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EP 0 250 243 B1

Description

The present invention relates to a burette which can be used for on-site titrimetric analysis, for example monitoring water quality.

Mechanically actuated burettes are known, for example from US Patent No. 4,086,062 issued 25 April 1978 to Clifford C. Hach, in which an actuator is manually operated to drive a plunger in a direction in which it expels liquid from the burette. The quantity of liquid dispensed can be indicated by way of a digital counter which records the number of turns of a rotor member serving to drive a linear actuator which engages the plunger.

An electrically operated pipette is also known, from EP-A-0 152 120 (Rainin Instrument Company) in which a stepper motor drives the pipette plunger in both an extension direction for dispensing liquid from the pipette and a retraction direction for taking up liquid into the pipette, again with a digital counter to indicate the displacement of the plunger and hence the quantity of liquid taken in or dispensed. EP-A-0 152 120 discloses the possibility of several different sizes of dispensing chambers for use with the same drive module in order to allow different quantity ranges of liquid to be handled in the pipette.

It is a disadvantage of the electrical pipette system of EP-A-0 152 120 that the liquid cannot safely be stored in the pipette and hence if on-site analysis is to be carried out it is necessary to take containers of the respective reagents and the pipette itself on-site so that, as required, liquid can be taken up into the pipette and then dispensed for the titrimetric analysis.

It is an object of the present invention to overcome the disadvantages of the prior art system and to provide a burette which is particularly convenient for use in on-site titration.

Accordingly, the present invention provides a burette comprising a housing, means on the housing for receiving a releasable reagent container including a displaceable plunger and a discharge passage, linear actuator means for driving the plunger in a reagent discharge direction, and display means responsive to displacement of the linear actuator for indicating the dispensing travel of the plunger, wherein the removable reagent container includes a self-re-sealing disphragm and means for piercing the diaphragm for dispensing of reagent from the container and for allowing the diaphragm to re-seal at termination of dispensing.

The releasable reagent containers may be sealed disposable plastic cartridges which self-re-seal after use, thereby simplifying greatly the handling of the reagent and eliminating the dangers of chemical spillage. Preferably the releasable reagent container may be made self-re-sealing by means of a diaphragm which can re-seal satisfactorily at least 20 times, so a considerable number of separate titrimetric analysis operations can be carried out on one reagent container before it is eventually empty and needs to be disposed of.

The display means preferably give a direct read-out of analyte concentration (by appropriate relationship of the reagent concentration to the rate of dispensing of the reagent). This considerably simplifies the operator's task of titrimetric analysis.

The ability to pre-pack the reagents with reduced concentration, as compared with those employed in the past, ensures that the operator in the field is much less at risk of inadvertent dispensing of the reagent onto the skin or other body tissue.

It is particularly convenient if the burette in accordance with the present invention can be equipped with interface means allowing the motorised burette to be controlled from a programmed or programmable controller which will effect standard titrimetric analysis according to a pre-determined programme.

The ability to connect the burette to a remote controller such as a microcomputer, using the interface means, considerably extends the versatility of the burette.

The optional ability to recharge the battery by way of the interface adds to the convenience of operation in the field.

In order that the present invention may more readily be understood the following description is given, merely by way of example, with reference to the accompanying drawings in which:-

FIGURE 1 is a schematic view of one embodiment of burette in accordance with the present invention;

FIGURE 2 is a block diagram of the electrical units incorporated in the pipette of Figure 1; and

FIGURE 3 is a side elevational view of the reagent container and cannula support of Figure 1.

The burette illustrated in Figure 1 comprises a main housing 1 which has at its front end a recess 2 for a pre-packed container 3 including a reagent to be used during titrimetric analysis for on-site water monitoring. A plunger 4 within the reagent container 3 is held in place by a flange 5 so that even when the container 3 is outside the burette body 1 the plunger will be held in situ.

The reagent container 3 is held in place by means of a clip 6 on the front end of the body 1, positioned so as not to obstruct a cannula 7 through which reagent is to be dispensed during analysis.

The dispensing of reagent from the container 3 is achieved by means of a stepping motor 8 cooperating with a linearly displaceable shaft 9 so that the stepping motor and the shaft together form

a linear actuator. The shaft 9 is of a cross-sectional shape, for example splined, which prevents it from rotating and hence it is subject solely to linear reciprocation generated by way of a screw (not shown) within the rotor of the stepping motor 8.

