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(54) AUTOMATIC ANALYZER AND AUTOMATIC ANALYSIS METHOD

AUTOMATISIERTER ANALYSATOR UND AUTOMATISIERTES ANALYSEVERFAHREN

ANALYSEUR AUTOMATIQUE ET PROCÉDÉ D'ANALYSE AUTOMATIQUE

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Description

BACKGROUND

Technical Field

[0001] The present invention relates to automatic analyzers and automatic analysis methods.

Related Art

[0002] An automatic analyzer for analyzing biological components contained in a specimen such as blood or urine includes dispensing probes for respectively dispensing a specimen, a diluted specimen, and a reagent into a reaction container and a washing function for washing these dispensing probes.

[0003] Regarding the automatic analyzer with such a configuration, JP 08-194004 A discloses that "when the sample pipette 22 accesses the dilution container 11, the sampling pump 27 operates and sucks, for example, a diluted sample of 5 ul. When the sample pipette 22 accesses the reaction tube 51, the sampling pump 27 operates and discharges the diluted sample of 5 ul. As a result, the sample of 1 pl is injected into the reaction tube. The sample pipette 22 is washed in the washing pot 28. In the same manner as the case of a dilution pipette, the inside of the sample pipette 22 is washed by a high-pressure washing pump HWP and the outside of the sample pipette 22 is washed by a low-pressure washing pump LWP, and the washing liquids are discharged to a waste liquid tank".

[0004] JP2010019746A discloses an automatic analyzer in which a dilution rate is calculated to correct an analytical result by the calculated dilution rate.

SUMMARY

[0005] In the above-described automatic analyzer, by the way, the sample pipette is washed, whenever the diluted sample (specimen) is dispensed from the dilution container into the reaction tube. For this reason, as the number of dispensing times from one dilution container to the reaction tube increases, an amount of the washing liquid that is introduced into the dilution container from the washed sample pipette is increased, and the concentration of the diluted sample (specimen) in the dilution container is reduced.

[0006] However, the dispensing amount of a diluted sample (specimen) has a different value set for every measurement item, and the measurement items are also different for every specimen. Hence, after one time of dispensation is performed, the amount of the diluted sample (specimen) left in the dilution container is not constant, and the dilution ratio of the diluted sample (specimen) diluted with the washing liquid that has been introduced also takes a different value. Accordingly, in a case where the number of dispensing times from one dilution container is limited to a fixed number of times, even though the concentration of the specimen in the dilution container is sufficient, the diluted sample (specimen) is discarded in some cases.

[0007] Therefore, the present invention has an object to provide an automatic analyzer and an automatic analysis method, by which while analysis accuracy can be improved by using a specimen having a stable concentration, utilization efficiency of the specimen can be improved by minimizing a waste amount of the specimen.

[0008] To achieve such an object, according to the present invention, there are provided an automatic analyzer according to claim 1 and an automatic analysis method according to claim 6.

[0009] According to the present invention, there are provided an automatic analyzer and an automatic analysis method, by which while analysis accuracy can be improved by using a specimen having a stable concentration, utilization efficiency of the specimen can be improved by minimizing a waste amount of the specimen.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

FIG. 1 is a schematic configuration diagram showing an automatic analyzer according to an embodiment;
FIG. 2 is a block diagram showing the automatic analyzer according to an embodiment;
FIG. 3 is a diagram for indicating a configuration of a probe washing device provided in the automatic analyzer and washing of a diluted specimen probe, according to an embodiment; and
FIG. 4 is a flowchart showing an automatic analysis method using the automatic analyzer according to an embodiment.

DETAILED DESCRIPTION

<<Automatic analyzer>>

[0011] FIG. 1 is a schematic configuration diagram showing an automatic analyzer according to an embodiment. FIG. 1 is a schematic configuration diagram showing an automatic analyzer 1, in which the present invention is applied to a biochemical analyzer for analyzing biological components contained in a specimen such as blood or urine, as an example. As shown in the figure, the automatic analyzer 1 includes a measurement unit 1a and a controller 1b.

[0012] The measurement unit 1a includes, for example, a specimen holding unit 2, a diluted specimen holding unit 3, a first reagent holding unit 4, a second reagent holding unit 5, and a reaction container holding unit 6. The measurement unit 1a also includes a dilution mixing device 11, a dilution container washing device 12, a first reaction mixing device 13, a second reaction mixing device 14, an instrumentation unit 15, and a reaction container washing device 16.

[0013] The measurement unit 1a also includes a plurality of dispensing devices 20 and a probe washing device 30. The plurality of dispensing devices 20 are, for example, four dispensing devices including a specimen dispensing device 20a, a diluted specimen dispensing device 20b, a first reagent dispensing device 20c, and a second reagent dispensing device 20d. The dispensing devices 20 each have a dispensing probe 21.

[0014] FIG. 2 is a block diagram showing the automatic analyzer 1 according to an embodiment. As shown in this diagram, the controller 1b includes a display unit 51, an input unit 52, a storage unit 53, an arithmetic processing unit 54, and an input and output controller 55.

[0015] Hereinafter, the details of these component units will be described in the order of the measurement unit 1a and the controller 1b, based on FIGS. 1 and 2.

<<Measurement unit 1a>

[Specimen holding unit 2]

[0016] The specimen holding unit 2 holds a plurality of specimen containers P2, in each of which a specimen is stored. Such a specimen holding unit 2 has, for example, a turntable shape, and holds the plurality of specimen containers P2 in a plurality of rows along the periphery of the specimen holding unit 2, and conveys the specimen containers P2, which the specimen holding unit 2 holds, in both directions of the circumference. The specimen holding unit 2 is supported rotatably in the circumferential direction by a driving mechanism, not shown. In each specimen container P2, which is held by the specimen holding unit 2, a control specimen for accuracy management may be stored in addition to the specimen to be subject to measurement. The specimen holding unit 2 has a configuration in which such various specimens are respectively held at predetermined positions.

[0017] It is to be noted that in the specimen holding unit 2, in addition to the specimen container P2, a dilution liquid container in which a dilution liquid is stored or a washing container in which a washing liquid is stored may be held. Further, the above-described specimen holding unit 2 may have a function of cooling the specimen containers P2 and other containers, which the specimen holding unit 2 holds.

[Diluted specimen holding unit 3]

[0018] The diluted specimen holding unit 3 holds a diluted specimen container P3, in which a specimen that has been diluted (hereinafter, referred to as a "diluted specimen") is stored. Such a diluted specimen holding unit 3 has, for example, a turntable shape, and holds a plurality of diluted specimen containers P3 along the periphery of the diluted specimen holding unit 3, and conveys the diluted specimen containers P3, which the diluted specimen holding unit 3 holds, in both directions of the circumference. The diluted specimen holding unit 3 is supported rotatably in the circumferential direction by a driving mechanism, not shown.

[0019] The diluted specimen stored in the diluted specimen container P3 is obtained by dispensing the specimen that has been separated from the specimen container P2 disposed in the specimen holding unit 2 and that is diluted at a predetermined concentration. Hence, the diluted specimen container P3 serves as a specimen container for storing a specimen as well as a dispensed container into which a specimen is dispensed. In addition, the diluted specimen holding unit 3 for holding such diluted specimen containers P3 also serves as a specimen holding unit as well as a dispensed container holding unit.

[0020] It is to be noted that the diluted specimen holding unit 3 may hold a container in which a specimen that is not diluted is stored, together with the above-described diluted specimen container P3 in which the diluted specimen is stored. In this case, in the container, the specimen that has been separated from the specimen container P2 disposed in the specimen holding unit 2 is dispensed as it is without dilution. Further, the automatic analyzer 1 need not necessarily include the diluted specimen holding unit 3, but herein the description will be given of the configuration including the

diluted specimen holding unit 3.

[First reagent holding unit 4 and second reagent holding unit 5]

[0021] The first reagent holding unit 4 has, for example, a turntable shape, and holds a plurality of first reagent containers P4 along the periphery of the first reagent holding unit 4. In addition, the second reagent holding unit 5 has, for example, a turntable shape, and holds a plurality of second reagent containers P5 along the periphery of the second reagent holding unit 5. The first reagent holding unit 4 and the second reagent holding unit 5 respectively convey the first reagent containers P4 and the second reagent containers P5 in both directions of the circumferences. The first reagent holding unit 4 and the second reagent holding unit 5 are each supported rotatably in the circumferential direction by a driving mechanism, not shown. It is to be noted that the number of the reagent holding units provided in the automatic analyzer 1 is not limited to two of the first reagent holding unit 4 and the second reagent holding unit 5, and may be one or a plurality of more than two. In a case where one reagent holding unit is provided in the automatic analyzer 1, any one of the first reagent dispensing device 20c and the second reagent dispensing device 20d to be described later may be provided to correspond to such one reagent holding unit.

[Reaction container holding unit 6]

[0022] The reaction container holding unit 6 is one of the dispensed container holding units for holding dispensed containers into which a specimen is dispensed. Such a reaction container holding unit 6 is disposed among the diluted specimen holding unit 3, the first reagent holding unit 4, and the second reagent holding unit 5. The reaction container holding unit 6 has, for example, a turntable shape, and holds a plurality of reaction containers P6 (that is dispensed containers) along the periphery of reaction container holding unit 6, and conveys the reaction containers P6, which the reaction container holding unit 6 holds, in both directions of the circumference. The reaction container holding unit 6 is supported rotatably in the circumferential direction by a driving mechanism, not shown.

[0023] In the reaction container P6, which is held by the reaction container holding unit 6, a diluted specimen separated from the diluted specimen container P3 of the diluted specimen holding unit 3, a first reagent separated from the first reagent container P4 of the first reagent holding unit 4, and a second reagent separated from the second reagent container P5 of the second reagent holding unit 5 are respectively dispensed with predetermined amounts. Further, in the reaction container P6, the diluted specimen and at least one of the first reagent and the second reagent are mixed together and a reaction occurs.

[0024] The above-described reaction container holding unit 6 is configured to keep the temperature of the reaction container P6 constant using a thermostatic tank, not shown. It is to be noted that in a case where the automatic analyzer 1 does not include the diluted specimen holding unit 3, the specimen that has been separated from the specimen container P2 of the specimen holding unit 2 is dispensed into the reaction container P6, which is held by the reaction container holding unit 6.

