

BIOCHEMICAL OXYGEN DEMAND AUTOMATIC MEASUREMENT DEVICE**REFERENCE TO RELATED DISCLOSURES**

[0001] The Present Disclosure claims priority to prior-filed Japanese Patent Application No.

- 5 2010-069358, entitled "BOD Automatic Measurement Device," filed on 25 March 2011 with the Japanese Patent Office. The content of the aforementioned Patent Application is fully incorporated in its entirety herein.

BACKGROUND OF THE PRESENT DISCLOSURE

- 10 **[0002]** The Present Disclosure is directed to a device for measuring Biochemical Oxygen Demand (or Biochemical Oxygen Consumption), also known as "BOD," which is a standard for expressing water quality, and, more specifically, relates to a BOD measurement device that can automatically measure a D1 value, measured on the first day, a D5 value, measured after five days, and a BOD value, merely by loading a test sampling of original water.
- 15 **[0003]** The BOD water quality standard is a standard for measuring the water quality of industrial wastewater, river water or the like, and the measurement method is determined according to the JIS-K0102: 2008 standard. The JIS-K0102: 2008 standard designates the measurement method for a BOD value according to the following process: (1) a water sample (undiluted solution) is collected from industrial water, diluted to a prescribed concentration; (2)
- 20 after letting the diluted water sample stand for a prescribed amount of time, the dissolved oxygen concentration is measured as the D1 value which is the first value; (3) after the D1 value has been measured and the sample has been stored for five days, the dissolved oxygen concentration is measured for the same water sample as the D5 value which is the second value; and (4) the difference between the D1 value and the D5 value is calculated as the BOD value.
- 25 **[0004]** A large BOD value for the water sample indicates a large difference in value between the D1 value and the D5 value which means, that there was a large reduction in the dissolved oxygen concentration of the fifth day compared to the first day. In other words, it indicates that the larger the BOD value, the worse the state of the water quality.
- [0005]** Generally, the D1 value is measured on the day the water sample is collected, and the D5
- 30 value is measured five days after measuring the D1 value. Therefore, the measurement days for the D1 and D5 values are as follows:

Measurement Day of D1 Value	Measurement Day of D5 Value
Monday	Saturday
Tuesday	Sunday
Wednesday	Monday
Thursday	Tuesday
Friday	Wednesday

[0006] As can be understood from the corresponding relationship between the measurement day of the D1 value and the measurement day of the D5 value, even though the work to perform the D1 value measurement can be performed on effective workdays of Monday through Friday, the work for the D5 value measurement must be performed on Saturday and Sunday. Therefore, a method to automate the measurement of the D5 value is desired. Without an automated measurement for the D5 value, workers must commute to work on days off in order to measure the D5 value, creating disadvantages in cost and management. In addition, measuring the D1 value and the D5 value of the water sample is a complicated manual operation with a high potential for introducing measurement errors. Of course, measuring BOD values of water samples contained in multiple measurement containers is difficult.

[0007] Various technologies have been proposed under these types of conditions for automating the measurement of BOD values of water samples. For example, see Japanese Patent Application Publication Nos. H6-230013 and H6-016864 and 2004-101495.

[0008] The '013 Application discloses a sample automatic measurement device that provides a conveyor for supplying a sample bottle, a mechanism for opening and closing the sample bottle, and a mechanism for measuring the D1 value or the D5 value.

[0009] However, the automatic measurement device of the '013 Application includes a structure in which the sample bottle after completing the measurement of the D1 value is stored in a dedicated storage room and after retrieving the sample bottle that has been stored for five days, the D5 value is measured by the same measurement mechanism by which the D1 value was measured. In other words, the same sample bottle is transported on a conveyor so as to be on a five-day interval in relation to one measurement mechanism, and the dissolved oxygen content is

measured for the sample bottle on the first day and the fifth day by one measurement mechanism.

[0010] Therefore, the automatic measurement device of the '013 Application has a problem in that the number of sample bottles that can be measured is limited according to the capacity of the conveyor. In addition, because new sample bottles are introduced through a manual operation, operator error can generate a problem in which a D5 value is measured for a sample bottle that is not on the fifth day. Particularly, because the D1 value and the D5 value are measured by the same measurement mechanism, problems can be generated in which errors originating from manual operation or device errors can occur with respect to whether a D1 value or a D5 value has been measured or if they were measured on the correct today. Further, the automatic measurement device of Patent Document 1 has a problem in which operating errors are easily generated by manual operations because the operation is complicated in that diluting the concentration solution is performed manually and the sample bottle containing the diluted solution is introduced to the automatic measurement device by a manual operation.

[0011] In this way, the technology in the '013 Application has the problem of being restricted by the number of sample bottles as well as the generation of measurement errors caused by manual operation errors or device errors because partial manual operations are required.

[0012] The '864 Application includes a mechanism for automatically transporting a tray carrying sample containers and measuring the D1 value measured on the first day and the D5 value measured on the fifth day.

[0013] However, the '864 Application, similar to the '013 Application, has a problem in which the D5 measurement may be measured on a day that was not intended due to errors with the transportation mechanism of the tray or operational errors in the tray placement or tray transporting by the operator because the same measurement part measures the D1 value and the D5 value. In addition, with the technology of the '864 Application, the sample container after completing the measurement of the D1 value must be stored in a dedicated storage location. Therefore, there is a problem in that a dedicated storage location is required other than the device. Storage of the sample containers into the storage location and the retrieval of them from the storage location is a manual operation; therefore there is the problem of generating an operating error. If an operating error occurs in the storage or retrieval, a problem can be generated in that the D5 value can be measured on the wrong day.

[0014] The '495 Application discloses technology for an automatic analysis device in which a stocker to measure the D1 value and a stocker to measure the D5 value are prepared, and after introducing the respective stockers, the containers are unstopped and the D1 value or the D5 value is measured and then the container is returned to the stocker after the measurement is completed. At this time, measurements on Saturdays or Sundays are possible by introducing multiple days worth of stockers.

[0015] However, similar to the '013 or '864 Applications, the measurement mechanism for measuring the D1 value and the D5 value is the same mechanism used in common. Therefore, when an error occurs in the introduction operation of a stocker, a problem is generated in that the D5 value is measured on the wrong day. In addition, because measurement is performed on a sample container placed by the stocker, the stocker that stores the container after completing the measurement of the D1 value must be stored in the dedicated storage location. Therefore, a problem is generated in which a storage location is required.

[0016] In addition, because the storage of the sample container into the storage location as well as the retrieval of the sample container from the storage location is performed by manual operation, there is the potential for operating errors to occur. If an operating error occurs in the storage or retrieval, a problem can be generated in that the D5 value can be measured on the wrong day.

