

Description

This invention relates to a measuring apparatus, more particularly to an apparatus allowing dynamically measuring the properties of a liquid such as the amount, the density, the viscosity and, if desired, the temperature.

More particularly, the invention aims: measuring liquid levels with respect to one or several index marks; measuring density separation surfaces in the liquids and determining said surfaces with respect to one or several index marks; measuring densities of liquids at various levels; measuring viscosities of liquids at various levels; measuring temperatures of liquids at various levels; measuring the vertical dimensions of the liquid container or the liquid channels, as well as the height differences with respect to the liquid levels and/or the density separation surfaces.

The apparatus according to the invention will be advantageously used in any kind of liquid containers or channels, more particularly when vapours and/or gases likely to form an explosion danger and against which preventive steps must be taken, may exist or can occur, momentarily or permanently above the liquid, as well as when storing liquids and/or gases the pressure of which is higher than the atmospheric pressure.

For this purpose, the apparatus according to the invention allowing the above-mentioned measurements and still others uses a principle known per se, namely the measurement of the tension created in a cable, a rope or similar by means of oscillations induced in the said cable or rope.

A measuring apparatus comprising a pendulum whose oscillation frequency or/and amplitude variations are determinant for the measurement is known of the German patent application DE—A—2 012 475. However, the frequency or/and amplitude variations are in this case based on the friction of the pendulum with the liquid and not on the tension created in a cable.

The advantages obtained with the apparatus according to the invention are namely as follows:

- it allows completely separating the inside of the liquid container from the atmosphere and the possible electric control elements;
- it avoids electrical signals in the dangerous area above the liquid level and/or in the overpressure area;
- it may be installed and/or removed without extracting dangerous products, if any, from the container;
- even when it is firstly installed, it allows to independently determine the vertical dimensions of the liquid container as well as the absolute height difference of the liquid or the density separation surfaces with respect to the container, while indicating said differences in an agreed unit, e.g. in millimeters or fractions of millimeters.

The apparatus according to the invention which is namely capable of meeting the above mentioned requirements, comprises a pendulum actuating means for causing said pendulum to oscillate continuously; a logic control unit to control said actuating means; a position measuring device; a cable-like element which is secured at one of its ends to the position measuring device; a measuring body secured on the free end of said cable-like element, presenting such a weight that the latter is subjected to a force which is sufficiently high to maintain it in a tight state, said pendulum being forced towards its rest position by the tension in the cable-like element, said logic control unit being also arranged to receive and process a signal representative of the oscillation frequency of the pendulum; means for adjusting the position measuring device in such a way that the measuring body can be shifted in the vessel over the whole measuring range, the position measuring device being adapted to measure the position of the body in the vessel, the pendulum oscillation frequency, which is function of the apparent weight of the body, being indicative of one or more of said liquid properties.

The features of the present invention will be more clearly apparent from the following description of a preferred embodiment given by way of example, without any limitation, reference being made to the enclosed drawings in which:

Figure 1 is a diagrammatic vertical section of an apparatus according to the invention;

Figure 2 shows a view according to the arrow F2 of Figure 1;

Figure 3 is a diagrammatic view of a simple pendulum;

Figure 4 shows an application of the apparatus according to the invention;

Figure 5 shows a modified embodiment allowing the measurement of the temperature of a liquid.

As shown in Figures 1 and 2, the apparatus according to the invention comprises a position measuring device 1 formed by a drum; a cable-like element 2 such as a strand, a rope, a tape, a cable or similar; a measuring body 3; a pendulum 4 and a mechanical filter 5.

The cable-like element 2 is namely guided between first and second stationary guiding means 6—7 and 8—9, third guiding means 10 and leading means 11—12 secured on the pendulum 4.

The drum 1 is dimensioned so that it may receive an amount of the cable-like element 2 allowing the shifting of the measuring body 3 on the whole measuring height. It may be provided with a helical groove in order to obtain a high accuracy.

Needless to say that the relation between the rotation of the drum 1 and the vertical shifting of the measuring body 3 must be known with a very high accuracy, it being possible to drive the drum in any manner, e.g. through to a step motor, a permanent magnet driven into rotation by electromechanical solicitations, or similar.

The cable-like element 2 must be sufficiently thin and flexible to remain tight under the influence of the minimum force being detected, which is the case, e.g. when detecting the lower bottom of a liquid container. It must be also sufficiently strong to resist the maximum force being detected, which is the case, e.g. when detecting the upper bottom of the container. The cable-like element 2 must be capable of blocking the winding system without being distorted or broken.

The aimed accuracy determines the admissible elongation of the strand under a mechanical load, as well as the admissible expansion of the strand under the influence of the room temperature.