[Dilution mixing device 11]

[0025] The dilution mixing device 11 is disposed at a circumference of the diluted specimen holding unit 3. The dilution mixing device 11 includes a mixing mechanism and a driving mechanism for driving the mixing mechanism. The dilution mixing device 11 mixes a specimen with a dilution liquid in the diluted specimen container P3, which is held by the diluted specimen holding unit 3, and adjusts a diluted specimen in which the specimen and the dilution liquid are mixed together.

[Dilution container washing device 12]

[0026] The dilution container washing device 12 is disposed at a circumference of the diluted specimen holding unit 3. The dilution container washing device 12 is a device for washing the diluted specimen container P3 after the diluted specimen is separated by the diluted specimen dispensing device 20b to be described later.

[First reaction mixing device 13 and second reaction mixing device 14]

[0027] The first reaction mixing device 13 and the second reaction mixing device 14 are each disposed at a circumference of the reaction container holding unit 6. The first reaction mixing device 13 mixes the diluted specimen with the first reagent so as to promote the reaction between the diluted specimen and the first reagent, and the second reaction mixing device 14 mixes the diluted specimen with the second reagent so as to promote the reaction between the diluted specimen and the second reagent, in the reaction container P6, which is held by the reaction container holding unit 6. The first reaction mixing device 13 and the second reaction mixing device 14 may have the same configuration as the

dilution mixing device 11.

[Instrumentation unit 15]

[0028] The instrumentation unit 15 is disposed to face the outer wall of the reaction container holding unit 6 at a circumference of the reaction container holding unit 6. The instrumentation unit 15 is a multi-wavelength photometer for performing optical measurements on the diluted specimen that has been reacted with the first reagent and the second reagent corresponding to an inspection item in the reaction container P6. The instrumentation unit 15 outputs various component amounts in the specimen as absorbances, and detects a reaction state of the diluted specimen.

[Reaction container washing device 16]

[0029] The reaction container washing device 16 is disposed at a circumference of the reaction container holding unit 6. The reaction container washing device 16 is a device for washing the inside of the reaction container P6 after the inspection is completed.

[Specimen dispensing device 20a]

[0030] The specimen dispensing device 20a is one of the dispensing devices 20, includes a specimen probe 21a as a capillary-shaped dispensing probe 21, and is disposed at a circumference of the specimen holding unit 2 and a circumference of the diluted specimen holding unit 3. The specimen dispensing device 20a inserts a leading end of the specimen probe 21a keeping an axial direction vertical into a specimen in the specimen container P2, which is held by the specimen holding unit 2, and sucks a predetermined amount of the specimen into the specimen probe 21a to separate the predetermined amount of the specimen from the specimen container P2, by means of a driving mechanism, not shown, in accordance with a preset measurement program. In this situation, the specimen holding unit 2 moves the specimen container P2, which is held at a predetermined position of the specimen holding unit 2, to a predetermined specimen dispensation position in accordance with a preset measurement program.

[0031] In addition, the specimen dispensing device 20a inserts the leading end of the specimen probe 21a into the diluted specimen container P3 of the diluted specimen holding unit 3, and discharges the specimen that has been sucked into the specimen probe 21a and a predetermined amount of dilution liquid (for example, physiological saline) supplied from the specimen dispensing device 20a itself into the diluted specimen container P3. In this situation, the diluted specimen holding unit 3 moves the diluted specimen container P3, which is held at a predetermined position of the diluted specimen holding unit 3, to a predetermined specimen discharge position in accordance with a preset measurement program. Accordingly, in the diluted specimen container P3, the specimen is diluted to a concentration of a predetermined multiple. Further, a probe washing device, not shown, washes the inner wall of the specimen probe 21a of the specimen dispensing device 20a. In such a case, the probe washing device, not shown, also washes the outer wall of the specimen probe 21a.

[0032] It is to be noted that in a case where the automatic analyzer 1 does not include the diluted specimen holding unit 3, the specimen dispensing device 20a inserts the leading end of the specimen probe 21a into the reaction container P6 of the reaction container holding unit 6. Then, the specimen that has been sucked into the specimen probe 21a is discharged into the reaction container P6.

[Diluted specimen dispensing device 20b]

[0033] The diluted specimen dispensing device 20b is one of the dispensing devices 20, includes a diluted specimen probe 21b as a capillary-shaped dispensing probe 21, and is disposed between the diluted specimen holding unit 3 and the reaction container holding unit 6. The diluted specimen dispensing device 20b inserts a leading end of the diluted specimen probe 21b into the diluted specimen container P3, which has been moved to a predetermined diluted specimen dispensation position of the diluted specimen holding unit 3, and sucks a predetermined amount of the diluted specimen from the leading end of the diluted specimen probe 21b, which is filled with system water, by means of a driving mechanism, not shown, in accordance with a preset measurement program. Further, the diluted specimen dispensing device 20b inserts the leading end of the diluted specimen probe 21b into the reaction container P6, which has been moved to a predetermined diluted specimen discharge position of the reaction container holding unit 6, and discharges the diluted specimen that has been sucked into the diluted specimen probe 21b into the reaction container P6. It is to be noted that in the case where the automatic analyzer 1 does not include the diluted specimen holding unit 3, the automatic analyzer 1 need not necessarily include the diluted specimen dispensing device 20b.

[First reagent dispensing device 20c and second reagent dispensing device 20d]

[0034] Referring to FIG. 1, the first reagent dispensing device 20c and the second reagent dispensing device 20d are each one of the dispensing devices 20 and each have the same configuration as the other dispensing devices. The first reagent dispensing device 20c is disposed between the reaction container holding unit 6 and the first reagent holding unit 4, and the second reagent dispensing device 20d is disposed between the reaction container holding unit 6 and the second reagent holding unit 5. The first reagent dispensing device 20c dispenses the first reagent from the first reagent container P4 of the first reagent holding unit 4 into the reaction container P6 in accordance with a preset measurement program. Further, the second reagent dispensing device 20d dispenses the second reagent from the second reagent container P5 of the second reagent holding unit 5 into the reaction container P6 in accordance with a preset measurement program.

[Probe washing device 30]

[0035] The probe washing device 30 is provided for washing the leading end of the dispensing probe 21 in each dispensing device 20, and is disposed on a track along which each dispensing probe 21 moves. FIG. 1 shows, as an example, a state where the probe washing device 30 is disposed on a track of the diluted specimen probe 21b between the diluted specimen holding unit 3 and the reaction container holding unit 6.

[0036] FIG. 3 is a diagram for indicating a configuration of the probe washing device 30 provided in the automatic analyzer according to an embodiment and washing of the diluted specimen probe 21b. As shown in this diagram, the probe washing device 30 includes a washing tank 31 and a washing liquid supply pipe 32 for supplying a washing liquid L to the washing tank 31. The washing tank 31 is equipped with a drainpipe, not shown here. In addition, the washing liquid supply pipe 32 discharges the washing liquid L at a predetermined timing by means of a driving mechanism, not shown.

[0037] The washing liquid L is typically water, and washing water is used.

[0038] The diluted specimen probe 21b is washed by such a probe washing device 30 repeatedly in the following order in every cycle of one time for dispensing the diluted specimen Sp via the diluted specimen probe 21b.

[0039] That is, in one dispensing cycle, the diluted specimen dispensing device 20b inserts the diluted specimen probe 21b into the diluted specimen container P3 of the diluted specimen holding unit 3 in accordance with a preset measurement program. Then, a predetermined amount of the diluted specimen Sp is sucked into the diluted specimen probe 21b to separate a predetermined amount of the specimen from the diluted specimen container P3. Next, the diluted specimen dispensing device 20b inserts the diluted specimen probe 21b into one reaction container P6 of the reaction container holding unit 6, and discharges the diluted specimen Sp, which has been sucked into the diluted specimen probe 21b, to dispense a predetermined amount of the diluted specimen Sp into the reaction container P6. Subsequently, the diluted specimen dispensing device 20b moves the leading end of the diluted specimen probe 21b into the washing tank 31. Then, the probe washing device 30 supplies the washing liquid L from the washing liquid supply pipe 32, and washes the outer wall of the diluted specimen probe 21b, which has been inserted into the washing tank 31, by means of a driving mechanism, not shown, in accordance with a preset measurement program. In this situation, the probe washing device 30 also washes the inner wall of the diluted specimen probe 21b of the diluted specimen dispensing device 20b.

[0040] One dispensing cycle is operated as described above. The diluted specimen dispensing device 20b inserts the diluted specimen probe 21b, the outer wall of which has been washed in the washing tank 31, into the diluted specimen container P3 of the diluted specimen holding unit 3 again. After that, the same operation is repeatedly carried out.

[0041] It is to be noted that the probe washing device 30 having the configuration as described above may use a specimen container P2, which is held by the specimen holding unit 2, or a diluted specimen container P3, which is held by the diluted specimen holding unit 3, as a washing tank 31. As an example, in the case where the probe washing device 30 is provided on the track of the diluted specimen probe 21b as described above, one of the diluted specimen containers P3 may serve as the washing tank 31 of the probe washing device 30.

<Controller 1b>

[0042] Referring to FIGS. 1 and 2, the controller 1b is connected with the driving mechanisms of the respective component units constituting the measurement unit 1a, and the instrumentation unit 15. Such a controller 1b includes the display unit 51, the input unit 52, the storage unit 53, the arithmetic processing unit 54, and the input and output controller 55, which are connected with one another. Among them, the arithmetic processing unit 54 and the input and output controller 55 are each configured with a computer such as a microcomputer. The computer includes a storage unit such as a Central Processing Unit (CPU), a Read Only Memory (ROM), and a Random Access Memory (RAM), and controls operations of the respective units in the automatic analyzer 1. Hereinafter, details of the respective component units of the controller 1b will be described.

[Display unit 51]

[0043] The display unit 51 displays measurement results of the instrumentation unit 15, and displays various setting information and various history information in the automatic analyzer 1.