The housing 1 further includes a rechargeable battery 10 to provide power to drive the stepping motor 8. On the exterior of the recess for the battery 10 are two control buttons 11 and 12 whose function will be described later.

At the extreme rear end of the burette housing 1 is a digital indicator 13, for example an LCD indicator, and an interface socket 14 allowing the burette to be connected by means of a suitable multi-pin plug to a battery-charging power supply and/or to a programmable or programmed controller (not shown), for example a microcomputer. This controller is then able to instruct the burette to carry out automatically pre-programmed analysis sequences, if desired.

As with any conventional burette, the burette shown in Figure 1 will normally be operated with the cannula 7 at the lower end and the display 13 uppermost where it can be viewed by the operator.

In the then uppermost end portion 15 of the housing 1 are various control circuits whose functions will be described with reference to Figure 2.

It is a particularly important characteristic of the present invention that the reagent container 3 be of a self-sealing type so that the reagent in the container will be kept safe against inadvertent dilution or loss until such time as dispensing is required. Normally there will be some air trapped within the reagent container in order to allow for expansion of the liquid reagent. In such cases where the reagent is oxygen-sensitive, the container 3 may be topped up with an inert gas such as nitrogen which will of course remain trapped within the container during storage and transport of the containers and during use of the burette.

In order to guard against inadvertent operation of the linear actuator comprising the stepping motor 8 and the shaft 9, a switch 16 in the reagent container recess 2 is tripped only when a reagent container 3 is in place.

The block diagram shown in Figure 2 employs the same reference numerals as Figure 1 for those components which are shown in both drawings, but additionally illustrates the burette control circuit 17 and a burette driver circuit 18 which generate the appropriate pulses to drive the stepping motor 8.

As can be seen from Figure 2, the battery 10 has its output branched to drive the display 13, the control circuit 17, and the burette driver circuit 18. Equally, as mentioned above, it has an input from the interface 14 to allow for recharging of the battery when desired.

The interface 14 has two further outputs which join up with the output lines from the control buttons 11 and 12 so as to provide inputs to the control circuit 17. The button 11, and the appropriate by-passing output from the interface 14, causes the control circuit 17 to generate a stream of control pulses to the driver circuit 18 which in turn generates power pulses to the motor 8.

The push button 12 and the appropriate output from the interface 14 provides a means of resetting the digital display 13 to zero.

The push button 12 has an additional function in association with the control circuit 17 in that the control circuit 17 is such that when the two push buttons 11 and 12 are depressed simultaneously (or the corresponding outputs of the interface 14 are energised simultaneously) the control pulses emitted by the control circuit 17 and the corresponding drive pulses emitted by the driver circuit 18 cause the stepper motor 8 to cycle rapidly for advancing the drive shaft 9 into engagement with the plunger 4 of, for example, a newly inserted reagent container 3 to prime the burette. As soon as the operator sees a quantity of liquid expelled from the cannula 7 he releases the two push buttons 11 and 12.

Once this priming operation is complete, the operator then pushes button 12 alone in order to reset the display 13 to zero and then when dispensing of reagent from the container 3 during titrimetric analysis is required the operator presses button 11 alone, causing the stepper motor 8 to cycle slowly. When the operator releases the button 11 the stepper motor stops. Each pulse generated by the control circuit 17 is recorded on the digital display 13 and is delivered to any remote programme controller connected to the burette via interface 14. Each such pulse corresponds to a known fixed volume of liquid dispensed from the cartridge.

Preferably the concentration of the chemical reagent used in the container 3 is related to the incremental quantity of liquid dispensed per control pulse from the control circuit 17 such that the value visible on the digital display 13 at the end of the titration procedure corresponds to the concentration of the analyte being determined by titration, for example expressed in milligrams per litre.

Advantageously the burette includes pulse-emitting means to deliver, via the interface socket, pulses proportional to the volume of liquid dispensed.

As a preferred optional characteristic of the burette, the control circuit includes means for counting the number of control pulses emitted from the fully retracted position of the shaft 9, for example from the instant of installation of a fresh reagent container 3 tripping the switch 16, and the counter triggers the control circuit to cease to deliver

pulses when the number of pulses counted is equivalent to travel of the shaft 9 to its limit position in which the plunger 4 has run out of travel. Alternatively some mechanical sensing means may be incorporated for signalling to the control circuit 17 when the plunger 4 is fully forward. In this way it is possible to ensure that no damage to the drive transmission occurs at full travel position.