[0017] Further, the technology in '495 Application measures the process for diluting the original water by an automatic diluting device that is separate from the automatic analysis device. And an error in the diluting process can cause a problem in which the diluted water sample is placed mistakenly in the automatic analysis device.

[0018] In this way, the automatic measurement devices of the prior art have (1) the problem of the D5 value being measured on the wrong day which is caused by a manual operation error or a device error because the D1 value and the D5 value are measured by the same measurement mechanism, (2) the problem of requiring a dedicated storage location to store the sample containers after completing the measurement of the D1 value, (3) the problem that the process for diluting the original water is a separate process, (4) the problem of performing measurement on the wrong sample caused by an operating error at the time of placing the diluted water sample into the measurement device by a manual process, and (5) the problem that automation is insufficient due to requiring a variety of manual operations during measurement.

[0019] As result of these problems, a problem is generated in that there is incomplete automation for the process for diluting then measuring the D5 value on Saturdays, Sundays, and holidays, the process for retrieving from the storage location, and so forth.

[0020] The Present Disclosure, upon consideration of the above problems, provides a BOD automatic measurement device that, merely by loading original water, automates everything for diluting, measuring the D1 value, storing the container after completing the measurement of the D1 value, measuring the D5 value on the accurate day, and discharging the container after completing measurement of the D5 value.

SUMMARY OF THE PRESENT DISCLOSURE

[0021] In order to solve the problems described above, the BOD automatic measurement device of the Present Disclosure provides a repository for storing a water sample after measuring a first value until measuring a second value, a first measurement device for measuring the first value of the water sample, and a second measurement device for retrieving the water sample from the repository and measuring the second value; wherein, the repository includes a plurality of day of the week racks for storing water samples according to the day of the week on which the first value was measured; the first measurement device includes a dilution means for diluting the water sample by a prescribed scale, a standby means for holding the water sample that was diluted by the dilution means in standby for a prescribed minimum time period, and a supply means for injecting a water sample measured by the first measurement means into a container and supplying the container to the day of the week rack; and the second measurement device includes a retrieval means for retrieving the container from the rack according to the day of the week on which the second measurement is to be taken, and a second measurement means for collecting a water sample from the container retrieved by the retrieval means and measuring the second value.

[0022] The BOD automatic measurement device of the Present Disclosure, by merely loading original water, automates everything for diluting, measuring the first value, storing the container after completing the measurement of the first value, measuring the second value on the accurate day, and discharging the container after completing measurement of the second value.

[0023] In addition, the first measurement device and the second measurement device are individual mechanisms and therefore the problem of mistaking the measurement day for the first

value and the measurement day for the second value can be prevented. Further, the first value and the second value can be measured separately, and therefore measurement of the D1 value, which is the first value, and measurement of the D5 value, which is the second value, can be measured simultaneously.

5 [0024] Particularly because the standard for a repository is to store containers that store water samples after completing measurement of the first value separately according to the day measurement was completed for the first value, the first measurement device and the second measurement device can be operated independently. As a result, the measurement day of the second value in relation to the measurement day of the first value is dependent only upon
10 separation by the repository and thus the potential for the second measurement device to mistake the measurement day is eliminated. Separation by the repository depends only on the measurement day of the first value, and since the measurement day of the first value does not depend on a manual operation outside of an operation for loading the original water, there is no possibility for the measurement day of the first value to be mistaken.

15 [0025] As a result of this, mistaken measurements caused by errors in manual operation can be prevented.

[0026] In addition, the second value is automatically measured without the need for manual operation even when measuring the second value on a Saturday, a Sunday, or a holiday.

[0027] Accordingly, the need for storing the container after completing measurement of the first
20 value in a dedicated storage location is also eliminated.

BRIEF DESCRIPTION OF THE FIGURES

[0028] The organization and manner of the structure and operation of the Present Disclosure, together with further objects and advantages thereof, may best be understood by reference to the
25 following Detailed Description, taken in connection with the accompanying Figures, wherein like reference numerals identify like elements, and in which:

[0029] Fig 1 is a block diagram of the BOD automatic measurement device in the first embodiment of the Present Disclosure;

[0030] Fig 2 is a flow chart of the measurement process of the BOD automatic measurement
30 device in the first embodiment of the Present Disclosure;

[0031] Fig 3 is a schematic drawing of the dilution means for implementing the dilution process in the first embodiment of the Present Disclosure;

[0032] Fig 4 is an explanatory drawing for describing the flow of the dilution process in the first embodiment of the Present Disclosure;

5 [0033] Fig 5 is an explanatory drawing for describing the D1 measurement process in the first embodiment of the Present Disclosure;

[0034] Fig 6 is a schematic drawing illustrating the arrangement of containers in the standby process in the first embodiment of the Present Disclosure;

10 [0035] Fig 7 is a schematic drawing illustrating the relationship between the day of the week rack and the D1 measuring instrument and the D5 measuring instrument;

[0036] Fig 8 is a schematic drawing illustrating the D5 measurement process in the first embodiment of the Present Disclosure;

[0037] Fig 9 is a block diagram of the BOD automatic measurement device in the second embodiment of the Present Disclosure; and

15 [0038] Fig 10 is an image diagram of a measurement data table for the second embodiment of the Present Disclosure.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

20 [0039] While the Present Disclosure may be susceptible to embodiment in different forms, there is shown in the Figures, and will be described herein in detail, specific embodiments, with the understanding that the disclosure is to be considered an exemplification of the principles of the Present Disclosure, and is not intended to limit the Present Disclosure to that as illustrated.

[0040] In the embodiments illustrated in the Figures, representations of directions such as up, down, left, right, front and rear, used for explaining the structure and movement of the various
25 elements of the Present Disclosure, are not absolute, but relative. These representations are appropriate when the elements are in the position shown in the Figures. If the description of the position of the elements changes, however, these representations are to be changed accordingly.

[0041] The BOD automatic measurement device that relates to the first aspect of the Present Disclosure provides a repository for storing a water sample after measuring a first value until
30 measuring a second value, a first measurement device for measuring the first value of the water sample, and a second measurement device for retrieving the water sample from the repository

and measuring the second value; wherein, the repository includes a plurality of day of the week racks for storing water samples according to the day of the week on which the first value was measured; the first measurement device includes a dilution means for diluting the water sample by a prescribed scale, a standby means for holding the water sample that was diluted by the
5 dilution means in standby for a prescribed minimum time period, and a supply means for injecting a water sample measured by the first measurement means into a container and supplying the container to the day of the week rack; and the second measurement device includes a retrieval means for retrieving the container from the rack according to the day of the week on which the second measurement is to be taken, and a second measurement means for collecting a
10 water sample from the container retrieved by the retrieval means and measuring the second value.

[0042] According to this configuration, the BOD automatic measurement device can automatically measure the BOD value by merely loading a water sample that is original water.