[Input unit 52]

[0044] The input unit 52 receives inputs related to various settings and other inputs performed by an operator of the automatic analyzer 1, and outputs signals that have been input to the input and output controller 55. For the input unit 52, for example, a mouse, a keyboard, a touch panel provided on a display surface of the display unit 51, or the like is used. Also included is another case where the input unit 52 is, for example, a bar code reader for reading a bar code of the specimen container P2, which is held by the specimen holding unit 2.

[Storage unit 53]

[0045] The storage unit 53 is composed of, for example, a recording device having a large capacity, such as a Hard Disk Drive (HDD) or a semiconductor memory. Further, a part of the storage unit 53 may constitute the above computer. Various programs to be executed by the input and output controller 55 to be described next and various setting information for executing the programs are stored in the storage unit 53.

[0046] The setting information in the information stored in the storage unit 53 includes dispensing information related to each measurement item and dispensing information common to the measurement items. These pieces of information are stored in the storage unit 53 beforehand, or include information stored in the storage unit 53, based on an input from the input unit 52.

[0047] The dispensing information related to the measurement item includes information about a dilution condition of a diluted specimen used in an analysis process of each measurement item, a dispensing order between the measurement items, and a diluted specimen usage amount [Si] in the analysis process of each measurement item. These pieces of information are assumed to be stored in the storage unit 53 in association with each measurement item.

[0048] Further, the common dispensing information includes a washing liquid introduced amount [a], a dispensing loss amount [b], an initial amount [V_0], and a dilution ratio maximum value [Rmax], when a diluted specimen is dispensed from the diluted specimen container P3 into the reaction container P6. Among these, the washing liquid introduced amount [a] is an amount of the washing liquid L that is introduced from the probe washing device 30 into the diluted specimen container P3 via the diluted specimen probe 21b after one dispensing cycle. In addition, the dispensing loss amount [b] is an amount of a diluted specimen that needs to be separated additionally from the diluted specimen container P3 to the diluted specimen probe 21b in order to ensure dispensing accuracy via the diluted specimen probe 21b. Furthermore, the initial amount [V_0] is an initial amount of the diluted specimen stored in one diluted specimen container P3. Such an initial amount [V_0] may be information input from the input unit 52 when the analysis is started. Further, the dilution ratio maximum value [Rmax] is an upper limit value of the dilution ratio with respect to the initial concentration of the diluted specimen Sp in the diluted specimen container P3, and is an upper limit value of the dilution ratio of the diluted specimen Sp to be diluted with the washing liquid L.

[Arithmetic processing unit 54]

[0049] The arithmetic processing unit 54 sets a maximum number of times [imax] for dispensation from one diluted specimen container P3 to a plurality of reaction containers P6 for every specimen, based on the information input from the input unit 52 and the information stored in the storage unit 53. A procedure by the arithmetic processing unit 54 for setting the maximum number of times [imax] for dispensation will be described in detail in an automatic analysis method below.

[Input and output controller 55]

[0050] The input and output controller 55 controls operations of the driving mechanisms of the respective component units constituting the measurement unit 1a, based on signals from the input unit 52, the storage unit 53, and the arithmetic processing unit 54, and performs an analysis process of the specimen contained in the specimen container P2 of the specimen holding unit 2.

<<Automatic analysis method>>

[0051] FIG. 4 is a flowchart showing an automatic analysis method using the automatic analyzer 1 according to an

embodiment. Hereinafter, the automatic analysis method using the automatic analyzer 1 according to an embodiment will be described in the order shown in the flowchart of FIG. 4 with reference to FIGS. 1 and 2 as shown above. The automatic analysis method to be described with reference to these figures is a procedure applied as a process to be performed before a specimen in a diluted specimen container P3 is dispensed into a reaction container P6.

[0052] This procedure is carried out as follows by the CPU, which constitutes the arithmetic processing unit 54 and the input and output controller 55, which have been described with reference to FIG. 2, performing a program stored in the storage unit 53.

<Step S001>

[0053] In step S001, the input and output controller 55 determines whether specimen information has been input from the input unit 52, and waits until determining that the specimen information has been input (YES). Here, the specimen information is information related to the specimen in the specimen container P2, which is held by the specimen holding unit 2, and includes ID information of the specimen and measurement items set for the specimen. In addition, the specimen information may also include an initial amount [V_0] of the diluted specimen stored in one diluted specimen container P3. Such specimen information may be, for example, bar code information attached to the specimen container P2, and may be information that has been read by a bar code reader as the input unit 52. When it is determined that such specimen information has been input (YES), the arithmetic processing unit 54 proceeds to the next step S002.

<Step S002>

[0054] In step S002, the input and output controller 55 acquires the dispensing information related to measurement items of an identical dilution condition for a specimen in one specimen container P2, which is held at a specific position of the specimen holding unit 2, based on the specimen information input in step S001.

[0055] That is, in the automatic analyzer 1, the specimen information about the specimen in one specimen container P2 has been input from the input unit 52, and then an automatic analysis flow for the specimen starts. In this case, the analysis process of a plurality of measurement items starts, based on the specimen information that has been input from the input unit 52 for the specimen in one specimen container P2.

[0056] Then, the input and output controller 55 first makes a group of the measurement items set for the specimen in one target specimen container P2 for each identical dilution condition, based on the specimen information that has been input from the input unit 52 and the dispensing information stored in the storage unit 53. Next, the input and output controller 55 acquires the dispensing information related to each measurement item from the storage unit 53 for each group having the identical dilution condition. The dispensing information related to the measurement item acquired here includes an [i]-th time dispensation, which represents a dispensing order among the measurement items, and a diluted specimen usage amount [Si] for each measurement item in the analysis process, as shown in Table 1 below. It is to be noted that the [i]-th time dispensation is applied to each measurement item set for the specimen in one target specimen container P2, based on the dispensing order among the measurement items stored in the storage unit 53.

[Table 1]

Dispensing information		
Measurement item	Dispensing time [i]	Diluted specimen usage amount [S_i] (μl)
1 TP	1	7.5
2 ALB	2	8
3 LD	3	10
4 AST	4	6.3
5 ALT	5	15
6 ALP	6	4.2
7 LAP	7	7.5
8 ChE	8	9
9 AMY	9	4.7
10 BUN	10	2.4
11 TC	11	4.5

(continued)

Dispensing information		
Measurement item	Dispensing time [i]	Diluted specimen usage amount [S_i] (μl)
12 NH3	12	3.6
13 Ca	13	6.1
14 Fe	14	5
15 UA	15	3.2

[0057] It is to be noted that in Table 1, item numbers are respectively applied to the measurement items of the group having the identical dilution condition. Here, only the dispensing information for one group having the identical dilution condition is shown, but the dispensing information is acquired in the same manner for another group having an identical dilution condition. Additionally, in the next step S003 and later, the same processes are performed in parallel for the respective groups, or the process is sequentially performed for each group.

<Step S003>

[0058] In step S003, the input and output controller 55 performs a process for setting a dilution container number [N] to [N] = 1. In addition, the number of measurement items [M] is set to the total number of measurement items acquired in step S002. Here, the number of measurement items [M] = 15 is set, based on Table 1 above.

<Step S004>

[0059] In step S004, the arithmetic processing unit 54 sets the maximum number of times [imax] for dispensation from one diluted specimen container P3. In this situation, the arithmetic processing unit 54 sets the maximum number of times [imax] for dispensation from one diluted specimen container P3 as follows, based on the dispensing information related to the measurement item acquired in step S002 and the common dispensing information stored in the storage unit 53. It is to be noted that the dispensing information related to the measurement item includes [i]-th time dispensation, which represents the dispensing order among the measurement items, and the diluted specimen usage amount [Si] for each measurement item in the analysis process, as described above. In addition, the common dispensing information includes the washing liquid introduced amount [a], the dispensing loss amount [b], the initial amount [V_0], and the dilution ratio maximum value [Rmax], when the diluted specimen is dispensed from the diluted specimen container P3 into the reaction container P6, as described above.

[0060] First, the arithmetic processing unit 54 calculates a diluted specimen residual liquid amount [V_i] left in the diluted specimen container P3 and a diluted specimen concentration [Ci], as shown by Equations (1) to (6) below, for every [i]-th time dispensation, that is, after the dispensing cycle of an [i]-th time dispensation ends. The diluted specimen concentration [Ci] is a concentration of the specimen in the diluted specimen container P3, which has been diluted by introducing the washing liquid L adhered to the leading end of the diluted specimen probe 21b in the probe washing device 30 into the diluted specimen container P3.

[Expression 1]

When dispensing time [i] = 1

$$\text{Diluted specimen residual liquid amount } [V_1] = [V_0]+[a]-[b]-[S_1] \quad \cdots \text{Equation(1)}$$

$$\text{Diluted specimen concentration } [C_1] = \frac{[V_0]}{[V_0]+[a]} \times 100 \quad \cdots \text{Equation(2)}$$

Washing liquid introduced amount	[a]
Dispensing loss amount	[b]
Initial amount	[V_0]
Dispensing time	[i]

(continued)

Diluted specimen usage amount ([i]-th time) $[S_i]$

[Expression 2]

When dispensing time [i] = 2

Diluted specimen residual liquid amount $[V_2] = [V_1]+[a]-[b]-[S_2]$ ···Equation(3)

Diluted specimen concentration $[C_2] = \frac{[V_1]\times[C_1]}{[V_1]+[a]} \times 100$ ···Equation(4)

[Expression 3]

When dispensing time [i]

Diluted specimen residual liquid amount $[V_i] = [V_{i-1}]+[a]-[b]-[S_i]$ ···Equation(5)

Diluted specimen concentration $[C_i] = \frac{[V_{i-1}]\times[C_{i-1}]}{[V_{i-1}]+[a]} \times 100$ ···Equation(6)

[0061] Then, the maximum number of times [imax] is set, based on the diluted specimen concentration $[C_i]$, which has been calculated as described above. In this case, for example, the initial diluted specimen concentration $[C_0]$ before the dispensation is performed is set to 100%. A value obtained by subtracting the diluted specimen concentration [Ci] from the initial diluted specimen concentration $[C_0]$ ($[C_0]$ - [Ci]) is calculated as a dilution ratio $[R_i]$ of the diluted specimen Sp after the dispensing cycle of an [i]-th time dispensation ends. The dilution ratio $[R_i]$ calculated here becomes a dilution ratio $[R_i]$ of the diluted specimen Sp in the diluted specimen container P3 immediately before the dispensing cycle of the next dispensing time [i + 1] starts.