The measuring body 3 will have preferably a cylindrical shape. It is made of a material the specific weight of which is such that, when immersing the said body 3 in a liquid the density of which is the highest one being provided, the latter subjects the said cable-like element to a force which is sufficiently high to maintain the cable-like element 2 in a tight state.

The said body 3 will be finished so that, when it is removed from the liquid, it carries away the minimum amount of liquid.

The pendulum 4 allowing to convert the tension in the cable-like element 2 into a measuring signal will be brought to its rest position through the cable-like element 2 with a force which is function of the weight with which the cable-like element is loaded, i.e. the apparent weight of the measuring body 3.

The oscillation of the pendulum 4 is obtained and held through to a logic control unit which is also capable of recording and treating the resonance signals of the pendulum 4.

In a preferred embodiment, the oscillation of the pendulum 4 is obtained through a permanent magnet (not shown in the drawings) secured on the axis 14 and capable of being actuated through an electromagnet connected with the said logic control unit.

The said logic control unit consist of a micro-processor controlling both the position of the body 3 and the oscillation of the pendulum 4 and treating the resonance signals of the pendulum 4. Such a control unit can make measuring available to each concerned person and it is capable of receiving controls and possibly parameters valuable for the system.

The purpose of the mechanical filter 5 is to prevent acceleration forces in the cable-like element 2 resulting from oscillations of the pendulum 4 from acting on the body 3.

The resonance frequency of the elements 3—5 must be suitably damped so that it does not influence the function of the pendulum 4 and it must be outside the frequency band which is axially generated by the pendulum 4 in the cable-like element 2. The mechanical filter 5 may be of any resilient material such as an artificial or synthetic resin, a spring or similar.

Before describing the functioning of the apparatus according to the invention, it seems

judicious to start from the pendulum according to Figure 3 for our description.

As regards a pendulum such as shown in Figure 3, it is known that the frequency thereof is given by the formula:

$$f = \frac{1}{2\pi} \sqrt{\frac{\mu}{J} - \frac{\lambda^2}{4J^2}}$$

wherein:

f=the frequency;

μ =a constant determining for the torque about A;

λ =friction constant;

J=inertia moment of the pendulum;

A=suspension point.

As regards specifically the pendulum of Figure 3:

$\mu = mgl$

$J = ml^2$

m=the mass of the object 15 secured to the pendulum (the mass proper of the pendulum is neglected);

g=gravitation constant;

l=the length of the pendulum.

Considering that the friction in the point A and the air resistance are being neglected, λ will be zero.

Accordingly, the above formula becomes:

$$f = \frac{1}{2\pi} \sqrt{\frac{g}{l}}$$

From the foregoing, it results that, J and λ being invariable, the frequency is determined by μ , i.e. the return torque.

According to the invention and as shown in Figure 1, the pendulum 4 is provided with a measuring body 3 which will influence the said return torque and, accordingly, the frequency.

In that case:

μ =constant determining for the return torque about axis 14, which is itself determined by the weight of the pendulum 4; the weight of the body 3 and the weight of the strand portion situated between the points 16 and 17;

J=inertia moment of all the elements participating to the oscillation about the axis 14;

λ =friction, about the axis 14, of all the elements participating to the oscillation.

In the apparatus according to the invention, it is admitted that the weight of the cable-like element 2, the weight of the pendulum 4 and the friction in the points 16 and 18 between the first and second guiding means 6—7—8—9 are neglected, which means that λ and J are constants independently from the unwound length of the cable-like element 2, whereas μ is determined by the weight of the measuring body 3.

The apparatus according to the invention allows to measure various properties of a liquid and it operates as described hereafter.

In order to measure the level of a liquid, use is

made of the fact that the oscillation frequency of the pendulum 4 is determined by the weight of the measuring body 3. In fact, when said body 3 is immersed in a liquid, the apparent weight is lowered, thereby reducing the said frequency.

It is apparent that the immersion of the measuring body 3, e.g. down to the half height of the latter into a liquid corresponds to a determined frequency, e.g. f_r which may be selected as a reference frequency.

It results that the measurement of a liquid level requires an adjusting system which may change the position of the measuring body 3 until the pendulum 4 oscillates at a frequency f_r . When the axis 13 of the drum 1 is controlled by a step motor, this means that the number of steps of the motor in the same direction determines the height difference relative to a reference position.

In order to measure a liquid level situated between two liquids, like in the previous example, it is sufficient to select a predetermined frequency value f_r , to inform the said logic control unit about this value and to measure the height difference relative to a reference point.

A current application of a measuring apparatus according to the invention is shown in Figure 4.

