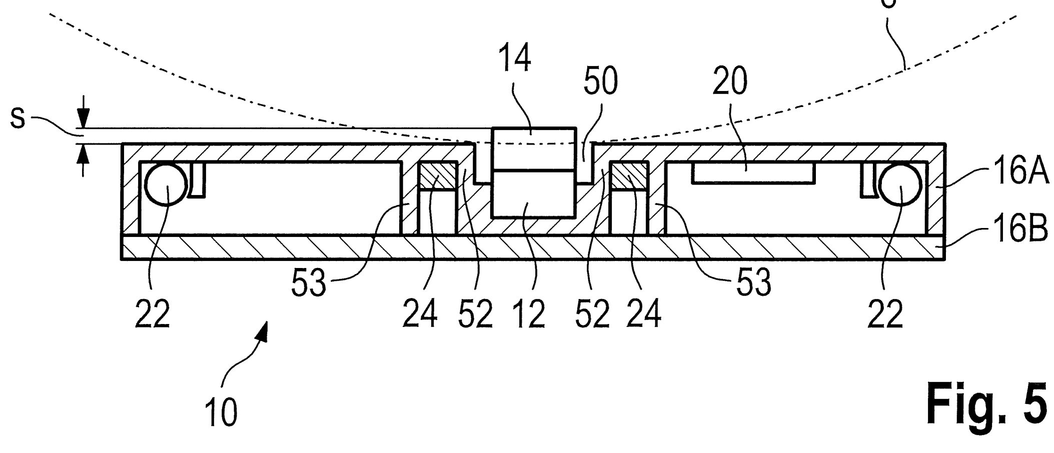

Fig. 5

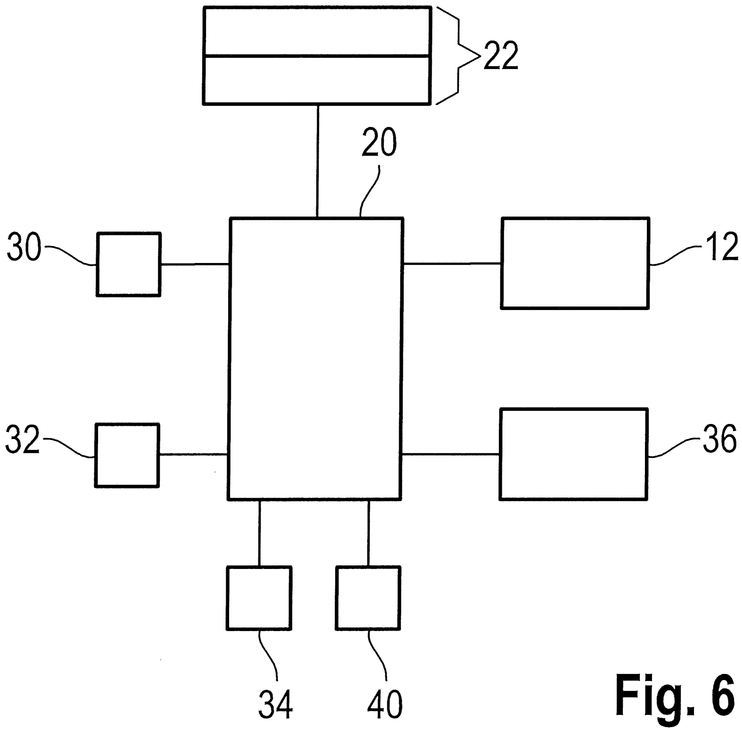

Fig. 6

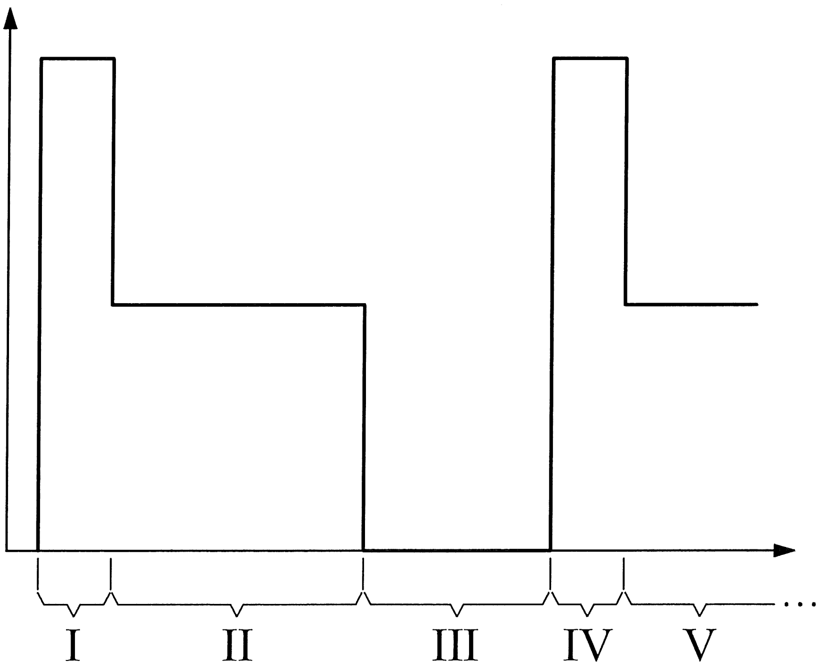