[0062] Table 2 below shows the dilution ratio $[R_i]$ of the diluted specimen Sp, which has been calculated as described above for the dilution container number [N] = 1, together with the diluted specimen residual liquid amount $[V_i]$ and the diluted specimen concentration $[C_i]$.

[Table 2]

Table for calculation of diluted specimen concentration / dilution ratio ([N]=1)

Item	Dispensing time [i]	Diluted specimen usage amount [S_i] (μl)	After [i]-th time		
			Diluted specimen residual liquid amount [V_i] (μl)	Diluted specimen concentration [C_i]	Dilution ratio [R_i]
–	0	–	150 ([V_0])	100.00%	0.00%
1 TP	1	7.5	139.6	99.93%	0.07%
2 ALB	2	8	128.7	99.86%	0.14%
3 LD	3	10	115.8	99.78%	0.22%
4 AST	4	6.3	106.6	99.70%	0.30%
5 ALT	5	15	88.7	99.60%	0.40%
6 ALP	6	4.2	81.6	99.49%	0.51%
7 LAP	7	7.5	71.2	99.37%	0.63%
8 ChE	8	9	59.3	99.23%	0.77%
9 AMY	9	4.7	51.7	99.06%	0.94%
10 BUN	10	2.4	46.4	98.87%	1.13%
11 TC	11	4.5	39	98.66%	1.34%
12 NH3	12	3.6	32.5	98.41%	1.59%
13 Ca	13	6.1	23.5	98.11%	1.89%
14 Fe	14	5	15.6	97.69%	2.31%
15 UA	15	3.2	9.5	97.07%	2.93%

Washing liquid introduced amount[a]=0.1 μl

Dispensing loss amount[b]=3.0 μl

Initial amount[V_0]=150 μl

Dilution ratio maximum value[Rmax]=1.5%

[0063] Then, the arithmetic processing unit 54 sets an [i]-th time dispensation, in which the calculated dilution ratio [R_i] exceeds the dilution ratio maximum value [Rmax] stored in the storage unit 53, as the maximum number of times [imax] for dispensation. In the example shown in Table 2 above, in the [i]-th time dispensation, in which the calculated dilution ratio [R_i] exceeds the preset dilution ratio maximum value [Rmax], [i] = 12 to 15. Hence, the dispensing time [i] = 12, which is the smallest number of the dispensing times exceeding the preset dilution ratio maximum value [Rmax], is set as a maximum number of times [imax] for dispensation.

[0064] In addition, in a case where the dilution ratio [R_i], which has been calculated at the last [i]-th time dispensation, does not exceed the dilution ratio maximum value [Rmax], the arithmetic processing unit 54 sets a number larger than the measurement item number [M] set in step S003, for example, the number of measurement items [M] + 1 to the maximum number of times [imax].

[0065] It is to be noted that the maximum number of times [imax] may be set by comparing the diluted specimen concentration [Ci] with a lower limit value of the diluted specimen concentration. In this case, the lower limit value of the diluted specimen concentration is stored in the storage unit 53. Then, from among the dispensing times [i] in which the calculated diluted specimen concentration [Ci] is less than the lower limit value (for example, 98.5%, here) of the diluted specimen concentration stored in the storage unit 53, the minimum number of the dispensing times is set as the maximum number of times [imax] for dispensation.

<Step S005>

[0066] In step S005, the input and output controller 55 compares the number of measurement items [M] with the maximum number of times [imax] calculated by the arithmetic processing unit 54, and determines whether the number of measurement items [M] is larger than the maximum number of times [imax]. When determining that the number of measurement items [M] is larger than the maximum number of times [imax] (YES), the input and output controller 55

proceeds to the next step S006. On the other hand, when determining that the number of measurement items [M] is not larger than the maximum number of times [imax] (NO), the input and output controller 55 proceeds to step S009.

[0067] In the example shown in Table 2 above, the number of measurement items [M] = 15 and the maximum number of times [imax] = 12. Hence, it is determined that the number of measurement items [M] is larger than the maximum number of times [imax] (YES), and the flow proceeds to the next step S006.

<Step S006>

[0068] In step S006, the input and output controller 55 creates a dispensing item list including the number of items from the dispensing time [i] = 1 to the maximum number of times [imax] (for example, [imax] = 12) for the dilution container number [N] (for example, [N] = 1). Table 3 below shows the dispensing item list for the dilution container number [N] = 1, which has been created in such a manner.

[Table 3]

Dispensing item list for [N] = 1		
Item	Dispensing time [i]	Diluted specimen usage amount [S_i] (μl)
1 TP	1	7.5
2 ALB	2	8
3 LD	3	10
4 AST	4	6.3
5 ALT	5	15
6 ALP	6	4.2
7 LAP	7	7.5
8 ChE	8	9
9 AMY	9	4.7
10 BUN	10	2.4
11 TC	11	4.5
12 NH3	12	3.6

[0069] It is to be noted that after the dispensing item list is created, a specimen and a dilution liquid may be discharged from the specimen container P2 into one diluted specimen container P3 (for example, [N] = 1), based on the dispensing item list created in step S006, so as to adjust the diluted specimen having an amount corresponding to the initial amount [V_0], and the dispensation of the diluted specimen may be started from the above-described diluted specimen container P3 to each reaction container P6. In this case, it is assumed that the above-described one diluted specimen container P3 contains the diluted specimen Sp, which is diluted on a corresponding dilution condition. Further, such adjustment of the diluted specimen and the operation of dispensing the diluted specimen that has been adjusted may be performed after a series of processes shown in the flowchart ends.

<Step S007>

[0070] In step S007, the input and output controller 55 performs a process of setting the number of measurement items [M] to [M] = [M] - [imax]. In addition, the input and output controller 55 performs a process of setting the dilution container number [N] to [N] = [N] + 1.

<Step S008>

[0071] In step S008, the input and output controller 55 reorganizes the dispensing information. In this situation, the input and output controller 55 excludes the dispensing information in the dispensing item list created in step S006 from the current dispensing information shown in Table 1 above, and obtains new dispensing information by reapplying an [i]-th time dispensation, which represents a dispensing order among the measurement items, as shown in Table 4 below.

[Table 4]

Dispensing information (reorganization)		
Item	Dispensing time [i]	Diluted specimen usage amount [S_i] (μl)
13 Ca	1	6.1
14 Fe	2	5
15 UA	3	3.2

[0072] After that, the flow returns to step S004, and the following steps are repeatedly performed.

<Step S009>

[0073] Step S009 is proceeded from step S005, because the number of measurement items [M] is not larger than the maximum number of times [imax] (NO), that is, it is determined that the number of measurement items [M] is equal to or less than the maximum number of times [imax]. In this step S009, the input and output controller 55 creates a dispensing item list of all item numbers [M] starting from the dispensing time [i] = 1, for the dilution container number [N].

[0074] In step S004 performed before step S009, here, the maximum number of times for dispensation is set as described above.

[0075] As an example, a case where the dispensing information of Table 4 above is obtained at the time of step S004 will be described. In this case, in step S004, the arithmetic processing unit 54 first calculates the diluted specimen residual liquid amount [V_i], the diluted specimen concentration [C_i], and the dilution ratio [R_i] of the diluted specimen Sp from the dispensing information in Table 4 above. Table 5 below shows the dilution ratio [R_i] of the diluted specimen Sp that has been calculated as described above for the dilution container number [N] = 2, together with the diluted specimen residual liquid amount [V_i] and the diluted specimen concentration [C_i].

[Table 5]

Table for calculation of diluted specimen concentration / dilution ratio ([N]=2)					
Item	Dispensing time [i]	Diluted specimen usage amount [S_i] (μl)	After [i]-th time		
			Diluted specimen residual liquid amount [V_i] (μl)	Diluted specimen concentration [C_i]	Dilution ratio [R_i]
-	-	-	150 ([V_0])	100.00%	0.00%
13 Ca	1	6.1	141	99.93%	0.07%
14 Fe	2	5	133.1	99.85%	0.15%
15 UA	3	3.2	127	99.77%	0.23%
Washing liquid introduced amount [a] =0.1 μl Dispensing loss amount [b]=3.0 μl Initial amount [V_0]=150 μl Dilution ratio maximum value [Rmax]=1.5%					

[0076] Next, the arithmetic processing unit 54 calculates the [i]-th time dispensation, in which the calculated dilution ratio [R_i] exceeds the dilution ratio maximum value [Rmax] stored in the storage unit 53, as the maximum number of times [imax] for dispensation. In this situation, the dilution ratio [R_i], which has been calculated at the last [i]-th time dispensation, does not exceed the dilution ratio maximum value [Rmax]. Therefore, in step S004, a larger number than the number of measurement items [M] (here, [M] = 3), for example, the number of measurement items [M] + 1 is set to the maximum number of times [imax] (here, [imax] = 4).

[0077] Accordingly, in step S005 performed before the current step S009, the number of measurement items [M] (= 3) is not larger than the maximum number of times [imax] (= 4) (NO). That is, it is determined that the number of measurement items [M] is equal to or less than the maximum number of times [imax].

[0078] Then, in the current step S009, the input and output controller 55 creates a dispensing item list of all item numbers [M] starting from the dispensing time [i] = 1, for the dilution container number [N] (for example, [N] = 2). Table 6 below shows the dispensing item list for the dilution container number [N] = 2, which has been created in such a manner.

[Table 6]

Dispensing item list for [N] = 2		
Item	Dispensing time [i]	Diluted specimen usage amount [S_i] (μl)
13 Ca	1	6.1
14 Fe	2	5
15 UA	3	3.2

[0079] After step S009, a series of processes is ended. It is to be noted that after the dispensing item list is created, a specimen and a dilution liquid may be discharged from the specimen container P2 into one diluted specimen container P3 (for example, [N] = 2), based on the dispensing item list created in step S009, so as to adjust the diluted specimen having an amount corresponding to the initial amount [V_0], and the dispensation of the diluted specimen may be started from the above-described diluted specimen container P3 into each reaction container P6. The above-described one diluted specimen container P3 in this case contains the diluted specimen Sp, which is diluted on a corresponding dilution condition, and is another diluted specimen container P3 (for example, [N] = 2), which is different from the diluted specimen container P3 used in the dispensation based on the dispensing item list created in step S006. Further, such adjustment of the diluted specimen and the operation of dispensing the diluted specimen that has been adjusted may be performed after a series of processes shown in the flowchart ends.