A further optional characteristic is that when the reagent container 3 is removed, and the switch 16 tripped to its alternative position, the control circuit automatically instructs the driver circuit 18 to drive the stepper motor 8 in the reverse direction until the drive shaft 9 is fully retracted. When the shaft 9 reaches this rearward limit of travel, the contents of the counter register are reset to zero and power is disconnected from the driver circuit 17 leaving the burette in its quiescent state ready to receive a reagent container.

Figure 3 shows in more detail the reagent container 3 and its end fitting carrying the cannula 7. If desired, a short length of small bore plastic tubing may be slipped over the end of the cannula 7 to facilitate dispensing reagent without splashing.

As shown in this drawing, the reagent container 3 has its plunger 4 provided with a recess 19 intended to accommodate the air bubble when the container 3 is in the operative configuration, and hence the inadvertent dispensing of air along with the reagent liquid is avoided.

The end of the reagent container 3 opposite the plunger-retaining flange 5 is closed by a screw cap 20 which supports an end extension 21 on which an end fitting 22 is secured by way of a bayonet fastening means 23. Although not shown in Figure 3, the end fitting 22 includes a part of the cannula 7 having a sharpened point 24 which pierces a self-sealing diaphragm 25 all of which are shown in Figure 4. When the end fitting 22 is snapped in place by operation of its bayonet fastener 23, the sharpened tip 24 of the cannula is automatically driven through the diaphragm 25 to pierce it. When, on the other hand, the end fitting 22 is released from the screw cap 20 the cannula tip 24 is withdrawn from the diaphragm 25, leaving the diaphragm to re-seal, and also allowing a neoprene sheath 26 on the cannula 7 to extend into the Figure 4 position to maintain the cannula tip 24 safe against pollution. It will of course be understood that when the cannula tip 24 pierces the diaphragm 25 the neoprene sheath 26 yields concertina-fashion to expose the cannula tip 24 to the diaphragm.

The diaphragm 25 is a plug of natural "india" rubber having a thickness of between 2.0 and 2.5 mm and subjected to radial compression on insertion, in order to enhance its self-sealing properties.

As indicated above, the provision of the interface 14 allows the illustrated burette either to be used as a hand-held on-site digital burette for titration, or to be used as part of a fully automated titration apparatus when linked to an appropriate controller such as a microcomputer. Starting from the above-mentioned quiescent state, when the drive shaft 9 is fully retracted and the drive circuit 17 de-energised, one complete sequence of operation of the burette for titrimetic determination of total alkalinity in water will now be described.

A 25 cm^3 aliquot of the water to be analysed is placed in a small flask or beaker, and the water is then dosed with one or two drops of BDH 4.5 indicator, a proprietary chemical indicator solution which undergoes a colour change at pH 4.5 to cause the solution to become blue in colour.

A pre-filled reagent container 3 containing 0.0618 $mol.dm^{-3}$ sulphuric acid is then inserted into the burette housing 1 and is clipped in place by operation of the clip 6 of Figure 1.

The priming procedure described above, under which the drive shaft 9 is advanced rapidly by simultaneous depression of the two push buttons 11 and 12, is carried out to bring the drive shaft into engagement with the plunger 4 of the reagent container, and to ensure that the liquid/air interface in the container 3 reaches the discharge end of the cannula 7.

The operator then slowly dispenses the acid from the container 3 into the sample flask, by depressing the push button 11, while agitating the sample in order to ensure thorough mixing. The operator continues to add acid in this way until the blue colour of the indicator just changes to a pale orange/yellow.

At this point the value shown on the digital display 13 of the burette is noted, and by virtue of the specially chosen gearing of the stepper motor 8 and the dimensions of the reagent container 3, related to the above-mentioned concentration of the sulphuric acid in the container 3, the value displayed corresponds to the total alkalinity of the water sample expressed in $mg.dm^{-3}$ $CaCO_3$.

Once this titrimetric analysis is complete, it is possible either to use the burette immediately for similar titrimetric analysis on a further sample of water, or to remove the end fitting 22 (Figures 3 and 4) with the cannula to cause the self-sealing diaphragm 25 to re-seal and the neoprene sheath 26 to recover the tip 24 of the cannula 7. The burette can then be transported to a fresh site for further titrimetric analysis with the same reagent container 3 or be stored for some future use.