Fig. 7

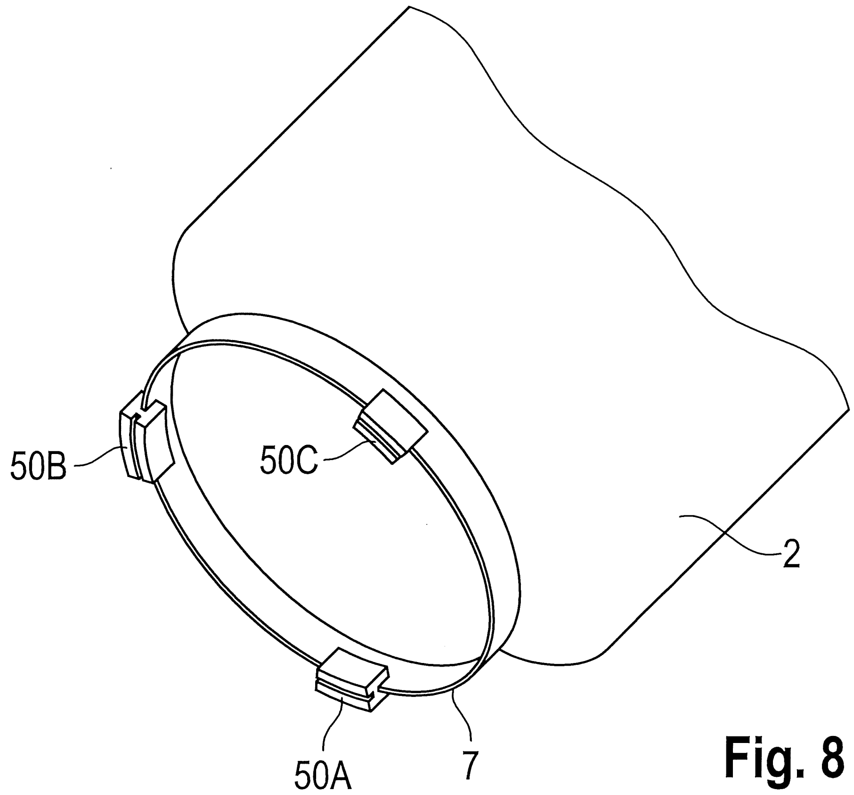

Fig. 8

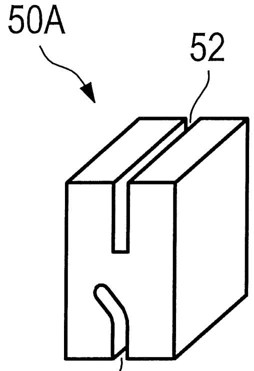

Fig. 9