<<Effects of embodiments>>

[0080] In the automatic analyzer 1 and the automatic analysis method according to embodiments described above, the maximum number of times [imax] for dispensation from the diluted specimen container P3 is set for every specimen, based on the concentration of the diluted specimen Sp in the case where the washing liquid L adhered to the leading end of the diluted specimen probe 21b is introduced into the diluted specimen container P3 in every dispensing cycle. Therefore, even in a case where analyses are performed on a plurality of measurement items respectively having different diluted specimen usage amounts [Si], analysis accuracy can be improved by performing an analysis using a diluted specimen having a stable concentration, and in addition, utilization efficiency of the specimen can be improved by minimizing a waste amount of the specimen.

<<Variations>>

[0081] Next, variations of the automatic analyzer and the automatic analysis method will be described.

[0082] An automatic analyzer according to a variation is different from the automatic analyzer 1, which has been described above with reference to FIGS. 1 to 3, in setting information stored in the storage unit 53 of the controller 1b. In addition, an automatic analyzer according to the variation is different from the automatic analyzer 1, which has been described above with reference to FIGS. 1 to 3, in a procedure of step S004' in the flowchart of FIG. 4, from among programs of an automatic analysis method performed by the arithmetic processing unit 54 and the input and output controller 55. Since other component units are the same as those of the automatic analyzer 1 and the automatic analysis method that have been described above, hereinafter only the differences will be described.

<Controller 1b>

[Storage unit 53]

[0083] In the storage unit 53 of the automatic analyzer 1, dispensing information related to each measurement item and a maximum number of times [imax] derivation information for dispensation are stored as setting information. These pieces of information are stored in the storage unit 53 beforehand, or include information stored in the storage unit 53, based on an input from the input unit 52.

[0084] The dispensing information related to the measurement item is the same as the information described above, and includes information about a dilution condition of a diluted specimen used in an analysis process of each measurement item, an [i]-th time dispensation, which represents a dispensing order among the measurement items, and a diluted

specimen usage amount [Si] in the analysis process of each measurement item. These pieces of information are assumed to be stored in the storage unit 53 in association with each measurement item.

[0085] Further, the maximum number of times [imax] derivation information for dispensation is information for deriving the maximum number of times [imax] for dispensation from one diluted specimen container P3 to the reaction container P6. Table 7 below shows an example of the maximum number of times [imax] derivation information.

[Table 7]

[imax]	Average value of diluted specimen usage amounts [S_{av}] (μl) including dispensing loss amount [b]=3.0(μl)																							
Initial amount [V_0] (μl)	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
50	7	6	6	6	5	5	5	5	5	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3
100	12	12	11	10	10	9	9	8	8	8	7	7	7	6	6	6	6	6	6	5	5	5	5	5
150	18	17	16	15	14	13	13	12	11	11	10	10	10	9	9	8	8	8	8	7	7	7	7	7
200	24	22	21	20	19	18	17	16	16	15	14	14	13	13	12	12	11	11	11	10	10	10	9	8
250	29	27	25	24	23	21	20	19	18	17	17	16	15	15	14	13	13	12	12	12	11	11	11	10
300	35	33	31	29	27	26	24	23	22	21	20	19	18	17	17	16	15	15	14	14	13	13	12	12

Washing liquid introduced amount [a]=0.1 μl

Dispensing loss amount [b]=3.0 μl

[0086] As shown in FIG. 7, the maximum number of times [imax] derivation information is information for deriving the maximum number of times [imax], based on, for example, an initial amount [V_0] of the diluted specimen Sp contained in the diluted specimen container P3 and an average value [Sav] of the diluted specimen usage amounts, and is created

as follows.

[0087] First, an approximate value [Cai] of the diluted specimen concentration is calculated, based on Equation (7) below, after the dispensing cycle of an [i]-th time dispensation ends.

[Expression 4]

When dispensing time [i] = 1

$$\text{Approximate value of diluted specimen concentration } [Ca_i] = \frac{[C_{i-1}] \times ([V_0] - (i-1) \times ([S_{av}] + [b]))}{[V_0] - (i-1) \times ([S_{av}] + [b]) + [a]} \quad \cdots \text{Equation (7)}$$

Washing liquid introduced amount	[a]
Dispensing loss amount	[b]
Initial amount	$[V_0]$
Dispensing time	[i]
Average value of diluted specimen usage amounts	$[S_{av}] = \Sigma[S_i]/[M]$
The number of measurement items	[M]

[0088] It is to be noted that the washing liquid introduced amount [a] is an amount of the washing liquid L that is introduced from the probe washing device 30 to the diluted specimen container P3 via the diluted specimen probe 21b after one dispensing cycle. The washing liquid introduced amount [a] takes a fixed value. The dispensing loss amount [b] is an amount of a diluted specimen, which needs to be separated additionally from the diluted specimen container P3 to the diluted specimen probe 21b in order to ensure dispensing accuracy via the diluted specimen probe 21b. The dispensing loss amount [b] takes a fixed value. The initial amount $[V_0]$ is an initial amount of the diluted specimen stored in one diluted specimen container P3, and takes a variable. The [i]-th time dispensation is a dispensing order among measurement items. The average value [Sav] of the diluted specimen usage amounts is an amount based on the average value of the diluted specimen usage amounts [Si] in the number of measurement items [M], and takes a variable.

[0089] Here, on each condition in which the initial amount $[V_0]$ and the average value [Sav] of the diluted specimen usage amounts are varied, the approximate value [Cai] of the diluted specimen concentration is calculated, based on Equation (7) above with the [i]-th time dispensation as a parameter.

[0090] Then, the maximum number of times [imax] is set, based on the approximate value [Cai] of the diluted specimen concentration that has been calculated as described above. In this case, the initial diluted specimen concentration $[C_0]$ is set to 100%, and a value obtained by subtracting the approximate value [Cai] of the diluted specimen concentration from the initial diluted specimen concentration $[C_0]$ ($[C_0] - [Ca_i]$), is calculated as a dilution ratio $[R_i]$ of the diluted specimen Sp after the dispensing cycle of each of the [i]-th time dispensation ends. Then, regarding the case where the initial amount $[V_0]$ and the average value [Sav] of the diluted specimen usage amounts satisfy the respective conditions, the [i]-th time dispensation, in which the calculated dilution ratio $[R_i]$ exceeds the dilution ratio maximum value [Rmax] stored in the storage unit 53, is calculated as the maximum number of times [imax] for dispensation corresponding to the respective conditions, and Table 7 above is obtained.

[0091] It is to be noted that the maximum number of times [imax] may be set by comparing the approximate value [Cai] of the diluted specimen concentration with a lower limit value of the diluted specimen concentration. In this case, the lower limit value of the diluted specimen concentration is stored in the storage unit 53. Then, from among the dispensing times [i] in which the calculated approximate value [Cai] of the diluted specimen concentration is less than the lower limit value (for example, 98.5%, here) of the diluted specimen concentration stored in the storage unit 53, the minimum number of the dispensing times is set as the maximum number of times [imax] for dispensation, and Table 7 above is obtained.

<Step S004'>

[0092] In step S004', the arithmetic processing unit 54 calculates the maximum number of times [imax] for dispensation from one diluted specimen container P3, as follows.

[0093] That is, the arithmetic processing unit 54 calculates the maximum number of times [imax], based on the dispensing information related to the measurement item, the initial amount $[V_0]$ of the diluted specimen Sp contained in the diluted specimen container P3, and the maximum number of times [imax] derivation information shown in Table 7 above. The dispensing information related to the measurement item is the information acquired in step S002, and an average

value [Sav] of the diluted specimen usage amounts is calculated from the dispensing information. The average value [Sav] of the diluted specimen usage amounts calculated here takes a value (for example, [Sav] = 9.47 pl), which is obtained by adding a dispensing loss amount [b] (for example, [b] = 3 ul) to an average value (= 6.47 μl) of the diluted specimen usage amounts [Si] in the dispensing information shown in Table 1.

[0094] Then, the calculated average value [Sav] (= 9.47 μl) of the diluted specimen usage amounts and the initial amount [V_0] (for example, [V_0] = 150 ul) are collated with the maximum number of times [imax] derivation information shown in Table 7 to derive the maximum number of times [imax] (= 13).

[0095] Regarding the later steps, it is sufficient if the later steps are carried out in the same manner as described with reference to the flowchart of FIG. 4.

<<Effects of variations>>

[0096] Also in the configuration according to a variation that has been described above, the maximum number of times [imax] for dispensation from the diluted specimen container P3 is set for every specimen, based on an approximate value of the concentration of the diluted specimen Sp in the case where the washing liquid L adhered to the leading end of the diluted specimen probe 21b is introduced into the diluted specimen container P3 in every dispensing cycle. Therefore, in the same manner as the embodiments described above, while the analysis accuracy can be improved, utilization efficiency of the specimen can be improved. Furthermore, since the maximum number of times [imax] derivation information shown in Table 7 above is prepared beforehand, a calculation process for setting the maximum number of times [imax] is facilitated. Consequently, the setting of the maximum number of times [imax] can be accelerated, and the analysis process can be accelerated, accordingly.

[0097] It is to be noted that in the embodiments including the variations described above, the case where the present invention is applied to the dispensation from the diluted specimen container P3 to the reaction container P6 has been described. The present invention, however, is applicable to dispensing from the specimen container P2 to the diluted specimen container P3 or dispensing from the specimen container P2 to the reaction container P6, and the same effects are obtainable, when applied. In addition, the specimen holding unit 2 may be a specimen rack conveying device for conveying a specimen rack that stores a plurality of specimen containers, and the specimen container P2 may be a specimen container conveyed by the specimen rack conveying device.