When the next titrimetric analysis with the same reagent container 3 is required, the end fitting 22 is first of all re-attached to re-open the diaphragm 25, and then the button 11 is depressed to cause the stepper motor 8 to drive the plunger 4

forwardly until the end fitting 22 (Figures 3 and 4) and the cannula 7 are once again filled with reagent.

Once the container 3 has been depleted of reagent solution, the container can be removed by release of the clip 6, whereupon the switch 16 will be released to trigger the control circuit 17 to reverse the stepper motor 8 in order to retract fully the shaft 9 and to return the burette to its quiescent state.

In addition to the particular example of titrimetric analysis mentioned above, various other titrimetric determinations can be carried out in an analogous manner, using a suitable combination of reagent and indicator for each particular analyte to be determined, and preferably using a reagent concentration related to the incremental volume of liquid dispensed so as to give a direct read out, as in the above example.

Other applications for the invention, for example when used in conjunction with a remote-controlling device, may include the performance of fully automatic titrimetric analysis, the intermittent or continuous dispensing of bio-chemical reagents in luminescence assays of biological material, and the intermittent or continuous dispensing of calibration standards or samples or reagents into chemical sensing systems for industrial process monitoring.

Claims

1. A burette comprising a housing (2) for receiving a reagent in a releasable reagent container (3) which includes a displaceable plunger (4) and a discharge passage (7) through which the reagent is to be controllably dispensed by the burette; a linear actuator (8,9) for driving the plunger in a reagent discharge direction; display means (13) responsive to displacement of the linear actuator (8,9) for indicating the dispensing travel of the plunger (4); characterised by the fact that the removable reagent container includes both a self-re-sealing diaphragm (25) and means (22,24) for piercing the diaphragm for dispensing of reagent from the container and for allowing the diaphragm to re-seal at termination of dispensing.

2. A burette according to claim 1, characterised in that the diaphragm piercing means comprise a releasable end fitting (22) having attached thereto a diaphragm piercing member (24) communicating with said discharge passage (7) whereby fastening of the end fitting in place on the reagent container automatically pierces the diaphragm, and removal of the end fitting from the reagent container allows the diaphragm to re-seal.

3. A burette according to claim 2, characterised in that the diaphragm-piercing member (24) comprises a discharge cannula of the reagent container end fitting, said cannula forming the discharge passage.

4. A burette according to claim 3, characterised in that the cannula (24) carried by the reagent container end fitting includes a resilient sheath (26) which is automatically retracted upon diaphragm piercing and will automatically extend upon release of the cannula from the diaphragm.

5. A burette according to any one of the preceding claims, characterised in that the linear actuator (8) is electrically powered and the burette includes power control means (18) for driving the linear actuator in both directions of travel of the plunger.

6. A burette according to claim 5, characterised in that the burette further includes a rechargeable battery (10) connected to the power control means (18).

7. A burette according to either of claims 5 and 6, and further characterised by a switch (16) responsive to the presence of a reagent container (3) in the burette body (2), and control means (17)responsive to said switch for driving the linear actuator to retract upon removal of a reagent container, until the actuator arrives at a fully retracted configuration.

8. A burette according to claim 7, characterised in that the control means (17) further de-energises the linear actuator automatically at its fully retracted end of travel position.

9. A burette according to any one of claims 5 to 8, further characterised by interface means (14) allowing the burette to be controlled from a remote programmable or programmed control means for operating the burette in accordance with a predetermined programme for automatic titration operations.

10. A burette according to claim 9, further characterised by a rechargeable battery (10) for powering the linear actuator (8) and energizing the power control means, the interface means (14) comprising a multi-pin plug and socket connector having means for re-charging the battery (10) from outside, and conductors for connecting the power control means (18) to a remote programmable or programmed controller.

11. A method of titrimetric analysis using apparatus according to any one of claims 1 to 10, characterised by selecting the concentration of reagents in the reagent container such that the quantity of reagent dispensed per unit of the value displayed on the display means allows the displayed value to be taken as the concentration of the appropriate analyte in a sample.

12. A method according to claim 11, characterised in that the titrimetric analysis is for measurement of total alkalinity of water, and the reagent is sulphuric acid, and in that the water sample is first of all dosed with a coloring indicator which indicates the alkalinity of the sample and which responds to attainment of a pH value of 4.5 during neutralisation of the alkalinity upon gradual dispensing of the acid reagent.