This figure shows a vessel 19 provided with an apparatus according to the invention which, in this example, is mounted on the upper end of a tube 20. The latter is preferably extended into the vessel 19 in order to form a guiding means for the measuring body 3. The inside of said tube 20 is permanently communicating with the content of the vessel, e.g. by means of a slit provided on the whole height of the container 19. The said content consists namely of two liquids 21, 22 respectively having different densities, the levels of which are situated on the lines A-A and B-B.

The said tube 20 comprises preferably two stops 23—24 respectively used as reference points. However, said stops are not necessary because the bottom 25 of the vessel and the lower portion of the apparatus according to the invention may also function as stops.

In order to determine the upper index point, it is sufficient to shift the measuring body 3 upwardly against the stop 24. Owing to said contact, the tension of the spring 5 increases and the weight of the measuring body 3 apparently increases too, thereby resulting in an increase of the resonance frequency. Thus, the value f_{r1} of said frequency corresponds to that position of the measuring body 3 and it is sufficient to inform the adjusting system (microprocessor) about this value. Accordingly, said reference point corresponds to a height difference of zero.

The determination of the lower index point (stop 23 or bottom 25) is carried out in the same manner, except that the contact of the body 3 with the stop 23 or the bottom 25 causes an apparent decrease of the weight of the measuring body 3 and, accordingly, a reduction of the resonance frequency. This frequency which is communicated to the adjusting system, corresponds to a maximum height difference.

Considering the fact that the apparent weight of a body depends on the density of the liquid into which it is immersed, it is sufficient to situate successively the measuring body 3 under the levels B-B and A-A in order to be able to determine the density of the liquids 22 and 21 starting from the resonance signals transmitted to the adjusting system.

In the same manner, it is possible to measure the viscosity of the liquid. In fact, it is known that the friction of the liquid on the measuring body 3 during its travel at a constant speed through the liquid is proportional to the viscosity. This viscosity may be determined starting from the apparent increase or decrease of the weight of the measuring body 3 and the increase or the decrease of the frequency of the pendulum 4.

The apparatus according to the invention allows also to measure the temperature in a liquid.

For this purpose and as shown in Figure 5, the measuring body 3 will be provided with a temperature sensor 26 interconnected through one of its ends, with the body 3, the other end 27 of said sensor being free. The shifting of the end 27 relative to the body 3 gives an indication of the temperature in and/or about the body 3.

The above-mentioned free end 27 is provided with rods 28 connected, outside the body 3, through a ring 29 forming a stop. The arrangement is completed by an element 30 bearing freely on the stop 24.

When the measuring body 3 is shifted upwardly, at a certain point, the ring 29 contacts the element 30 and raises it, thereby inducing a frequency change in the pendulum 4, so that it is possible to perfectly know the position of the measuring body 3 for a given temperature.

It results that a temperature variation of the sensor 26 brings the ring 29 against the element 30 in another position of the body 3.

Owing to the small amplitude of the pendulum 4 and the negligible friction in the guiding means of the cable-like element 2, the latter may be shifted slowly without disturbing the measurement.

In addition, it is to be noted that the control of the cable-like element 2 is positive, i.e. the oscillation of this element is obtained through the pendulum 4 which moves it in a well determined plane. It results that the unwanted movements of the cablelike element 2 in other planes are excluded, thereby providing a very accurate measurement.

Owing to the presence of the third guiding means 10, the unwanted oscillations of the point 17 are still damped.

It is still to be noted that the non-linearity of the pendulum 4 is treated through the elements 3 and 5.

In fact, the height variation of the point 17 is the square of that of the angular amplitude of the pendulum 4, thereby causing substantial accelerations of said point 17.

In order to prevent said accelerations from influencing the measurement, the measuring body 3 is interconnected with the cable-like element 2 through the intermediary of the mechanical filter or spring 5 damping out said accelerations.

This spring 5 must be designed so that the frequency of the elements 3 and 5 is higher than the double highest frequency of the pendulum 4.

Thus

$$\frac{1}{2\pi} \sqrt{\frac{k}{m}} > \frac{1}{2\pi} \sqrt{\frac{\mu}{J} - \frac{\lambda^2}{4J^2}}$$

wherein k is a constant of the spring.

In addition, this frequency of the elements 3 and 5 must be situated outside the frequency spectrum of the pendulum 4 in order to prevent the resonance of the measuring body 3 on the pendulum frequency or on a harmonic of said frequency.