Description of Symbols

[0098]

1 automatic analyzer
1b controller
2 specimen holding unit
3 diluted specimen holding unit (specimen holding unit, dispensed container holding unit)
6 reaction container holding unit (dispensed container holding unit)
21 dispensing probe
21b diluted specimen probe (dispensing probe)
30 probe washing device
54 arithmetic processing unit
L washing liquid
P2 specimen container
P3 diluted specimen container (specimen container, dispensed container)
P6 reaction container (dispensed container)
Sp diluted specimen (specimen)
[a] washing liquid introduced amount
[Ci] diluted specimen concentration (concentration)
[i] dispensing time (dispensing order)
[imax] maximum number of times
[Sav] average value of diluted specimen usage amounts (average value of specimen usage amounts)
[Si] diluted specimen usage amount (specimen usage amount)
[V_0] initial amount

Claims

1. An automatic analyzer (1) comprising:

a specimen holding unit (2) configured to hold a specimen container in which a specimen is stored;
a dispensed container holding unit (3) configured to hold a plurality of dispensed containers;
a dispensing probe (21) configured to separate a predetermined amount of the specimen from the specimen container, and configured to dispense the specimen that has been separated into the dispensed container;
a probe washing device (30) configured to wash a leading end of the dispensing probe (21) in a washing liquid, after the specimen is dispensed into the dispensed container and before a next predetermined amount of the specimen is separated from the specimen container; and
a controller (1b) configured to control driving of the dispensing probe (21),

characterized in that:
the controller (1b) comprises an arithmetic processing unit (54) configured to:

calculate, for the specimen, based on an initial amount of the specimen stored in the specimen container, specimen usage amounts of a plurality of measurement items set for the specimen, and a washing liquid introduced amount into the specimen container, a concentration of the specimen in the specimen container, the specimen being subject to dilution with the washing liquid adhered to the leading end of the dispensing probe (21) in the probe washing device (30); and
set a minimum number of times for dispensation, in which the concentration that has been calculated is lower than a preset concentration, as a maximum number of times for dispensing the specimen from the specimen container into the dispensed container.

2. The automatic analyzer (1) according to claim 1, further comprising

a storage unit (53) configured to store beforehand table information of the maximum number of times for dispensation that is set based on an approximate value of a specimen concentration in the specimen container calculated on each condition in which an initial amount of the specimen stored in the specimen container and an average value of specimen usage amounts for a plurality of measurement items set for the specimen are varied,
wherein
the arithmetic processing unit (54) calculates an average value of the specimen usage amounts of the plurality of measurement items set for the specimen, and sets the maximum number of times for dispensation, based on the average value of the specimen usage amounts that has been calculated, the initial amount of the specimen stored in the specimen container, and the table information of the maximum number of times for dispensation.

3. The automatic analyzer (1) according to any one of claim 1 to claim 2, wherein
the dispensing probe (21) dispenses the specimen from the specimen container into the dispensed container in accordance with a dispensing order between the plurality of measurement items set for the specimen.

4. The automatic analyzer (1) according to claim 3, wherein

the controller (1b) causes the specimen holding unit to hold a plurality of the specimen containers each storing the specimen, in a case where the number of the plurality of measurement items set for the specimen is greater than the maximum number of times that has been set by the arithmetic processing unit (54), and
the arithmetic processing unit (54) sets the maximum number of times for dispensing the specimen successively from the plurality of the specimen containers.

5. The automatic analyzer (1) according to any one of claim 1 to claim 4, wherein

the specimen container serves as a diluted specimen container in which the specimen diluted at a predetermined concentration is stored, and
the dispensed container serves as a reaction container into which the specimen and a reagent are dispensed.

6. An automatic analysis method, by an automatic analyzer (1) comprising:

a specimen holding unit (2) configured to hold a specimen container in which a specimen is stored;
a dispensed container holding unit (3) configured to hold a plurality of dispensed containers;
a dispensing probe (21) configured to separate a predetermined amount of the specimen from the specimen container, and configured to dispense the specimen that has been separated into the dispensed container;
a probe washing device (30) configured to wash a leading end of the dispensing probe (21) in a washing liquid, after the specimen is dispensed into the dispensed container and before a next predetermined amount of the specimen is separated from the specimen container; and
a controller (1b) configured to control driving of the dispensing probe (21),

characterized in that the automatic analysis method comprises:

calculating, for the specimen, a concentration of the specimen in the specimen container, the specimen being subject to dilution with the washing liquid adhered to the leading end of the dispensing probe (21) in the probe washing device (30), the calculating being based on an initial amount of the specimen stored in the specimen container, specimen usage amounts of a plurality of measurement items set for the specimen, and a washing liquid introduced amount into the specimen container, and
setting (S004) a maximum number of times for dispensing the specimen from the specimen container into the dispensed container, based on a minimum number of times for dispensation, in which the concentration that has been calculated is lower than a preset concentration.

Patentansprüche

1. Automatisches Analysegerät (1) mit:

einer Probenhalteeinheit (2), die konfiguriert ist, um einen Probenbehälter zu halten, in dem eine Probe gelagert ist;
einer Abgabebehälter-Halteeinheit (3), die konfiguriert ist, um eine Mehrzahl von Abgabebehältern zu halten;
einer Abgabesonde (21), die konfiguriert ist, um eine vorgegebene Menge der Probe aus dem Probenbehälter zu entnehmen, und konfiguriert ist, um die entnommene Probe in den Abgabebehälter abzugeben;
einer Sondenspülvorrichtung (30), die konfiguriert ist, um ein vorderes Ende der Abgabesonde (21) in einer Spülflüssigkeit zu spülen, nachdem die Probe in den Abgabebehälter abgegeben wurde und bevor eine nächste vorgegebene Menge der Probe aus dem Probenbehälter entnommen wird; und
einer Steuerung (1b), die konfiguriert ist, um den Antrieb der Abgabesonde (21) zu steuern,
dadurch gekennzeichnet, dass:
die Steuerung (1b) eine Arithmetikverarbeitungseinheit (54) umfasst, die konfiguriert ist zum:

Berechnen, für die Probe, einer Konzentration der Probe in dem Probenbehälter auf der Grundlage einer Anfangsmenge der in dem Probenbehälter gespeicherten Probe, von Probenverbrauchsmengen einer Mehrzahl von für die Probe eingestellten Messpositionen und einer in den Probenbehälter eingeführten Menge von Spülflüssigkeit, wobei die Probe einer Verdünnung durch am vorderen Ende der Abgabesonde (21) in der Sondenspülvorrichtung (30) haftende Spülflüssigkeit unterliegt; und
Festlegen einer Mindestzahl von Abgabevorgängen, bei denen die berechnete Konzentration niedriger ist als eine voreingestellte Konzentration, als eine Höchstzahl von Abgabevorgängen der Probe aus dem Probenbehälter in den Abgabebehälter.

2. Automatisches Analysegerät (1) nach Anspruch 1, ferner mit

einer Speichereinheit (53), die konfiguriert ist, um vorab Tabelleninformationen über die Höchstzahl von Abgabevorgängen zu speichern, die auf der Grundlage eines Näherungswerts einer Probenkonzentration in dem Probenbehälter festgelegt wird, der für jeden Fall berechnet wird, bei dem eine Anfangsmenge der in dem Probenbehälter gespeicherten Probe und ein Durchschnittswert von Probenverbrauchsmengen für eine Mehrzahl von für die Probe festgelegten Messwerten variiert werden, wobei
die Arithmetikverarbeitungseinheit (54) einen Durchschnittswert der Probenverbrauchsmengen der Mehrzahl von für die Probe eingestellten Messpositionen berechnet und die Höchstzahl von Abgabevorgängen auf der Grundlage des berechneten Durchschnittswerts der Probenverbrauchsmengen, der Anfangsmenge der in dem Probenbehälter gelagerten Probe und der Tabelleninformationen über die Höchstzahl von Abgabevorgängen festlegt.

3. Automatisches Analysegerät (1) nach einem der Ansprüche 1 bis 2, bei dem
die Abgabesonde (21) die Probe aus dem Probenbehälter in den Abgabebehälter in Übereinstimmung mit einer Abgabereihenfolge zwischen der Mehrzahl von für die Probe eingestellten Messpositionen abgibt.

4. Automatisches Analysegerät (1) nach Anspruch 3, bei dem

die Steuerung (1b) in einem Fall, in dem die Anzahl der mehreren für die Probe eingestellten Messpositionen größer ist als die maximale Anzahl von Malen, die von der arithmetischen Verarbeitungseinheit (54) eingestellt wurde, die Probenhalteeinheit veranlasst, eine Mehrzahl von Probenbehältern zu halten, von denen jeder die Probe enthält, und
die arithmetische Verarbeitungseinheit (54) die Höchstzahl von Malen zur aufeinanderfolgenden Abgabe der Probe aus der Mehrzahl der Probenbehälter einstellt.

5. Automatisches Analysegerät (1) nach einem der Ansprüche 1 bis 4, bei dem

der Probenbehälter als Behälter für die verdünnte Probe dient, in dem die mit einer vorgegebenen Konzentration verdünnte Probe aufbewahrt wird, und
der Abgabebehälter als Reaktionsbehälter dient, in den die Probe und ein Reagenz abgegeben werden.

6. Automatisches Verfahren für ein automatisches Analysegerät (1) mit:

einer Probenhalteeinheit (2), die konfiguriert ist, um einen Probenbehälter zu halten, in dem eine Probe gelagert ist;
einer Abgabebehälter-Halteeinheit (3), die konfiguriert ist, um eine Mehrzahl von Abgabebehältern zu halten;
einer Abgabesonde (21), die konfiguriert ist, um eine vorgegebene Menge der Probe aus dem Probenbehälter zu entnehmen, und konfiguriert ist, um die entnommene Probe in den Abgabebehälter abzugeben;
einer Sondenspülvorrichtung (30), die konfiguriert ist, um ein vorderes Ende der Abgabesonde (21) in einer Spülflüssigkeit zu spülen, nachdem die Probe in den Abgabebehälter abgegeben wurde und bevor eine nächste vorgegebene Menge der Probe von dem Probenbehälter entnommen wird; und
einer Steuerung (1b), die konfiguriert ist, um den Antrieb der Abgabesonde (21) zu steuern,
dadurch gekennzeichnet, dass das automatische Analyseverfahren umfasst:

Berechnen einer Konzentration der Probe in dem Probenbehälter für die Probe, wobei die Probe einer Verdünnung durch die am vorderen Ende der Abgabesonde (21) in der Sondenspülvorrichtung (30) anhaftende Spülflüssigkeit unterliegt, wobei die Berechnung auf einer Anfangsmenge der in dem Probenbehälter gelagerten Probe, Probenverbrauchsmengen einer Mehrzahl von für die Probe eingestellten Messpositionen und einer in den Probenbehälter eingeführten Menge an Spülflüssigkeit basiert, und
Festlegen (S004) einer Höchstzahl von Abgabevorgängen der Probe aus dem Probenbehälter in den Abgabebehälter, basierend auf einer Mindestzahl von Abgabevorgängen, bei denen die berechnete Konzentration niedriger als eine voreingestellte Konzentration ist.