Revendications

1. Burette comprenant un logement (2) pour recevoir un réactif dans un conteneur de réactif libérable (3) qui comporte un piston déplaçable (4) et un passage d'évacuation (7) où le réactif doit être distribué de manière contrôlable par la burette ; un moyen d'actionnement linéaire (8, 9) pour entraîner le piston dans une direction d'évacuation du réactif ; un moyen de visualisation (13) répondant au déplacement du moyen d'actionnement linéaire (8, 9) pour indiquer la course de distribution du piston (4) ; caractérisée en ce que le conteneur de réactif amovible comporte à la fois une membrane se refermant automatiquement (25) et un moyen (22, 24) pour percer la membrane afin de distribuer le réactif du conteneur et pour permettre à la membrane de se refermer à la fin de la distribution.

2. Burette selon la revendication 1, caractérisée en ce que le moyen de percement de la membrane comprend un raccord extrême libérable (22) auquel est attaché un organe (24) de percement de la membrane, communiquant avec ledit passage d'évacuation (7), pour qu'ainsi la fixation du raccord extrême sur le conteneur du réactif perce automatiquement la membrane, et l'enlèvement du raccord extrême du conteneur du réactif permet à la membrane de se refermer.

3. Burette selon la revendication 2, caractérisée en ce que l'organe de percement de la membrane (24) comprend une canule d'évacuation du raccord extrême du conteneur du réactif, ladite canule formant le passage d'évacuation.

4. Burette selon la revendication 3, caractérisée en ce que la canule (24) portée par le raccord extrême du conteneur du réactif comprend une gaine élastique (26) qui se retire automatiquement lors du percement de la membrane et qui s'étendra automatiquement lors de la libération de la canule par rapport à la membrane.

5. Burette selon l'une quelconque des revendications précédentes, caractérisée en ce que le moyen d'actionnement linéaire (8) est électriquement alimenté et en ce que la burette comporte un moyen de commande de puissance (18) pour entraîner le moyen d'actionnement linéaire dans les deux directions de la course du piston.

6. Burette selon la revendication 5, caractérisée en ce que la burette comporte de plus une batterie rechargeable (10) connectée au moyen de commande d'alimentation (18).

7. Burette selon l'une quelconque des revendications 5 ou 6, caractérisée de plus par un commutateur (16) répondant à la présence du conteneur du réactif (3) dans le corps (2) de la burette, et un moyen de commande (17) répondant au commutateur pour entraîner le moyen d'actionnement linéaire pour se retirer lors de l'enlèvement d'un conteneur du réactif jusqu'à ce que le moyen d'actionnement arrive à une configuration totalement retirée.

8. Burette selon la revendication 4, caractérisée en ce que le moyen de commande (17) désexcite de plus le moyen d'actionnement linéaire, automatiquement, à son extrémité totalement retirée de la position de sa course.

9. Burette selon l'une quelconque des revendications 5 à 8, caractérisée de plus par un moyen d'interface (14) permettant à la burette d'être commandée à partir d'un moyen de télécommande programmable ou programmé pour faire fonctionner la burette selon un programme prédéterminé pour des opérations automatiques de titration.

10. Burette selon la revendication 9, caractérisée de plus par une batterie rechargeable (10) pour alimenter le moyen d'actionnement linéaire (8) et exciter le moyen de commande d'énergie, le moyen d'interface (14) comprenant un connecteur à fiche multibroche et douille ayant un moyen pour recharger la batterie (10) de l'extérieur et des conducteurs

pour relier le moyen de commande (18) à une télécommande programmable ou programmée.

11. Méthode d'analyse titrimétrique utilisant l'appareil selon l'une quelconque des revendications 1 à 10, caractérisée en ce qu'on choisit la concentration des réactifs dans le conteneur de réactif de manière que la quantité du réactif distribué par unité de la valeur visualisée sur le moyen de visualisation permette de prendre la valeur visualisée en tant que la concentration de l'analyte approprié dans un échantillon.

12. Méthode selon la revendication 11, caractérisée en ce que l'analyse titrimétrique est pour la mesure de l'alcalinité totale de l'eau et le réactif est l'acide sulfurique, et en ce que l'échantillon d'eau est avant tout dosé par un indicateur colorant qui indique l'alcalinité de l'échantillon et qui répond lorsqu'est atteinte une valeur de pH de 4,5 pendant la neutralisation de l'alcalinité lors d'une distribution graduelle du réactif acide.