[0043] With the BOD automatic measurement device that relates to the second aspect of the
15 Present Disclosure, in addition to the first aspect, the first measurement device and the repository are connected with the ability transfer a container, and the repository and the second measurement device are connected with the ability to transfer a container, and the supply means and the retrieval means execute an automated process to the standard of the repository.

[0044] According to this configuration, the first measurement device and the second
20 measurement device have no mutual dependency other than the repository and thus errors are not able to be generated for mistakenly measuring the measurement day of the first value and the measurement day of the second value.

[0045] With the BOD automatic measurement device that relates to the third aspect of the
25 Present Disclosure, in addition to either of the first or second aspects, the repository moves containers on the day of the week rack from the first measurement device side across to the second measurement device side.

[0046] According to this configuration, the BOD automatic measurement device can deliver containers holding water samples that have completed measurement of the first value to the second measurement device.

[0047] With the BOD automatic measurement device that relates to the fourth aspect of the Present Disclosure, the repository further provides a discharge rack for separating and keeping containers that have completed measurement of the second value.

[0048] According to this configuration, containers that have completed measurement are delivered for easy and sure disposal or washing.

[0049] With the BOD automatic measurement device that relates to the fifth aspect of the Present Disclosure, in addition to any of the first through fourth aspects, the dilution means dilutes the water sample to prescribed scale.

[0050] According to this configuration, the BOD automatic measurement device can automatically dilute a water sample that is original water to a concentration determined by a standard.

[0051] With the BOD automatic measurement device that relates to the sixth aspect of the Present Disclosure, in addition to any of the first through fifth aspects, the standby means has a conveyor for moving the diluted water sample to the first measurement means, and the time required for the movement by the conveyor is a prescribed minimum time period.

[0052] According to this configuration, the BOD automatic measurement device can precisely provide a standby time of a prescribed minimum time period to the water sample.

[0053] With the BOD automatic measurement device that relates to the seventh aspect of the Present Disclosure, in addition to any of the first through sixth aspects, the first measurement device further includes a container supply means for automatically supplying a container to the supply means.

[0054] According to this configuration, because a container injected with a water sample is automatically supplied, the need for a supply operation by a person is eliminated and furthermore, soiling of the container due to dust can be prevented.

[0055] With the BOD automatic measurement device that relates to the eighth aspect of the Present Disclosure, in addition to any of the first through seventh aspects, the supply means provides an automatic stopping and stopping mechanism for the stopper of the container, and the retrieval means provides an unstopping mechanism for automatically unstopping the stopper of the container.

[0056] According to this configuration, the BOD automatic measurement device can accurately measure the second value without inflicting a negative impact to the water sample within the container.

[0057] With the BOD automatic measurement device that relates to the ninth aspect of the

5 Present Disclosure, in addition to any of the fourth through eighth aspects, the second measurement means further includes a discharge means for discharging the container for which measurement of the second value has completed, to the discharge rack.

[0058] According to this configuration, the BOD automatic measurement device can temporarily store the container that has completed measurement, and notify the completion of the

10 measurement to the worker.

[0059] With the BOD automatic measurement device that relates to the tenth aspect of the Present Disclosure, in addition to any of the first through ninth aspects, the second measurement device further provides a BOD calculation means for calculating the BOD value of the diluted water sample based on the first value and the second value.

15 [0060] According to this configuration, the BOD automatic measurement device can measure a BOD value with high precision.

[0061] With the BOD automatic measurement device that relates to the eleventh aspect of the Present Disclosure, in addition to any of the first through tenth aspects, a control unit is further provided for controlling at least a part of the first measurement device, the repository, and the
20 second measurement device, and the control unit performs updates to the measurement data table for the corresponding container, and the measurement data table adds the first value for the container by the first measurement device, and the second value as well as the BOD value for the container is added by the second measurement device.

[0062] According to this configuration, the BOD automatic measurement device can record the
25 water quality of the water sample as well as provide such information to the worker.

[0063] With the BOD automatic measurement device that relates to the twelfth aspect of the Present Disclosure, in addition to the eleventh aspect, the measurement data table further includes identification information for identifying the container, and the identification information is recognized by at least an ID code, a bar code, a two-dimensional barcode, or a
30 distinguishing mark provided by the container.

[0064] According to this configuration, the control unit can easily identify the water sample.

[0065] A description will be provided hereafter with reference to drawings.

[0066] Embodiment 1 will be described.

[0067] First, an overview of the BOD automatic measurement device in embodiment 1 will be described using FIG. 1 and FIG. 2.

5 [0068] The BOD automatic measurement device in embodiment 1 automatically executes all processes required to measure BOD values and measures the resulting BOD value merely by a sample container which holds a water sample such as industrial wastewater or river water being loaded. Since BOD value is a numerical value that expresses the water quality of industrial wastewater or river water, there is the possibility of measurement accuracy being reduced by
10 human operations during processing. In contrast, the BOD automatic measurement device in embodiment 1 can measure BOD values with high accuracy without human operations because it automatically executes all processes after the original water is loaded.

[0069] FIG. 1 is a block diagram of the BOD automatic measurement device in embodiment 1 of the Present Disclosure. FIG. 1 schematically illustrates the overall configuration of the BOD
15 automatic measurement device, and shows the relationships among the elements of the BOD automatic measurement device. FIG. 2 is a flowchart of the measurement processes of the BOD automatic measurement device in embodiment 1 of the Present Disclosure. FIG. 2 shows the processes executed by the BOD automatic measurement device.

[0070] As the major elements, the BOD automatic measurement device 1 comprises a repository
20 2 which holds storage containers 54 which are the containers in which the first value D1 is measured, a D1 measuring instrument 3 which is a first measurement device which measures the D1 value of the water sample, and a D5 measuring instrument 4 which is a second measurement device which measures the D5 value which is the second value of the water sample in the storage container 54 retrieved from the repository 2.

25 [0071] Note that in embodiment 1, the D1 value is defined as an example of the first value, and the D5 value is defined as an example of the second value, but the values defined by the first value and second value may be flexibly changed in accordance with changes in standards or procedures related to BOD measurement.

[0072] The repository 2 separates the storage containers 54 which hold the water samples of
30 which the D1 values were measured, for each day of the week that the D1 value was measured. To do so, the repository 2 is equipped with day of the week racks 20a–20e. The D1 measuring

instrument 3 measures the D1 value of the water sample in the original water container 50, and supplies the storage container 54 which holds the water sample of which D1 measurement has been completed to the day of the week rack 20a–20e corresponding to the day of the week on which it was measured. The D5 measuring instrument 4 retrieves the storage container 54 of the day of the week rack corresponding to the day five days before the D5 measurement day, and measures the D5 value of the water sample in the retrieved storage container. The D5 measuring instrument 4 supplies the empty storage container 54 after D5 measurement has been completed to the discharge rack 21, indicating that measurement has been completed.