Claims

1. Measuring apparatus for measuring properties of liquids contained in a vessel, such as level, density, viscosity and temperature, comprising a pendulum (4), actuating means for causing said pendulum to oscillate continuously and a logic control unit to control said actuating means, characterized in that it further comprises a position measuring device (1), a cable-like element (2) which is secured at one of its ends to the position measuring device (1); a measuring body (3) secured on the free end of said cable-like element (2), presenting such a weight that the latter is subjected to a force which is sufficiently high to maintain it in a tight state, said pendulum (4) being forced towards its rest position by the tension in the cable-like element (2), said logic control unit being also arranged to receive and process a signal representative of the oscillation frequency of the pendulum (4); means for adjusting the position measuring device (1) in such a way that the measuring body (3) can be shifted in the vessel over the whole measuring range, the position measuring device (1) being adapted to measure the position of the body (3) in the vessel, the pendulum oscillation frequency, which is function of the apparent weight of the body, being indicative of one or more of said liquid properties.

2. Apparatus according to claim 1, characterized in that said position measuring device comprises a drum (1).

3. Apparatus according to claims 1 or 2, characterized in that the said cable-like element (2) is a strand, a rope, a cable, a tape or the like.

4. Apparatus according to claim 1, characterized in that the free end of the cable-like element (2) is connected with the said measuring body (3) through the intermediary of a mechanical filter (5).

5. Apparatus according to claim 4, characterized

in that the mechanical filter (5) is made of a resilient material.

6. Apparatus according to claim 5, characterized in that the mechanical filter comprises a spring (5).

7. Apparatus according to claim 5, characterized in that said resilient material is an artificial or synthetic resin.

8. Apparatus according to claim 3, characterized in that the cable-like element (2) is guided by at least first (6, 7) and second (8, 9) guiding means, respectively positioned at a first and a second fixed points on two different levels, the pendulum having means (11, 12) leading the cable-like element (2), said leading means being situated at a point (16) between said two levels.

9. Apparatus according to claim 8, characterized in that said first and second fixed points and said point (16) between said two levels are situated in the same vertical plane perpendicular to the plane in which the pendulum moves, when the pendulum (4) is at rest.

10. Apparatus according to claim 8, characterized in that the said first and second fixed points and said point (16) between said two levels are situated in different vertical planes perpendicular to the plane in which the pendulum moves, when the pendulum (4) is at rest.

11. Apparatus according to claim 8, characterized in that said first and second fixed points, said point (16) between said two levels and the oscillation axis (14) of the pendulum (4) are situated in the same vertical plane perpendicular to the plane in which the pendulum moves, when the pendulum is at rest.

12. Apparatus according to claim 8, characterized in that said first and second fixed points, said point (16) between said two levels and the oscillation axis (14) of the pendulum (4) are situated in different vertical planes perpendicular to the plane in which the pendulum moves, when the pendulum (4) is at rest.

13. Apparatus according to claim 8, characterized in that said first and second fixed points, said point (16) between said two levels, the oscillation axis (14) of the pendulum (4) and the axis (13) of the said drum (1) are situated in the same vertical plane perpendicular to the plane in which the pendulum moves, when the pendulum (4) is at rest.

14. Apparatus according to claim 8, characterized in that said first and second fixed points, said point (16) between said two levels, the oscillation axis (14) of the pendulum (4) and the axis (13) of the said drum (1) are situated in different vertical planes perpendicular to the plane in which the pendulum moves, when the pendulum (4) is at rest.

15. Apparatus according to any one of claims 8 to 14, characterized in that the said cable-like element (2) is complementarily guided under the said second guiding means (8-9), by a third guiding means (10) at a third fixed point, said third fixed point being situated outside the

In order to prevent said accelerations from influencing the measurement, the measuring body 3 is interconnected with the cable-like element 2 through the intermediary of the mechanical filter or spring 5 damping out said accelerations.

This spring 5 must be designed so that the frequency of the elements 3 and 5 is higher than the double highest frequency of the pendulum 4.

Thus

$$\frac{1}{2\pi} \sqrt{\frac{k}{m}} > \frac{1}{2\pi} \sqrt{\frac{\mu}{J} - \frac{\lambda^2}{4J^2}}$$

wherein k is a constant of the spring.

In addition, this frequency of the elements 3 and 5 must be situated outside the frequency spectrum of the pendulum 4 in order to prevent the resonance of the measuring body 3 on the pendulum frequency or on a harmonic of said frequency.