Patentansprüche

1. Bürette mit einem Gehäuse (2) zur Aufnahme eines Reagenzmittels in einem abnehmbaren Reagenzbehälter (4) und einem Auslaßkanal (7), durch den das Reagenzmittel steuerbar von der Bürette abgegeben wird, einer linearen Betätigungseinrichtung (8, 9) zum Antrieb des Kolbens in einer Reagenzabgaberichtung, einer Anzeigeeinrichtung (13) zum Anzeigen des Abgabeweges des Kolbens (4) nach Maßgabe der Verschiebung der linearen Betätigungseinrichtung (8, 9), **dadurch gekennzeichnet,** daß der abnehmbare Reagenzbehälter sowohl eine selbst-wiederverschließende Membran (25) als auch Mittel (22, 24) zum Durchstechen der Membran aufweist, um das Reagenzmittel aus dem Behälter abzugeben und um nach Abschluß der Abgabe die Membran sich wieder verschließen zu lassen.

2. Bürette nach Anspruch 1, **dadurch gekennzeichnet,** daß die Mittel zum Durchstechen der Membran einen abnehmbaren Endaufsatz (22) enthalten, an dem ein mit dem Ausgabekanal (7) kommunizierendes Membran-Durchstichteil (24) befestigt ist, wodurch bei passender Befestigung des Endaufsatzes am Reagenzbehälter die Membran automatisch durchstochen wird und beim Abnehmen des Endaufsatzes vom Reagenzbehälter die Membran sich wieder verschließt.

3. Bürette nach Anspruch 2, **dadurch gekennzeichnet,** daß das Membran-Durchstichteil (24) eine Auslaß-Kanüle des Endaufsatzes für den Reagenzbehälter aufweist, wobei die Kanüle den Auslaßkanal bildet.

4. Bürette nach Anspruch 3, **dadurch gekennzeichnet,** daß die Kanüle (24), die auf dem Endaufsatz des Reagenzbehälters angebracht ist, eine elastische Schutzhülle (26) aufweist, die beim Durchstechen der Membran automatisch zurückgezogen und beim Abziehen der Kanüle aus der Membran automatisch aufgestellt wird.

5. Bürette nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** daß die lineare Betätigungseinrichtung (8) elektrisch angetrieben ist und die Bürette eine Leistungssteuereinheit (18) zum Antrieb der linearen Betätigungseinrichtung in beiden Bewegungsrichtungen des Kolbens aufweist.

6. Bürette nach Anspruch 5, **dadurch gekennzeichnet,** daß die Bürette eine wiederaufladbare Batterie (10) aufweist, die mit der Leistungssteuereinheit (18) verbunden ist.

7. Bürette nach einem der Ansprüche 5 und 6, **dadurch gekennzeichnet,** daß ein Schalter (16), der auf die Anwesenheit eines Reagenzbehälters (3) im Bürettenkörper (2) anspricht, und eine auf den Schalter reagierende Steuereinheit (17) vorhanden ist, um die lineare Betätigungseinrichtung bei Abnahme des Reagenzbehälters zum Zurückziehen anzutreiben, bis die Betätigungseinrichtung eine voll zurückgezogene Stellung erreicht.

8. Bürette nach Anspruch 7, **dadurch gekennzeichnet,** daß die Steuereinheit (17) die lineare Betätigungseinrichtung automatisch an ihrer voll zurückgezogenen Endposition abschaltet.

9. Bürette nach einem der Ansprüche 5 bis 8, **dadurch gekennzeichnet,** daß eine Schnittstelleneinrichtung (14) vorhanden ist, mit Hilfe derer die Bürette von einer entfernt angeordneten, programmierbaren oder programmierten Steuereinheit zum Betrieb der Bürette nach einem vorgegebenen Programm für automatische Titrationsvorgänge steuerbar ist.

10. Bürette nach Anspruch 9, **dadurch gekennzeichnet,** daß eine wiederaufladbare Batterie (10) zur Leistungsversorgung der linearen Betätigungseinrichtung (8) und zur Versorgung der Leistungssteuereinheit vorhanden ist, wobei die Schnittstelleneinrichtung (14) eine

mehrpolige Steckverbindung aufweist, die Mittel zum Wiederaufladen der Batterie (10) von außen hat, und daß Leitungen zur Verbindung der Leistungssteuereinheit (18) mit einer entfernt angeordneten, programmierbaren oder programmierten Steuereinheit vorhanden sind.