Revendications

1. Analyseur automatique (1) comprenant :

une unité de maintien de spécimen (2) conçue pour contenir un récipient de spécimen dans lequel un spécimen est stocké ;
une unité de maintien de récipient distribué (3) conçue pour contenir une pluralité de récipients distribués ;
une sonde de distribution (21) conçue pour séparer une quantité prédéterminée du spécimen du récipient de spécimen et conçue pour distribuer le spécimen qui a été séparé dans le récipient distribué ;
un dispositif de lavage de sonde (30) conçu pour laver une extrémité avant de la sonde de distribution (21) dans un liquide de lavage, une fois le spécimen distribué dans le récipient distribué et avant qu'une quantité prédéterminée du spécimen soit séparée du récipient de spécimen ; et
un contrôleur (1b) conçu pour contrôle le pilotage de la sonde de distribution (21),
caractérisé en ce que :
le contrôleur (1b) comprend une unité de traitement arithmétique (54) conçue pour :

calculer, pour le spécimen, sur la base d'une quantité initiale stockée dans le récipient de spécimen, de quantités d'usage de spécimens d'une pluralité d'éléments de mesure déterminés pour le spécimen, et une quantité de liquide de lavage introduite dans le récipient de spécimen, une concentration du spécimen dans le récipient de spécimen, le spécimen étant soumis à une dilution avec le liquide de lavage adhérent à l'extrémité avant de la sonde de distribution (21) dans le dispositif de lavage de sonde (30) ; et
déterminer un nombre minimal de fois pour la distribution, dans lequel la concentration qui a été calculée est inférieure à une concentration actuelle et un nombre maximal de fois pour la distribution du spécimen du récipient de spécimen vers le récipient distribué.

2. Analyseur automatique (1) selon la revendication 1, comprenant en outre

une unité de stockage (53) conçue pour stocker des tables d'informations préalables du nombre maximal de fois pour la distribution qui est déterminé sur la base d'une valeur approximative d'une concentration de spécimen dans le récipient de spécimen, calculé pour chaque condition dans laquelle une quantité initiale du spécimen stocké dans le récipient de spécimen et une valeur moyenne de quantité d'usage de spécimen pour une pluralité d'éléments de mesure déterminés pour le spécimen varient, dans lequel
l'unité de traitement arithmétique (54) calcule une valeur moyenne des quantités d'usage de spécimen de la pluralité d'éléments de mesure déterminés pour le spécimen et détermine le nombre maximal de fois pour la distribution, sur la base de la valeur moyenne des quantités d'usage du spécimen qui a été calculée, de la quantité initiale du spécimen stocké dans le récipient de spécimen et de la table d'informations du nombre maximal de fois pour la distribution.

3. Analyseur automatique (1) selon l'une des revendications 1 à 2, dans lequel
la sonde de distribution (21) distribue le spécimen du récipient de spécimen vers le récipient distribué conformément à un ordre de distribution entre la pluralité d'éléments de mesure déterminés pour le spécimen.

4. Analyseur automatique (1) selon la revendication 3, dans lequel

le contrôleur (1b) fait en sorte que l'unité de maintien de spécimen contient une pluralité de récipient de spécimen stockant chacun le spécimen, dans le cas où le nombre de la pluralité d'éléments de mesure déterminé pour le spécimen est supérieur au nombre maximal de fois qui a été déterminé par l'unité de traitement arithmétique (54) et
l'unité de traitement arithmétique (54) détermine le nombre maximal de fois pour la distribution du spécimen successivement depuis la pluralité de récipients de spécimen.

5. Analyseur automatique (1) selon l'une des revendications 1 à 4, dans lequel

le récipient de spécimen sert de récipient de spécimen dilué dans lequel le spécimen dilué à une concentration prédéterminée est stocké et
le récipient distribué sert de récipient de réaction dans lequel le spécimen et un réactif sont introduits.

6. Procédé d'analyse automatique à l'aide d'un analyseur automatique (1) comprenant :

une unité de maintien de spécimen (2) conçue pour contenir un récipient de spécimen dans lequel un spécimen est stocké ;
une unité de maintien de récipient distribué (3) conçue pour contenir une pluralité de récipients distribués ;
une sonde de distribution (21) conçue pour séparer une quantité prédéterminée du spécimen du récipient de spécimen et conçue pour distribuer le spécimen qui a été séparé dans le récipient distribué ;
un dispositif de lavage de sonde (30) conçu pour laver une extrémité avant de la sonde de distribution (21) dans un liquide de lavage après que le spécimen a été distribué dans le récipient distribué et avant qu'une quantité suivante prédéterminée du spécimen soit séparée du récipient de spécimen ; et
un contrôleur (1b) conçu pour contrôler le pilotage de la sonde de distribution (21),
caractérisé en ce que le procédé d'analyse automatique comprend :

le calcul, pour le spécimen, d'une concentration du spécimen dans le récipient de spécimen, le spécimen étant soumis à une dilution avec le liquide de lavage adhérant à l'extrémité avant de la sonde de distribution (21) dans le dispositif de lavage de sonde (30), ce calcul étant basé sur une quantité initiale du spécimen stocké dans le récipient de spécimen, les quantités d'usage du spécimen d'une pluralité d'éléments de

mesure déterminés pour le spécimen et une quantité de liquide de lavage introduite dans le récipient de spécimen et

la détermination (S004) d'un nombre maximal de fois pour la distribution du spécimen du récipient de spécimen vers le récipient distribué, sur la base d'un nombre minimal de fois pour la distribution, dans lequel la concentration qui a été calculée est inférieure à une concentration prédéterminée.

FIG. 1

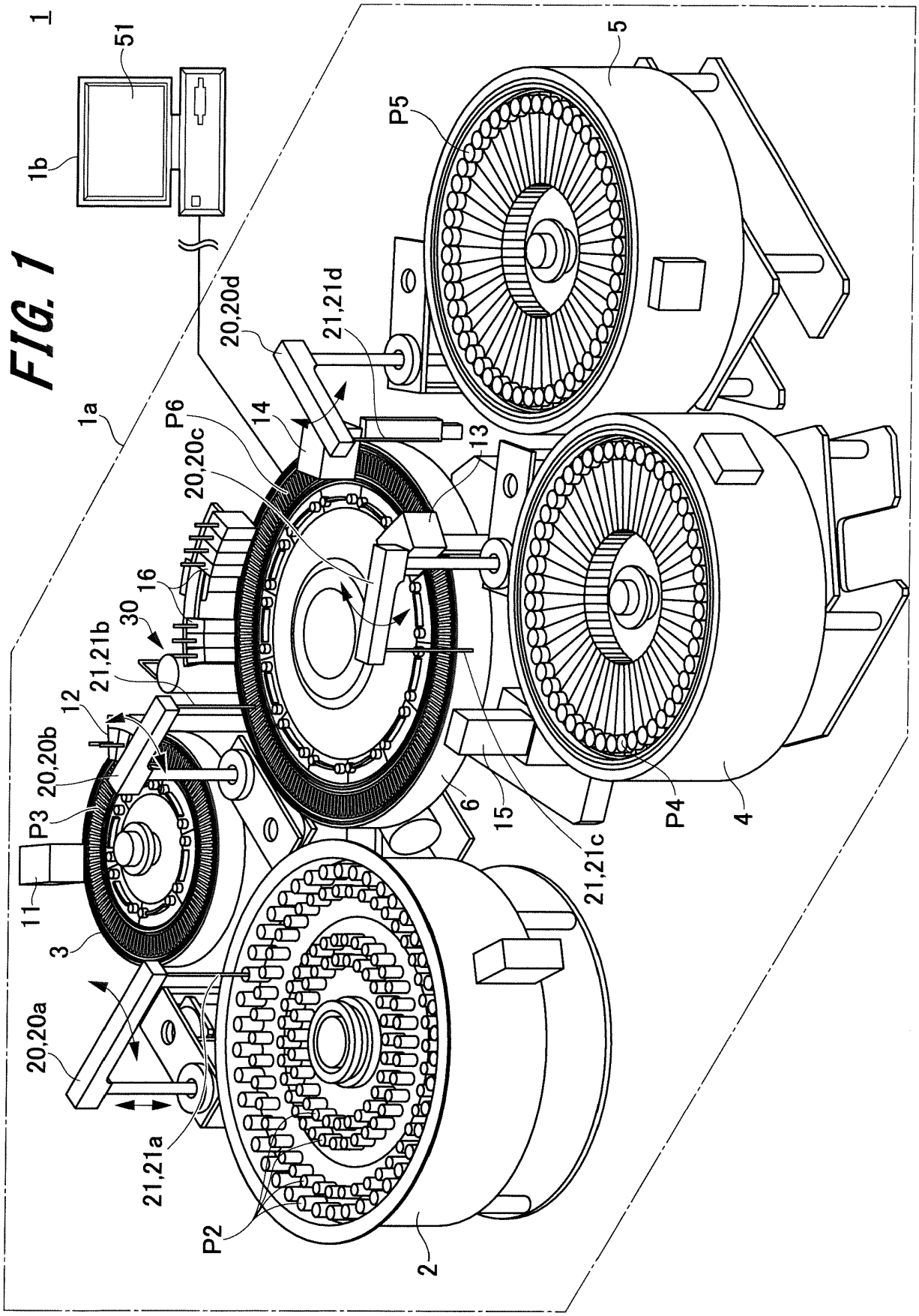

1
51
1b
5
P5
20,20d
21,21d
1a
P6
14
13
20,20c
16
30
21,21b
12
20,20b
P3
11
3
20,20a
21,21a
P2
2
6
15
21,21c
P4
4