[0073] The D1 value is the dissolved oxygen quantity of the water sample on the first day, and the D5 value is the dissolved oxygen quantity of the water sample five days later. Both are parameters required to measure the BOD value of a water sample. The value calculated from the D1 value and the D5 value is the BOD value which expresses the water quality of the water sample.

[0074] In the BOD automatic measurement device 1, the D1 measuring instrument 3 and D5 measuring instrument 4 can operate independently of one another, using as a reference the repository 2 which holds the storage containers 54 which hold the water sample of which D1 was measured. Due to the D1 measuring instrument 3 and D5 measuring instrument 4 operating mutually independently in this way while having the repository 2 interposed in between, D1 value measurement in the D1 measuring instrument 3 and D5 value measurement in the D5 measuring instrument 4 performed on a measurement day associated with the measurement day of the D1 value are executed without error due to the fact that the repository 2 securely holds the storage containers 54 separately.

[0075] In this way, with the repository 2 as a reference, the BOD automatic measurement device in embodiment 1 has the D1 measuring instrument 3 and D5 measuring instrument 4 provided on the two sides of the repository 2. On one end of the repository 2, the original water container 50 which holds the original water loaded by the D1 measuring instrument 3 and the storage container 54 which holds the water sample of which D1 was measured are handled, and on the other end of the repository 2, the storage container 54 which holds the water sample measured by the D5 measuring instrument 4 is handled. As a result, BOD can be measured without error while preventing the instruments or equipment from increasing in size.

[0076] In the BOD automatic measurement device 1, the D1 measuring instrument 3 and D3 [sic] measuring instrument 4 are each equipped with prescribed means to achieve the functionality described above.

[0077] The D1 measuring instrument 3 is equipped with an original water container loading means 30 which loads the original water container 50 in which the original water sample is held; a dilution means 31 which dilutes the water sample in the original water container 50; a standby means 32 which holds the standby container 52 which holds the diluted water sample in standby for at least a prescribed time; a D1 measurement means 33 serving as a first measurement means which measures the D1 value which is the dissolved oxygen quantity of the water sample in the standby container 52 after standing by; a storage container supply means 34 serving as a container supply means which supplies an empty storage container 54 to be used when storing the water sample in the repository 2; a filling means 35 which fills the storage container 54 with the water sample of which the D1 value was measured from the D1 measurement container 53; a plugging means 36 which plugs the plug 54a into the opening of the storage container which holds the water sample of which D1 was measured; and a supply means 37 which supplies the plugged storage container 54 to the day of the week rack 20a–20e corresponding to the day on which the D1 value was measured.

[0078] The repository 2 is equipped with day of the week racks 20a–20e which correspond to the day of the week on which the D1 value was measured. For example, day of the week rack 20a corresponds to Monday, day of the week rack 20b corresponds to Tuesday, day of the week rack 20c corresponds to Wednesday, day of the week rack 20d corresponds to Thursday, and day of the week rack 20e corresponds to Friday. Additionally, the repository 2 is also equipped with a discharge rack 21 which receives the storage container 54 which has become unnecessary after calculation of BOD has been completed.

[0079] Also, the D5 measuring instrument 4 is equipped with a retrieval means 40 which retrieves the storage container 54 from the day of the week rack 20a–20e; a D5 measurement means 41 serving as a second measurement means which measures the D5 value which is the dissolved oxygen quantity of the water sample in the storage container 54; a BOD calculation means 42 which calculates the BOD value based on D1 and D5; and a discharge means 43 which discharges the storage container 54 for which D5 measurement has been completed to the discharge rack 21.

[0080] Also, the D1 measuring instrument 3 and the repository 2 are connected such that they can transfer the storage container 54. In addition, the repository 2 and the D5 measuring instrument 4 are connected such that they can transfer the storage container 54. The supply means 37 and the retrieval means 40 execute processes automatically with the repository 2 as a reference.

[0081] Each of these means is equipped with the respective mechanical and electrical mechanisms required for execution by each means, and executes the desired processes.

[0082] Next, the processing procedure of the BOD automatic measurement device 1 will be described using FIG. 1 and FIG. 2. FIG. 2 is a flowchart of all processes performed by the entire D1 measuring instrument 3, repository 2 and D5 measuring instrument 4.

[0083] First, in step ST1, the original water container 50 which holds the water sample (original water) such as industrial wastewater or river water which is the target of measurement is loaded on the loading stand of the original water container loading means 30. Although this original water container 50 is loaded by human operations, it may also be loaded automatically by a crane or conveyor.

[0084] Then, in step ST2, the dilution means 31 executes the dilution process by pouring the water sample held in the original water container 50 into the dilution container 51 and diluting it. The dilution process is executed by diluting the water sample in the dilution container 51 using diluent water stipulated by JIS K 0102: 2008 (called “the JIS standard” hereinafter). The dilution means 31 dilutes the water sample to prescribed dilution ratios based on the specifications set forth in the JIS standard.

[0085] Next, in step ST3, the standby means 32 holds the standby container 52 into which the water sample was poured from the dilution container 51 in standby for at least a prescribed time. This is the standby process. In the standby process, the standby means 32 holds the standby container 52 in standby for at least the prescribed time set forth in the JIS standard. This is because if the standby time is insufficient, the D1 value is measured in an insufficiently diluted state, and as a result, the BOD value is calculated from an inaccurate value.

[0086] Then, in step ST4, the D1 measurement means 33 pours the water sample that has stood by in the standby container 40 into the D1 measurement container 53 described later using the drawings, and it measures the D1 value. This is the D1 measurement process serving as the first measurement process. The D1 measurement means 33 measures the D1 value using a known

measurement means based on the specifications set forth in the JIS standard. The measured D1 value is stored as measurement data in a prescribed memory unit, or is printed as measurement data on a prescribed recording form.

[0087] Also, in parallel with steps ST1–ST4, in step ST5, the storage container 54 is supplied by the storage container supply means 34. FIG. 2 shows that step ST5 is processed between step ST4 and step ST6, but step ST5 may also be processed before step ST4. In short, before step ST6, the storage container 54 used for holding in the repository 2 may be filled with a water sample that has undergone the process of step ST5 and D1 value measurement. Note that the storage container 54 may be supplied by human power. Or, the storage container 54 may also be supplied by a belt conveyor or crane.

[0088] Next, in step ST6, the filling means 35 fills the storage container 54 supplied from the storage container supply means 34 with the water sample of which the D1 value was measured held in the D1 measurement container 53. This is the filling process. The storage container 54 is loaded in the magazine, etc., and the magazine 80 in which a plurality of storage containers 54 have been loaded is subsequently sent to the day of the week racks 20a–20e of the repository 2.