11. Verfahren zur Titrationsanalyse unter Verwendung der Bürette nach einem der Ansprüche 1 bis 10, **dadurch gekennzeichnet,** daß die Konzentration des Reagenzmittels in dem Reagenzbehälter so ausgewählt ist, daß die abgegebene Reagenzmittelmenge pro Einheit des angezeigten Wertes auf der Anzeigeeinrichtung erlaubt, den angezeigten Wert als Konzentration des vorgegebenen zu analysierenden Stoffes in der Probe zu nehmen.

12. Verfahren nach Anspruch 11, **dadurch gekennzeichnet,** daß die Titrationsanalyse zur Messung der totalen Alkalinität von Wasser dient, das Reagenzmittel Schwefelsäure ist und die Wasserprobe zunächst mit einem Farbindikator versehen wird, der die Alkalinität der Probe anzeigt und auf das Erreichen eines pH-Wertes von 4,5 während der Neutralisierung der Alkalinität durch allmähliche Zugabe des sauren Reagenzmittels reagiert.

Fig. 1.

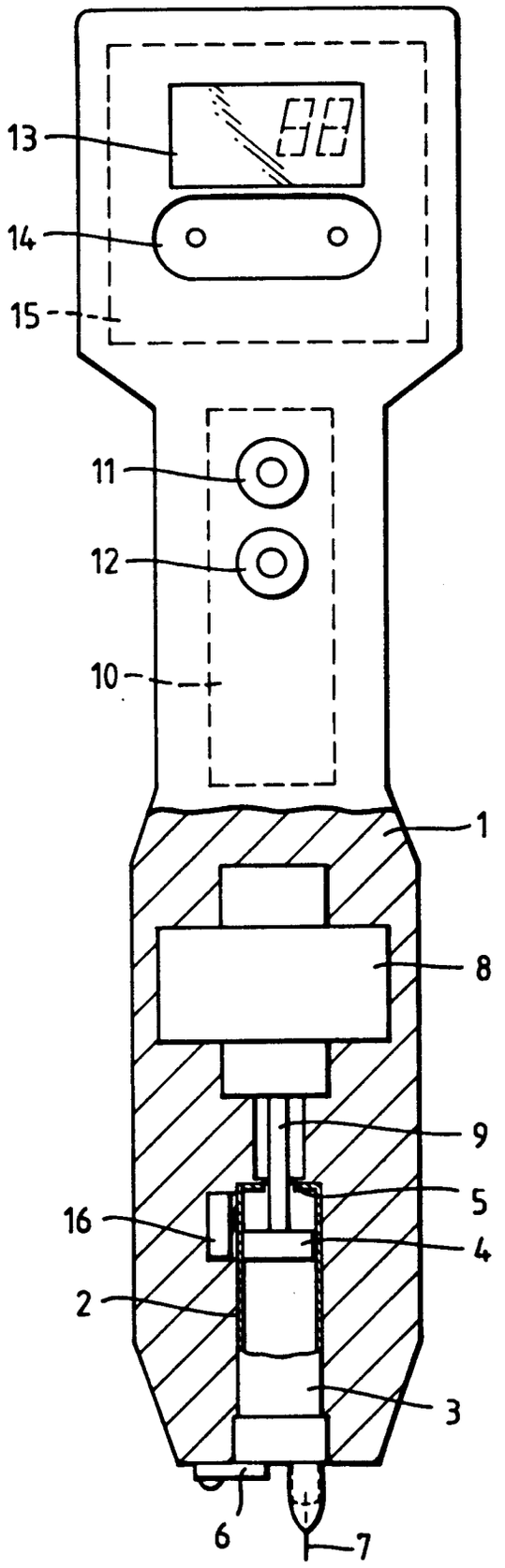

Fig.2.