Claims

1. Measuring apparatus for measuring properties of liquids contained in a vessel, such as level, density, viscosity and temperature, comprising a pendulum (4), actuating means for causing said pendulum to oscillate continuously and a logic control unit to control said actuating means, characterized in that it further comprises a position measuring device (1), a cable-like element (2) which is secured at one of its ends to the position measuring device (1); a measuring body (3) secured on the free end of said cable-like element (2), presenting such a weight that the latter is subjected to a force which is sufficiently high to maintain it in a tight state, said pendulum (4) being forced towards its rest position by the tension in the cable-like element (2), said logic control unit being also arranged to receive and process a signal representative of the oscillation frequency of the pendulum (4); means for adjusting the position measuring device (1) in such a way that the measuring body (3) can be shifted in the vessel over the whole measuring range, the position measuring device (1) being adapted to measure the position of the body (3) in the vessel, the pendulum oscillation frequency, which is function of the apparent weight of the body, being indicative of one or more of said liquid properties.

2. Apparatus according to claim 1, characterized in that said position measuring device comprises a drum (1).

3. Apparatus according to claims 1 or 2, characterized in that the said cable-like element (2) is a strand, a rope, a cable, a tape or the like.

4. Apparatus according to claim 1, characterized in that the free end of the cable-like element (2) is connected with the said measuring body (3) through the intermediary of a mechanical filter (5).

5. Apparatus according to claim 4, characterized

in that the mechanical filter (5) is made of a resilient material.

6. Apparatus according to claim 5, characterized in that the mechanical filter comprises a spring (5).

7. Apparatus according to claim 5, characterized in that said resilient material is an artificial or synthetic resin.

8. Apparatus according to claim 3, characterized in that the cable-like element (2) is guided by at least first (6, 7) and second (8, 9) guiding means, respectively positioned at a first and a second fixed points on two different levels, the pendulum having means (11, 12) leading the cable-like element (2), said leading means being situated at a point (16) between said two levels.

9. Apparatus according to claim 8, characterized in that said first and second fixed points and said point (16) between said two levels are situated in the same vertical plane perpendicular to the plane in which the pendulum moves, when the pendulum (4) is at rest.

10. Apparatus according to claim 8, characterized in that the said first and second fixed points and said point (16) between said two levels are situated in different vertical planes perpendicular to the plane in which the pendulum moves, when the pendulum (4) is at rest.

11. Apparatus according to claim 8, characterized in that said first and second fixed points, said point (16) between said two levels and the oscillation axis (14) of the pendulum (4) are situated in the same vertical plane perpendicular to the plane in which the pendulum moves, when the pendulum is at rest.

12. Apparatus according to claim 8, characterized in that said first and second fixed points, said point (16) between said two levels and the oscillation axis (14) of the pendulum (4) are situated in different vertical planes perpendicular to the plane in which the pendulum moves, when the pendulum (4) is at rest.

13. Apparatus according to claim 8, characterized in that said first and second fixed points, said point (16) between said two levels, the oscillation axis (14) of the pendulum (4) and the axis (13) of the said drum (1) are situated in the same vertical plane perpendicular to the plane in which the pendulum moves, when the pendulum (4) is at rest.

14. Apparatus according to claim 8, characterized in that said first and second fixed points, said point (16) between said two levels, the oscillation axis (14) of the pendulum (4) and the axis (13) of the said drum (1) are situated in different vertical planes perpendicular to the plane in which the pendulum moves, when the pendulum (4) is at rest.

15. Apparatus according to any one of claims 8 to 14, characterized in that the said cable-like element (2) is complementarily guided under the said second guiding means (8-9), by a third guiding means (10) at a third fixed point, said third fixed point being situated outside the



vertical plane passing through the said second fixed point.

16. Apparatus according to any one of claims 8 to 15, characterized in that at least the said leading means (11, 12) and the first (6, 7) and second (8, 9), guiding means each consists of two elements, preferably cylinders situated on both sides of the said cable-like element (2).

17. Apparatus according to claim 2, characterized in that the said drum (1) is driven through a step motor.

18. Apparatus according to claim 1, characterized in that the pendulum (4) is actuated through a magnet.

19. Apparatus according to one of the preceding claims, characterized in that the inside of the measuring body (3) is provided with a temperature sensor (26).

20. Apparatus according to claim 19, characterized in that rods (28) capable of cooperating with a moving stop (29) outside the said measuring body (3) are secured to the said temperature sensor (26).