[0089] Then, in step ST7, the plugging means 36 plugs the opening of the storage container 54 which holds the water sample for which D1 measurement has been completed. This is the plugging process. A robot arm (not shown in the drawings) provided in the plugging means 36 sets a plug 54a in alignment with the opening of the storage container 54, and plugs the plug 54a by pushing it into the opening. By this plugging, the storage container 54 which holds the water sample for which D1 measurement has been completed is not affected by the outside atmosphere, and when the dissolved oxygen quantity after several days is measured, results that depend only on the inside of the storage container 54 (that is, those of the water sample) are measured. When stored in the repository 2, the plugged storage container 54 is stored in a state where the dissolved oxygen quantity is changed only by being consumed by the microbes, etc., contained in the water sample.

[0090] Then, in step ST8, the supply means 37 supplies the plugged storage container 54 to the repository 2. This is the supply process. The repository 2 is equipped with day of the week racks 20a–20e corresponding to the day of the week on which the D1 value was measured. The supply means 37 supplies the storage container 54 to the day of the week rack 20a–20e corresponding to the day of the week on which the D1 value was measured.

[0091] Next, in step ST9, the repository 2 stores the storage container 54 supplied by the supply means 37 for a prescribed time. This is the storage process.

[0092] Then, in step ST10, the retrieval means 40 retrieves the storage container 54 from the repository 2. At this time, the retrieval means 40 retrieves the storage container 30 [sic] from the day of the week rack corresponding to the day five days before the D5 measurement day on which the D5 value is measured. This is the retrieval process. Since the storage container 54 which holds the water sample stored for five days after the D1 value was measured is held in the day of the week rack corresponding to the day five days before the D5 measurement day on which the D5 value is measured, the storage container 54 retrieved from the day of the week rack corresponding to the day five days before the D5 measurement day is the water sample that is the target of D5 measurement. Also, the retrieval means 40 unplugs the plug 54a of the storage container 54.

[0093] Next, in step ST11, the D5 measurement means 41 pours the water sample in the storage container 54 into the D5 measurement container 55 and measures the D5 value. The D5 value is the value that expresses the dissolved oxygen quantity of the water sample five days later. This is the D5 measurement process, which serves as the second measurement process. Similar to the D1 measurement means 33, the D5 measurement means 41 measures the dissolved oxygen quantity of the water sample of the D5 measurement container 55 using various known means. As a result, the D5 measurement means 41 can measure the D5 value. The D5 measurement means 41 stores the D5 value as measurement data in a prescribed memory unit, or prints it as measurement data on a prescribed recording form.

[0094] Then, in step ST12, the BOD calculation means 42 calculates the BOD value based on the D1 value and D5 value. This is the BOD calculation process. Or, the D5 measurement means 41 can calculate the BOD value in combination with measurement of the D5 value. That is, the D5 measurement means 41 can execute the D5 measurement process and the BOD calculation process. The BOD calculation means 42 stores the calculated BOD value as measurement data in a prescribed memory unit, or prints it as measurement data on a prescribed recording form. After receiving this measurement data, the user can know the water quality of the target industrial wastewater or river water.

[0095] Finally, in step ST13, the discharge means 43 discharges the empty storage container 54 after extracting the water sample to the D5 measurement container 55 to the discharge rack 21.

This is the discharge process. Since the storage container 54 that has undergone all processes of BOD measurement is held in the discharge rack, the user can cycle this unnecessary storage container 54 manually or automatically to washing, etc.

[0096] By the above series of processes being executed, the BOD value of the water sample which is the target of measurement is measured automatically, and the water quality of industrial wastewater or river water is measured.

[0097] As described above, the BOD automatic measurement device 1 in embodiment 1 automatically executes all processes from dilution to BOD calculation, merely by an original water container 50 which holds original water serving as the water sample which is the measurement target, such as industrial wastewater or river water, being loaded in a container loading means 30. By executing everything automatically, the BOD automatic measurement device 1 can calculate BOD of the water sample with high accuracy without measurement mistakes occurring.

[0098] Next, the details of the parts and major processes will be described.

[0099] As shown in FIG. 1, the D1 measuring instrument 3 is equipped with an original water container loading means 30 which loads the original water container 50, and a storage container supply means 34 which loads the empty storage container 54. It is also equipped with a dilution means 31 for diluting the water sample in the original water container 50 loaded in the original water container loading means 30. This dilution means 31 is equipped with a dilution container 51, a mechanism which puts diluent water in the dilution container 51, and a measurement gauge (not shown in drawings) that measures the volume (or weight, etc.) of the water sample and diluent water.

[0100] Also, the D1 measuring instrument 3 is equipped with a conveyor for realizing the standby process. This conveyor is used for holding the standby container 52 which holds the diluted water sample in standby for at least the prescribed time. That is, the conveyor moves the standby container 52 toward the D1 measurement means 33 while repeatedly moving and stopping. The movement time including this stoppage time is at least the prescribed time. Also, the D1 measuring instrument 3 is provided with a D1 measurement means 33 which measures the D1 value.

[0101] The D1 measuring instrument 3 is equipped with a mechanism that sends the storage container 54 to the day of the week racks 20a–20e at the end of the conveyor. Additionally, the

D1 measuring instrument 3 is equipped with a mechanism that can move in a direction orthogonal to the discharge direction of the day of the week racks 20a–20e.

[0102] The details of the dilution process will be described using FIG. 3 and FIG. 4. The dilution means 31 executes the dilution process.

5 [0103] FIG. 3 is a schematic diagram of the dilution means which executes the dilution process in embodiment 1 of the Present Disclosure. FIG. 4 is an explanatory diagram which explains the flow of the dilution process in embodiment 1 of the Present Disclosure.

[0104] In FIG. 3, the dilution means 31 is equipped with a dilution container 51, a dilution tank 311 in which diluent water is held, a diluent supply unit 312, and an original water supply unit
10 313. The dilution container 51 holds the original water sample, and the dilution tank 311 holds the diluent water.

[0105] The dilution means 31 supplies the water sample from the original water container 50 via the original water supply unit 313 to the dilution container 51, and supplies the diluent water from the dilution tank 311 via the diluent supply unit 312 to the dilution container 51. The
15 diluent supply unit 312 and original water supply unit 313 can automatically adjust the supplied quantities. The original water and diluent being supplied a prescribed amount at a time to the dilution container 51 results in the diluted water sample being held in the dilution container 51.

[0106] Also, the dilution means 31 dilutes the original water sample in three stages. For example, the dilution means 31 dilutes the original water sample in three stages, to 2 times, 4
20 times and 8 times. FIG. 4 shows this three-stage dilution process.