FIG. 2

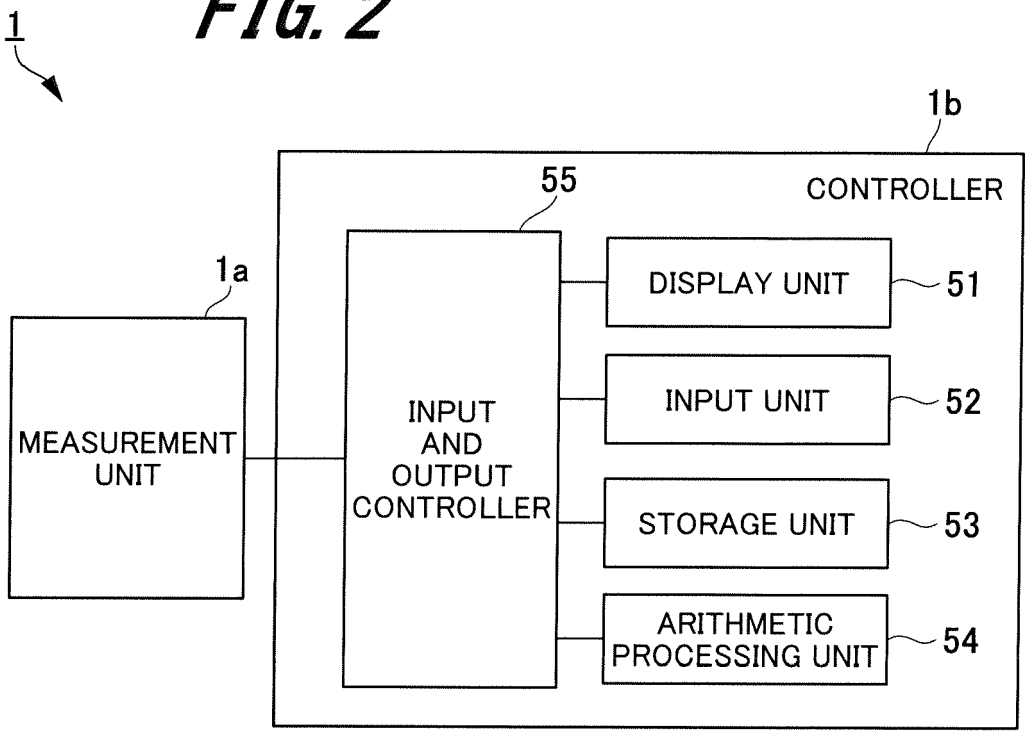

1
1b
CONTROLLER
55
1a
MEASUREMENT UNIT
INPUT AND OUTPUT CONTROLLER
DISPLAY UNIT
51
INPUT UNIT
52
STORAGE UNIT
53
ARITHMETIC PROCESSING UNIT
54

FIG. 3

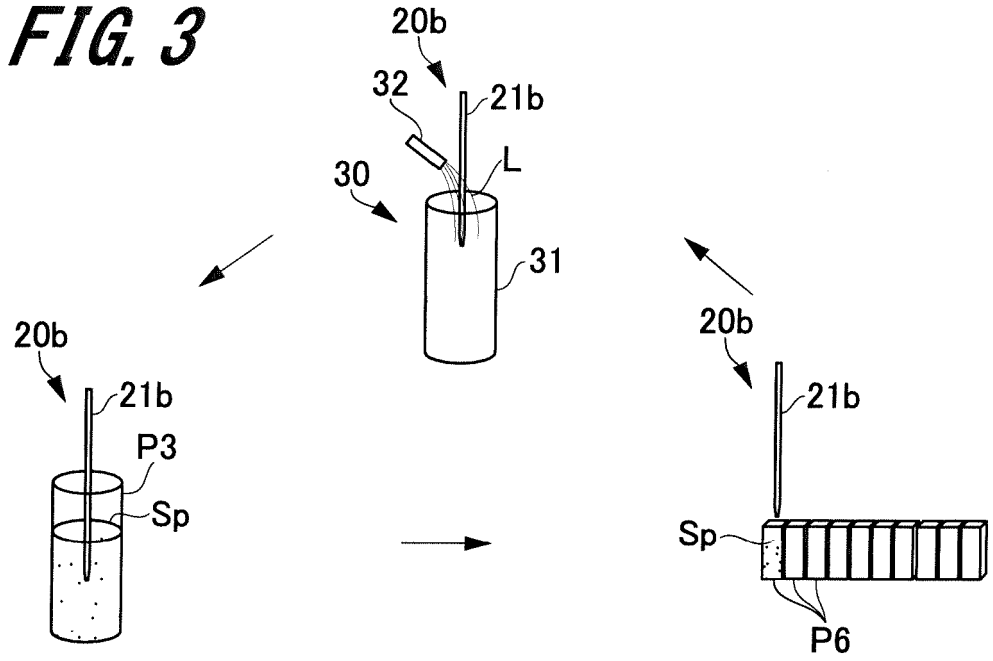
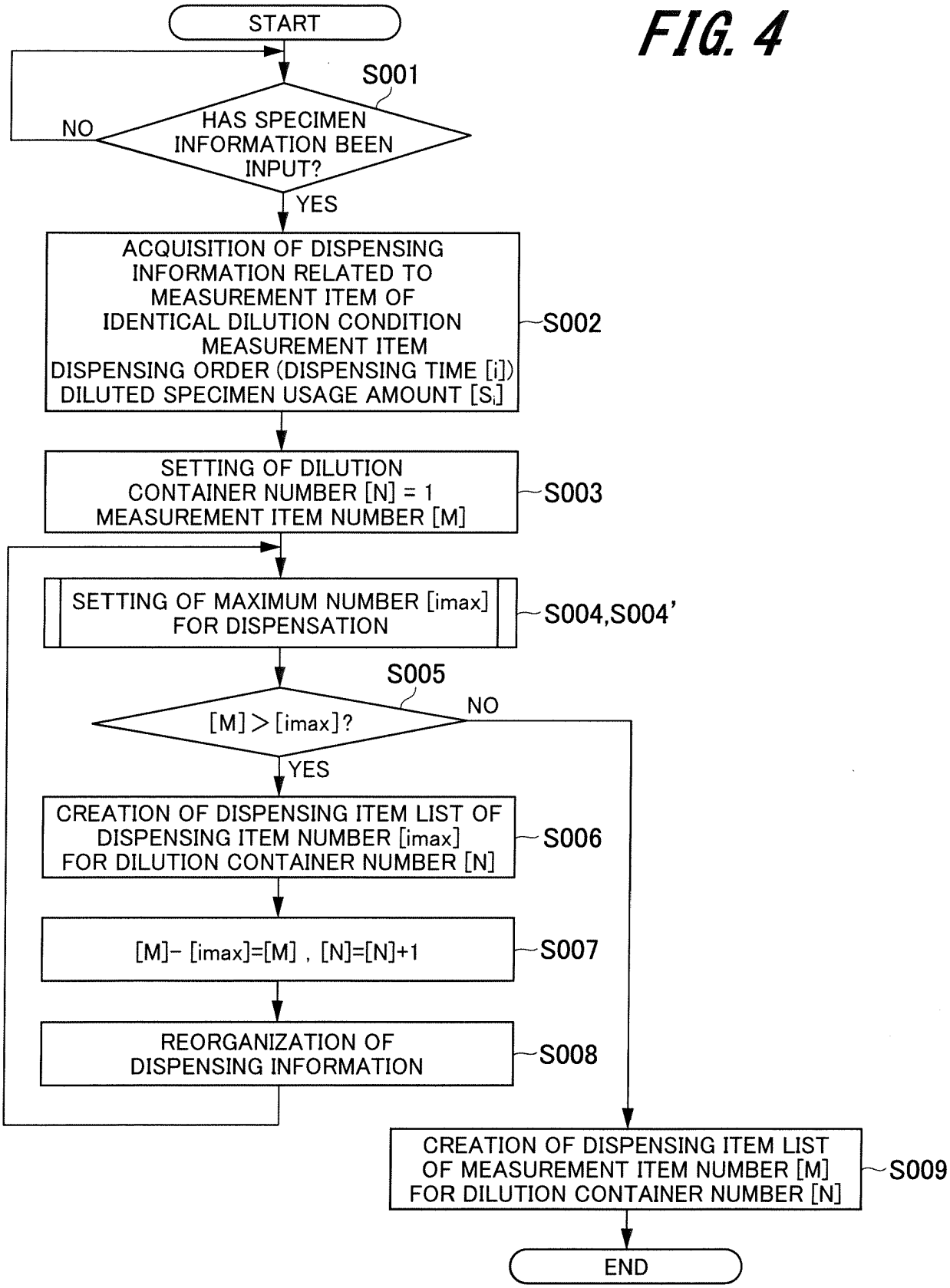

20b
32
21b
L
30
31
20b
21b
P3
Sp
20b
21b
Sp
P6

FIG. 4


START
S001
HAS SPECIMEN INFORMATION BEEN INPUT?
NO
YES
ACQUISITION OF DISPENSING INFORMATION RELATED TO MEASUREMENT ITEM OF IDENTICAL DILUTION CONDITION
MEASUREMENT ITEM
DISPENSING ORDER (DISPENSING TIME [i])
DILUTED SPECIMEN USAGE AMOUNT [Si]
S002
SETTING OF DILUTION CONTAINER NUMBER [N] = 1
MEASUREMENT ITEM NUMBER [M]
S003
SETTING OF MAXIMUM NUMBER [imax] FOR DISPENSATION
S004,S004'
S005
[M] > [imax]?
NO
YES
CREATION OF DISPENSING ITEM LIST OF DISPENSING ITEM NUMBER [imax] FOR DILUTION CONTAINER NUMBER [N]
S006
[M]- [imax]=[M] , [N]=[N]+1
S007
REORGANIZATION OF DISPENSING INFORMATION
S008
CREATION OF DISPENSING ITEM LIST OF MEASUREMENT ITEM NUMBER [M] FOR DILUTION CONTAINER NUMBER [N]
S009
END

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 8194004 A **[0003]**
- JP 2010019746 A **[0004]**