Patentansprüche

1. Meßgerät für die Bestimmung verschiedener Eigenschaften (Pegel, Wichte, Viskosität, Temperatur usw.) von in einem Behälter befindlichen Flüssigkeiten, bestehend aus einem Pendel (4), einem Steuermittel zum kontinuierlichen Schwingungsantrieb dieses Pendels und einem Logiksteuerkreis zur Steuerung dieses Steuermittels, dadurch gekennzeichnet, daß es außerdem versehen ist mit einer Positionsbestimmungsvorrichtung (1); einem mit einem seiner Enden an dieser Positionsbestimmungsvorrichtung (1) befestigten seilförmigen Element (2); einem am freien Ende dieses seilförmigen Elementes (2) befestigten Meßkörper (3), dessen Gewicht derart gewählt ist, daß die dadurch auf das seilförmige Element (2) ausgeübte Zugkraft groß genug ist, um es gespannt zu halten, wobei das Pendel (4) durch die Spannkraft des seilförmigen Elementes (2) fortwährend nach seiner Ruhelage hinzugezogen wird und der vorgenannte Logiksteuerkreis für den Empfang und die Verarbeitung der für die Schwingungsfrequenz des Pendels (4) maßgebenden Zeichen gedacht und angeordnet ist; einem Mittel für eine derartige Regelung der vorgenannten Positionsbestimmungsvorrichtung, daß der vorgenannte Meßkörper (3) über den Gesamtmeßbereich im Behälter verschoben werden kann, wobei die Positionsbestimmungsvorrichtung (1) für die Positionsbestimmung des Meßkörpers (3) im Flüssigkeitsbehälter eingestellt ist und die vom scheinbaren Gewicht des Meßkörpers abhängige Schwingungsfrequenz des Pendels maßgebende für eine oder mehrere der vorgenannten Eigenschaften der betreffenden Flüssigkeit ist.

2. Meßgerät gemäß dem Anspruch 1, dadurch gekennzeichnet, daß die vorgenannte Positionsbestimmungsvorrichtung mit einer Trommel (1) ausgestattet ist.

3. Meßgerät gemäß dem Anspruch 1 oder 2, dadurch gekennzeichnet, daß das vorgenannte seilförmige Element 2 eine Schnur, ein Seil, ein Kabel, ein Band o.dgl. ist.

4. Meßgerät gemäß dem Anspruch 1, dadurch gekennzeichnet, daß das freie Ende des vorgenannten seilförmigen Elementes (2) mittels eines mechanischen Filters (5) an den vorgenannten Meßkörper (3) angeschlossen ist.

5. Meßgerät gemäß dem Anspruch 4, dadurch gekennzeichnet, daß das vorgenannte Filter (5) aus einem federnden Material hergestellt ist.

6. Meßgerät gemäß dem Anspruch 5, dadurch gekennzeichnet, daß das vorgenannte mechanische Filter aus einer Feder (5) besteht.

7. Meßgerät gemäß dem Anspruch 5, dadurch gekennzeichnet, daß das federnde Material ein geeignetes Kunstharz ist.

8. Meßgerät gemäß dem Anspruch 3, dadurch gekennzeichnet, daß die Führung des seilförmigen Elementes mit wenigstens einem ersten und einem zweiten Führungsmittel (6, 7 und 8, 9) stattfindet, welche respektive in einem ersten und einem zweiten Festpunkt auf verschiedenen Höhen angeordnet sind, das Pendel mit einem geeigneten Mittel (11, 12) für die Führung des seilförmigen Elementes (2) versehen ist und dieses Führungsmittel sich in einem Punkt (16) zwischen den beiden Höhen befindet.

9. Meßgerät gemäß dem Anspruch 8, dadurch gekennzeichnet, daß der erste und der zweite Festpunkt, sowie der vorgenannte zwischen den beiden vorgenannten Höhen befindliche Punkt (16), in einer und derselben senkrecht auf der Bewegungsebene des Pendels stehenden Vertikalebene liegen, wenn das Pendel (4) sich in seiner Ruhelage befindet.

10. Meßgerät gemäß dem Anspruch 8, dadurch gekennzeichnet, daß der erste und der zweite Festpunkt, sowie der vorgenannte zwischen den beiden vorgenannten Höhen befindliche Punkt (16), in verschiedenen senkrecht auf der Bewegungsebene des Pendels stehenden Vertikalebenen liegen, wenn das Pendel (4) sich in seiner Ruhelage befindet.

11. Meßgerät gemäß dem Anspruch 8, dadurch gekennzeichnet, daß der erste und der zweite Festpunkt, der vorgenannte zwischen den beiden vorgenannten Höhen befindliche Punkt (16) und die Schwingungsachse des Pendels (4) in einer und derselben senkrecht auf der Bewegungsebene des Pendels stehenden Vertikalebene liegen, wenn das Pendel (4) sich in seiner Ruhelage befindet.

12. Meßgerät gemäß dem Anspruch 8, dadurch gekennzeichnet, daß der erste und der zweite Festpunkt, der vorgenannte zwischen den beiden vorgenannten Höhen befindliche Punkt (16) und die Schwingungsachse (14) des Pendels in verschiedenen senkrecht auf der Bewegungsebene des Pendels stehenden Vertikalebenen liegen, wenn das Pendel (4) sich in seiner Ruhelage befindet.