[0107] First, in step ST20, the original water sample 60 and an equal amount of diluent water 61 are supplied to the dilution container 52 [*sic*]. Then, in step ST21, the water sample 60 and diluent 61 supplied to the dilution container 52 [*sic*] are stirred. By means of this stirring, the water sample in the dilution container 52 [*sic*] in step ST21 becomes diluted to 2 times with
25 respect to the original water.

[0108] Next, in step ST22, half of the water sample in the dilution container 52 [*sic*] (diluted to 2 times) is supplied to the standby container 52a. This standby container 52a holds the 2x-diluted water sample, and is held in standby for at least the prescribed time in the standby process. In addition, the D1 measurement means 33 measures the D1 value of the 2x-diluted water sample in
30 the standby container 52a.

[0109] Then, in step ST23, diluent water 61 is supplied in an equal quantity to the water sample (diluted to 2 times) remaining in the dilution container 51. Then, in step ST24, the water sample and diluent water 61 are stirred. By means of this stirring, the water sample in the dilution container 52 [*sic*] becomes diluted to 4 times with respect to the original water.

5 [0110] Next, in step ST25, half of the 4x-diluted water sample remaining in the dilution container 51 is supplied to the standby container 52b. This standby container 52b holds the 4x-diluted water sample. The standby container 52b is held in standby for at least the prescribed time in the standby process. In addition, the D1 measurement means 33 measures the D1 value of the 4x-diluted water sample in the standby container 52b.

10 [0111] Then, in step ST26, diluent water 61 is supplied in an equal quantity to the water sample (diluted to 4 times) remaining in the dilution container 51. Then, in step ST27, the water sample and diluent water 61 are stirred. By means of this stirring, the water sample in the dilution container 51 becomes diluted to 8 times with respect to the original water.

[0112] Next, in step ST28, the 8x-diluted water sample in the dilution container 51 is supplied to
15 the standby container 52c. This standby container 52c holds the 8x-diluted water sample. The standby container 52c is held in standby for at least the prescribed time in the standby process. In addition, the D1 measurement means 33 measures the D1 value of the 8x-diluted water sample in the standby container 52c.

[0113] Finally, in step ST29, the emptied dilution container 51 is washed in order to receive the
20 next original water.

[0114] As described above, the dilution means 31 dilutes the water sample in three stages, to 2 times, 4 times and 8 times, by adding diluent water 61 to the original water sample held in the dilution container 51. As shown in FIG. 3 and FIG. 4, since this dilution process is processed automatically, no mistakes occur due to human operations.

25 [0115] Next, the details of the standby process will be described.

[0116] The standby process is a process in which the standby container 52 which holds the diluted water sample is held in standby for at least the prescribed time, and it is executed by the standby means 32. The JIS standard stipulates that the D1 value is measured after the diluted water sample is held in standby for at least the prescribed time. This is because if the state of
30 dilution of the water sample after dilution is insufficient, irregularities arise in measurement of the D1 value which expresses the dissolved oxygen quantity.

[0117] The standby means 32 is equipped with a conveyor. This conveyor moves the standby container 52 which holds the diluted water sample toward the D1 measurement means 33. By utilizing this movement time, the standby means 32 holds the standby container 52 in standby for at least the prescribed time.

5 [0118] Here, the prescribed time of 15 minutes (that is, the standby time in the standby process of least 15 minutes) is set forth in the current JIS standard. For this reason, in the standby process, the movement time of the conveyor which moves the standby container 52 toward the D1 measurement process is to be at least 15 minutes. Using this movement time, the standby means 32 can hold the standby container 52 in standby for at least 15 minutes from the dilution
10 process to the D1 measurement process.

[0119] Note that the prescribed time of at least 15 minutes is an example set forth in the JIS standard, and the standby process can also hold the standby container 52 in standby for a different time according to the standard. In particular, if changes occur in the future in standards regarding BOD measurement such as the JIS standard, the prescribed time may become
15 something other than 15 minutes.

[0120] When the standby process is finished, the diluted water sample is sent to the D1 measurement process in which the D1 value is measured. Note that since the water sample was diluted in three stages in the dilution process, the standby container that holds the water sample is equipped with a plurality of standby containers 52a, 52b and 52c. The standby process holds
20 the standby containers 52a, 52b and 52c which hold the water samples diluted to these different dilution ratios in standby for at least the prescribed time.

[0121] Next, the details of the D1 measurement process are described. In the D1 measurement process, the D1 measurement means 33 measures the D1 value which expresses the dissolved oxygen quantity of the water sample that was diluted and held in standby.

25 [0122] FIG. 5 is an explanatory diagram which explains the D1 measurement process in embodiment 1 of the Present Disclosure. FIG. 5 shows the dilution process and the D1 measurement process combined. The dilution process is as described above, and its description is omitted here.

[0123] The D1 measurement means 33 pours the diluted water sample extracted from the
30 standby container 52 into the D1 measurement container 53. The D1 measurement means 33 measures the dissolved oxygen quantity and measures the D1 value using a measurement method

of various known techniques. Note that known techniques of measurement include, for example, a dissolved oxygen quantity measuring instrument equipped with an electrical or optical detector.

[0124] The D1 measurement means 33 measures the D1 values in each of the measurement containers which hold the water samples that were diluted in three stages. Also, since there are many types of sample in accordance with original waters collected at a plurality of locations or times, the D1 measurement process measures the D1 value for each type. For this reason, in embodiment 1 of the Present Disclosure, it is described that the standby means 32 moves each of the standby containers 52, consisting of three standby containers 52a, 52b and 52c lined up in a row in accordance with the type of water sample, toward the D1 measurement means 33, where the D1 value is measured. This is as shown in FIG. 6.

[0125] FIG. 6 is a schematic diagram illustrating the row of measurement containers in the standby process in embodiment 1 of the Present Disclosure. Eight standby containers 52 are lined up (in the vertical direction in FIG. 6) with respect to the standby means 32, and a plurality of standby containers corresponding to the types of water sample are lined up in the direction of movement.

[0126] The standby container 52a holds the 2x-diluted water sample, the standby container 52b holds the 4x-diluted water sample, and the standby container 52c holds the 8x-diluted standby container.

[0127] Also, water sample A of a certain factory's wastewater and water sample B of another factory's wastewater are lined up in the direction orthogonal to the movement direction of the conveyor. In short, the respective diluted water samples of water sample A and water sample B are contained in three measurement containers lined up in the movement direction, which hold water samples diluted to 2 times, 4 times and 8 times, respectively.

[0128] By this row of standby containers flowing to the subsequent D1 measurement process, the D1 measurement means 33 measures their D1 values by a flowing operation. Also, the D1 measurement means 33 stores the measured D1 values as measurement data in a memory unit, or prints it as measurement data on a recording form. By it being saved as measurement data, workers can check the measured D1 values.