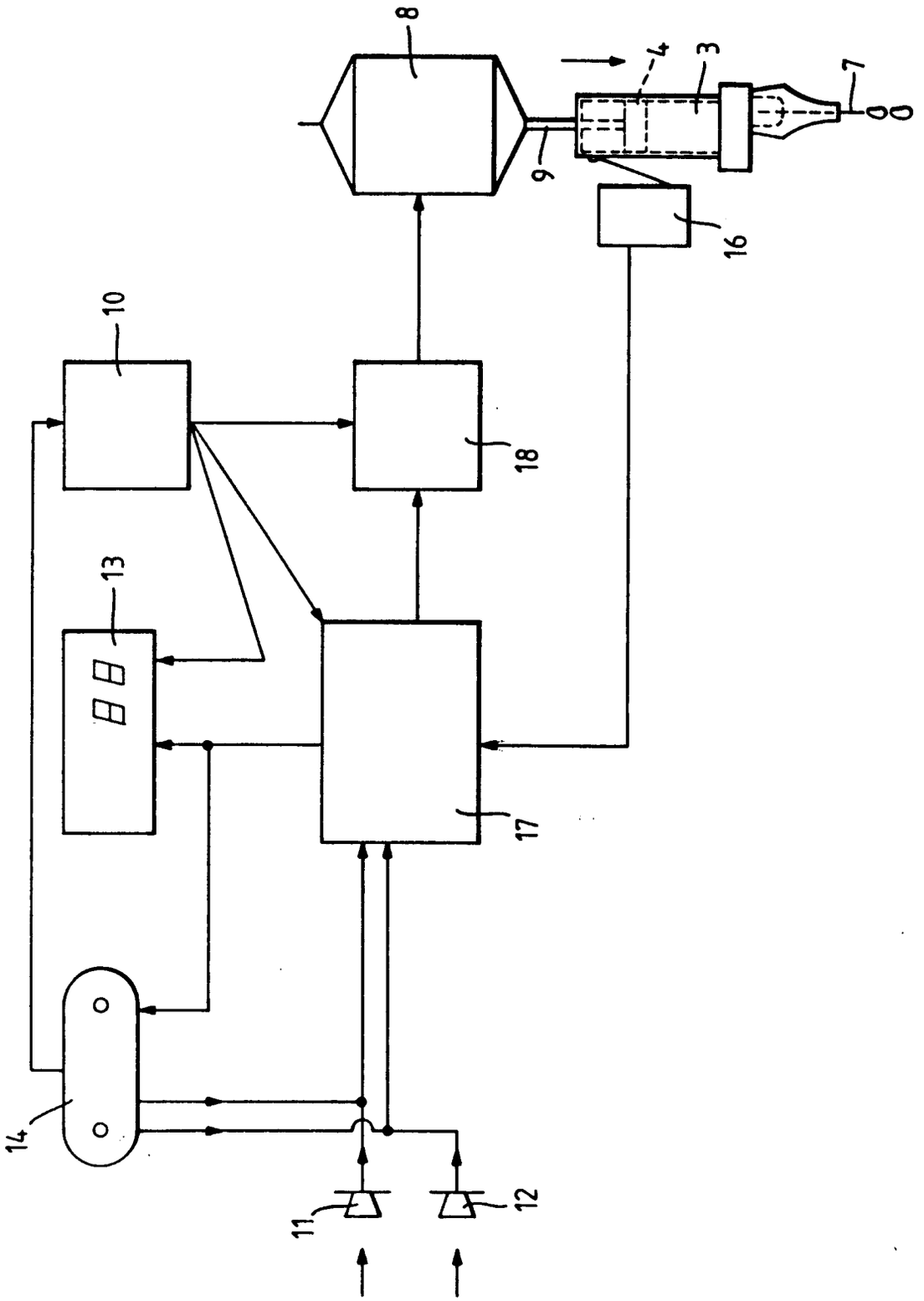

Fig. 3.

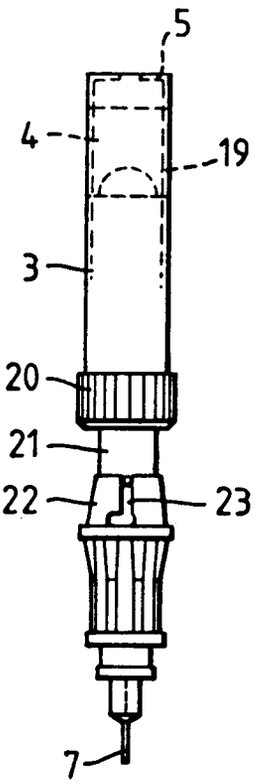

Fig. 4.