13. Meßgerät gemäß dem Anspruch 8, dadurch gekennzeichnet, daß der erste und der zweite



Festpunkt, der vorgenannte zwischen den beiden vorgenannten Höhen befindliche Punkt (16), die Schwingungsachse (14) des Pendels (4) und die Achse (13) der vorgenannten Trommel (1) in einer und derselben auf der Bewegungsebene des Pendels senkrecht stehenden Vertikalebene liegen, wenn das Pendel (4) sich in seiner Ruhelage befindet.

14. Meßgerät gemäß dem Anspruch 8, dadurch gekennzeichnet, daß der erste und der zweite Festpunkt, der vorgenannte zwischen den beiden vorgenannten Höhen befindliche Punkt (16), die Schwingungsachse (14) des Pendels (4) und die Achse (13) der vorgenannten Trommel (1) in verschiedenen auf der Bewegungsebene des Pendels senkrecht stehenden Vertikalebenen liegen, wenn das Pendel (4) sich in seiner Ruhelage befindet.

15. Meßgerät gemäß irgendeinem der vorhergehenden Ansprüche 8—14, dadurch gekennzeichnet, daß das vorgenannte seilförmige Element (2), außer seiner Führung unter der vorgenannten zweiten Führungsvorrichtung (8—9), überdies durch eine dritte, in einem dritten Festpunkt befindliche Führungsvorrichtung (10) geführt wird, wobei dieser dritte Punkt außerhalb der durch den vorgenannten zweiten Festpunkt gehenden Vertikalebene liegt.

16. Meßgerät gemäß irgendeinem der vorhergehenden Ansprüche 8—15, dadurch gekennzeichnet, daß wenigstens die vorgenannten Führungen (11, 12), die erste Führung (6, 7) und die zweite Führung (8, 9) je aus zwei Elementen und zwar vorzugsweise aus zwei beiderseits des vorgenannten seilförmigen Elementes angeordneten Rollen bestehen.

17. Meßgerät gemäß dem Anspruch 2, dadurch gekennzeichnet, daß der Antrieb der vorgenannten Trommel (1) mittels eines Stufenmotors stattfindet.

18. Meßgerät gemäß dem Anspruch 1, dadurch gekennzeichnet, daß der Antrieb des Pendels (4) mittels eines Magneten stattfindet.

19. Meßgerät gemäß irgendeinem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Meßkörper (3) innen mit einem Temperaturdetektor ausgestattet ist.

20. Meßgerät gemäß dem Anspruch 19, dadurch gekennzeichnet, daß mehrere mit einem beweglichen Anschlag (29) außerhalb des Meßkörpers (3) zusammenwirkende Stäbe (28) am vorgenannten Temperaturdetektor (26) befestigt sind.

Revendications

1. Appareil de mesure destiné à la mesure de propriétés de liquides présents dans un récipient, telles que le niveau, la densité, la viscosité et la température, comportant un pendule (4), un moyen de commande servant à engendrer l'oscillation ininterrompue de ce pendule, et un circuit de commande logique servant à commander ledit moyen de commande, caractérisé en ce qu'il comporte en outre un dispositif de mesure de

position (1), un élément sous forme de câble (2) fixé à l'une de ses extrémités à ce dispositif de mesure de position (1); un corps de mesure (3) fixé à l'extrémité libre de cet élément sous forme de câble (2) et ayant un poids suffisant pour exercer sur ce dernier un effort de traction suffisant pour le maintenir constamment à l'état tendu, le pendule (4) étant sollicité vers sa position de repos par la tension régnant dans cet élément sous forme de câble (2) et ledit circuit de commande étant conçu et disposé en vue de la réception et du traitement d'un signal représentatif de la fréquence d'oscillation du pendule (4); un moyen de réglage de la position de l'appareil de mesure (1), permettant le déplacement du corps de mesure (3) dans le récipient sur toute la portée de mesure, tout cela de manière que ledit dispositif de mesure de position (1) soit à même de mesurer la position du corps (3) dans le récipient et que la fréquence d'oscillation du pendule, qui varie en fonction du poids apparent du corps (3), soit représentative d'une ou de plusieurs propriétés du liquide concerné.

2. Appareil de mesure selon la revendication 1, caractérisé en ce que ledit dispositif de mesure de position se présente sous forme d'un tambour (1).