[0129] Next, the supply process, etc., is described.

[0130] First, the filling means 35 fills the storage container 54 with the water sample of the measurement container 52 which holds the water sample of which D1 value measurement has

been completed. This is as shown in FIG. 5. The storage container 54 is the container used when held by the repository 2, and is sent after being loaded by the storage container supply means 34. The filling means 35 fills this sent storage container 54 with the water sample of which D1 value measurement has been completed from the measurement container 53.

5 [0131] The filled storage container 54 is plugged by the plugging means 36. By being plugged, the water sample in the storage container 54 is stored in the repository 2 without being affected by the outside.

[0132] The supply process supplies the storage container 54 to the repository 2 using the supply means 37.

10 [0133] Here, the repository 2 is equipped with day of the week racks 20a–20e which correspond to the day of the week on which the D1 value was measured. Day of the week rack 20a corresponds to the case where the D1 measurement day is Monday, day of the week rack 20b corresponds to the case where the D1 measurement day is Tuesday, day of the week rack 20c corresponds to the case where the D1 measurement day is Wednesday, day of the week rack 20d
15 corresponds to the case where the D1 measurement day is Thursday, and day of the week rack 20e corresponds to the case where the D1 measurement day is Friday. Note that since Saturday and Sunday are generally non-work days, the repository 2 shown in FIG. 1 does not have day of the week racks corresponding to Saturday or Sunday. Of course, the repository 2 may also have day of the week racks corresponding to Saturday and Sunday. The repository 2 also has a
20 discharge rack 21 which discharges the storage container 54 after D5 measurement has been completed (that is, after BOD calculation has been completed).

[0134] By moving in the direction orthogonal to the transport direction of the repository 2 as shown in FIG. 7 (or, by the supply means 37 moving), the D1 measuring instrument 3 supplies the storage container 54 to the day of the week rack corresponding to the day of the week on
25 which D1 was measured. FIG. 7 is a schematic diagram illustrating the relationship between the day of the week rack and the D1 measuring instrument and D5 measuring instrument in embodiment 1 of the Present Disclosure.

[0135] The supply means 37 supplies the storage container 54 held in the magazine 80 to the day of the week rack corresponding to the D1 measurement day. In this case, by the D1 measuring
30 instrument 3 or the supply means 47 moving in the direction of transport of the repository 2, the supply means 37 supplies the storage container 54 held in the magazine 80 to the day of the week

rack corresponding to the D1 measurement day. For example, if the D1 measurement day on which the D1 value was measured is Monday, the supply means 37 supplies the storage container 54 to the day of the week rack 20a as shown in FIG. 7.

[0136] Note that the supply means 37 may supply the storage container 54 to the day of the week racks 20a–20e as is, or in the state where it is held in the magazine 80 as shown in FIG. 7.

[0137] Also, if the D1 measurement day is Wednesday, the supply means 37 supplies the storage container 54 to the day of the week rack 20c.

[0138] In this way, the supply means 37 supplies the storage container 54 which holds the water sample of which D1 measurement has been completed to the day of the week rack corresponding to the D1 measurement day while separating them by the day of the week on which measurement was performed, by moving in the vertical or horizontal direction with respect to the repository 2.

[0139] The repository 2 can store the sample containers 30 by separating them by the day of the week on which measurement was performed.

[0140] Next, the storage process will be described.

[0141] The repository 2 stores the storage containers 54 in the day of the week rack 20a–20e corresponding to the D1 measurement day for a prescribed time in a constant environment. The diluted water sample is cultured for that prescribed time. Note that a prescribed time of five days as set forth in the JIS standard is described, but it may be changed as appropriate.

[0142] Next, the retrieval process will be described.

[0143] The day of the week racks 20a–20e of the repository 2 each have a conveyor function, which sequentially moves the storage containers 54 supplied from the D1 measuring instrument 3 from the end on the D1 measurement side to the end on the D5 measurement side. By this movement, the storage container 54 which holds the water sample of which D1 measurement has been completed gradually approaches the D5 measuring instrument 4, and the D5 measuring instrument 4 easily retrieves the storage container 54.

[0144] In the retrieval process, the retrieval means 40 retrieves the storage container from the day of the week rack. Here, the D5 measurement day is five days after the D1 measurement day. For example, if the D1 measurement day is Monday, the D5 value of the water sample held in this storage container 54 must be measured on Friday.

[0145] To do this, the retrieval means 40 retrieves the storage container 54 from the day of the week rack corresponding to the day five days before the D5 measurement day, among the day of

the week racks 20a–20e. If the D5 measurement day is Friday, the retrieval means 40 retrieves the storage container 54 from the day of the week rack 20a that corresponds to Monday, which is five days before.

[0146] FIG. 7 illustrates this situation. Similar to the D1 measuring instrument 3, the D5

measuring instrument 4 (retrieval means 40) can move in the direction orthogonal to the transport direction of the repository 2. By this orthogonal-direction movement, the retrieval means 40 moves to the required location of the day of the week rack, and retrieves the storage container 54 from the day of the week rack. In this case, since the retrieval means 40 retrieves the storage container 54 from the day of the week rack corresponding to the day five days before the D5 measurement day, there is no risk of calculating the BOD value while mixing up the D1 measurement day and the D5 measurement day corresponding to it.

[0147] Next, the D5 measurement process will be described.

[0148] In the D5 measurement process, the D5 measurement means 41 measures the D5 value which is the dissolved oxygen quantity of the water sample in the storage container 54 retrieved by the retrieval means 40.

[0149] FIG. 8 is a schematic diagram illustrating the D5 measurement process in embodiment 1 of the Present Disclosure. FIG. 8 shows the state where the storage container 54 retrieved by the retrieval means 40 is moved into the D5 measurement container, and the D5 value of the water sample is measured by the D5 measurement means 41.

[0150] The water samples in the storage containers 54 retrieved by the retrieval means 40 are sequentially sent into the D5 measurement container 55 of the D5 measurement means 41. FIG. 8 illustrates the state where they are sequentially sent from the storage containers 54 to the respectively D5 measurement containers 55 of the D5 measurement means 41.

[0151] Also, the D5 measuring instrument 4 is equipped with an unplugging mechanism which unplugs the plug 54a of the storage container 54. By this unplugging mechanism, the D5 measuring instrument 4 can remove the plug 54a of the storage container 54 and retrieve the water sample held within.

[0152] Here, the D5 measurement means 41 measures the D5 value using the same type of dissolved oxygen quantity measuring instruments using the same measurement methods of various known techniques as used in the D1 measurement means. Also, when the D5

measurement means 41 finishes D5 measurement, it discards the water sample into a discharge tank 411. As a result, the D5 measurement container 55 becomes empty.