3. Appareil de mesure selon la revendication 1 ou 2, caractérisé en ce que ledit élément sous forme de câble (2) est un cordon, une corde, un ruban ou un autre moyen analogue.

4. Appareil de mesure selon la revendication 1, caractérisé en ce que l'extrémité libre dudit élément sous forme de câble (2) est réunie audit corps de mesure (3) par l'entremise d'un filtre mécanique (5).

5. Appareil de mesure selon la revendication 4, caractérisé en ce que ledit filtre mécanique (5) est fait d'un matériau résilient.

6. Appareil de mesure selon la revendication 5, caractérisé en ce que ledit filtre mécanique comporte un ressort (5).

7. Appareil de mesure selon la revendication 5, caractérisé en ce que ledit matériau résilient est une résine artificielle ou synthétique.

8. Appareil de mesure selon la revendication 3, caractérisé en ce que ledit élément sous forme de câble (2) est guidé par au moins un premier et un deuxième guidage (6, 7 et 8, 9), disposés respectivement en un premier et un deuxième point fixe à deux niveaux différents, et en ce que ledit pendule (4) est muni de guidages (11, 12) pour guider cet élément sous forme de câble (2), qui se trouvent en un point (16) situé entre ces deux niveaux.

9. Appareil de mesure selon la revendication 8, caractérisé en ce que ce premier et ce deuxième point fixe et ce point (16) situé entre deux niveaux différents se trouvent dans le même plan vertical perpendiculaire au plan dans lequel le pendule se meut, lorsque le pendule (4) est au repos.

10. Appareil de mesure selon la revendication 8, caractérisé en ce que ce premier et ce deuxième point fixe et ce point (16) situé entre deux niveaux différents se trouvent en des plans verticaux différents perpendiculaires au plan dans lequel le



pendule se meut, lorsque le pendule (4) est au repos.

11. Appareil de mesure selon la revendication 8, caractérisé en ce que ce premier et ce deuxième point fixe, ce point (16) situé entre deux niveaux différents et l'axe d'oscillation (14) du pendule (4) se trouvent dans le même plan vertical perpendiculaire au plan dans lequel le pendule se meut, lorsque le pendule (4) est au repos.

12. Appareil de mesure selon la revendication 8, caractérisé en ce que ce premier et ce deuxième point fixe, ce point (16) situé entre ces deux niveaux différents et l'axe d'oscillation (14) du pendule (4) se trouvent en des plans verticaux différents perpendiculaires au plan dans lequel le pendule se meut, lorsque le pendule est au repos.

13. Appareil de mesure selon la revendication 8, caractérisé en ce que ce premier et ce deuxième point fixe, ce point (16) (16) situé entre deux niveaux différents, l'axe d'oscillation (14) du pendule (4) et l'axe de rotation (13) dudit tambour (1) se trouvent dans le même plan vertical perpendiculaire au plan dans lequel le pendule se meut, lorsque le pendule (4) est au repos.

14. Appareil de mesure selon la revendication 8, caractérisé en ce que ce premier et ce deuxième point fixe, ce point (16) situé entre deux niveaux différents, l'axe d'oscillation (14) du pendule (4) et l'axe de rotation (13) dudit tambour (1) se trouvent dans des plans verticaux différents perpendiculaires au plan dans lequel le pendule

se meut, lorsque le pendule (4) est au repos.

15. Appareil de mesure selon l'une ou l'autre des revendications précédentes 8—14, caractérisé en ce que ledit élément sous forme de câble (2) est, à titre de mesure supplémentaire, guidé en dessous du deuxième guidage (8—9) par un troisième guidage (10) en un point fixe, situé hors du plan vertical passant par le deuxième point fixe.

16. Appareil de mesure selon l'une ou l'autre des revendications précédentes 8—15, caractérisé en ce qu'au moins le guidage (11, 12) et le premier et le deuxième guidage (6, 7 et 8, 9) se composent chacun de deux éléments, de préférence sous forme de rouleaux, situés de part et d'autre de l'élément sous forme de câble (2).

17. Appareil de mesure selon la revendication 2, caractérisé en ce que ledit tambour (1) est attaqué par un moteur pas à pas.

18. Appareil de mesure selon la revendication 1, caractérisé en ce que ledit pendule (4) est commandé au moyen d'un aimant.

19. Appareil de mesure selon l'une ou l'autre des revendications précédentes, caractérisé en ce qu'un détecteur de température (26) est prévu à l'intérieur du corps de mesure (3).

20. Appareil de mesure selon la revendication 19, caractérisé en ce qu'audit détecteur de température (26) sont fixées des tiges (28) susceptibles de coopérer avec un arrêt mobile, situé à l'extérieur dudit corps de mesure (3).