[0153] Also, the D5 measurement means 41 measures the water sample of the storage container 54 retrieved from the day of the week rack corresponding to the day five days before the D5 measurement day retrieved by the retrieval means 40. The retrieval means 40 automatically retrieves the storage container from the required day of the week rack while moving perpendicular to the repository 2. For this reason, since the D5 measuring instrument 4 retrieves the storage container 54 prepared in advance in the repository 2 from the corresponding day of the week rack, D5 measurement is not missed even on non-work days such as Saturday and Sunday. That is, by a worker merely loading the original water container 50 which holds the original water in the D1 measuring instrument 3 on a work day from Monday through Friday, all processes through the D5 measurement process are subsequently performed automatically. As a result, the D1 value and D5 value of a water sample are measured based on the correct combination of days of the week.

[0154] That is, in the D1 measurement process, the D1 value of the water sample must be measured on any day from Monday through Friday, and the BOD automatic measurement device 1 must measure the D1 value on all of these days of the week. To this point, the BOD automatic measurement device 1 automatically measures the D1 value after the original water sample is loaded. Additionally, it automatically supplies the storage container 54 to any of the day of the week racks 20a–20e corresponding to the D1 measurement day.

[0155] On the other hand, since the D5 measuring instrument 4 automatically retrieves the storage container 54 from the day of the week rack corresponding to the day five days before the D5 measurement day, the D5 value can be measured by the D5 measurement process without any problem even if the D5 measurement day is a Saturday or Sunday.

[0156] From the above facts, the BOD automatic measurement device 1 can measure BOD values regardless of whether it is a non-work day such as Saturday or Sunday, due to the fact that the D1 measuring instrument 3 and D5 measuring instrument 5 move independently of each other with the repository 2 as a reference, where the repository 2 is equipped with day of the week racks 20a–20e which can separate samples by the D1 measurement day on which the D1 value was measured.

[0157] For this reason, the BOD value of the water sample is measured correctly. Additionally, since the repository 2 correctly transfers the sample from D1 measurement to D5 measurement, the BOD automatic measurement device 1 can both achieve operational efficiency and make the work space more efficient.

5 [0158] When it measures the D5 value, the D5 measurement means 41 stores the D5 value as measurement data in a memory unit, or prints it as measurement data on a recording form.

[0159] In addition, the D5 measurement means 41 calculates the BOD value from the D5 value and the D1 value. This BOD value expresses the water quality of the water sample. The D5 measurement means 41 stores the BOD value in a memory unit, or prints it on a recording form,
10 similar to the D5 value. That is, the D5 measurement means 41 is also equipped with a BOD calculation means 42 which calculates the BOD value.

[0160] In the discharge process, the discharge means 43 discharges the storage container 54 from which the sample water was extracted to the discharge rack 21. The discharge rack 21 is provided in the repository 2, and it temporarily stores empty storage containers 54 which have
15 become unnecessary after BOD measurement has been completed. The discharge rack 21 sends out the storage container 54 by means of a conveyor, and transfers it to the washing process. In this case, the storage container 54 can be automatically sent by the conveyor to the washing means which executes the washing process, or a worker can move the storage container 54 to the washing means by human operation. Here, whether or not any water sample remains in the
20 storage container 54, the storage container 54 is washed so that it can be reused in subsequent measurements.

[0161] Note that FIG. 8 also shows the state where an empty storage container 54 is discharged to the discharge rack 21.

[0162] The discharge rack 21 is provided near the day of the week rack 20e corresponding to
25 Friday, but it can also be provided near the day of the week rack 20a corresponding to Monday, or one can be provided near the day of the week rack 20a and day of the week rack 20e.

[0163] Similar to the day of the week racks 20a–20e, the discharge rack 21 is also equipped with a conveyor mechanism, which transports the received empty storage container 54 (or the magazine 80 which stores it) in the prescribed direction. By this transport, workers can cycle the
30 empty storage container 54 to be discharged to the washing process, etc.

[0164] The D5 measuring instrument 4 is equipped with an unplugging mechanism which unplugs the plug 54a of the storage container 54.

[0165] The unplugging mechanism removes the plug using the principle of leverage. That is, the unplugging mechanism has an arm, and the fulcrum of the arm is pressed against the part where the storage container 54 and the plug 54a are connected, and the unplugging mechanism removes the plug by the arm being aligned with the fulcrum and widened. Of course, the unplugging mechanism can also remove the plug by the principle of leverage while using a member other than an arm, or the plug can be removed by a structure that utilizes something other than the principle of leverage.

[0166] By such an unplugging mechanism, the D5 measuring instrument 4 can reliably and easily remove the plug 54a of the storage container 54.

[0167] As described above, merely by the original water container 50 which holds the original water sample being loaded, the BOD automatic measurement device 1 of embodiment 1 can automatically measure the BOD value of a water sample without the measurement day of the week being mistaken.

[0168] Next, embodiment 2 will be described.

[0169] In embodiment 2, the functions that handle the measured D1 value, D5 value and BOD value as measurement data in the BOD automatic measurement device 1 described in embodiment 1 will be described.

[0170] FIG. 9 is a block diagram of the BOD automatic measurement device in embodiment 2 of the Present Disclosure. FIG. 9 shows a simplification of the BOD automatic measurement device 1. In addition to having the elements of the repository 2, D1 measuring instrument 3 and D5 measuring instrument 4, the BOD automatic measurement device 1 in embodiment 2 is also equipped with a control unit 100 which controls at least part of the D1 measuring instrument 3, repository 2 and/or D5 measuring instrument 4. The control unit 100 controls at least part of the processes performed by the BOD automatic measurement device 1 described in embodiment 1.

[0171] Additionally, the control unit 100 creates and updates the measurement data table corresponding to the D1 measurement container 53 or the D5 measurement container 55 which holds the water sample that is the target of BOD measurement.

[0172] The original water container 50 is differentiated by the location or time at which the water sample was collected. BOD value measurement must be performed while differentiating

the containers by the location and time of the collected water sample. This is because if BOD is measured while mistaking the origin of the water sample, it will not result in measurement of water quality of the industrial wastewater or river water from which the water sample was collected.

5 [0173] For this reason, the control unit 100 must measure the BOD value after identifying the location and time at which the water sample was collected for the specific containers in each process. This is because, in the BOD automatic measurement device 1, the D1 value, D5 value and BOD value of a water sample collected at a certain location and time are measured sequentially over the course of a minimum five-day schedule. This is because, if the control unit
10 100 cannot identify a certain original water container 50, it becomes unknown which water samples the measured D1 value, D5 value and BOD value each correspond to. Note that in FIG. 1, the original water container 50 is used until the D1 value is measured, but even in this case, since the water sample after D1 measurement is held in the storage container 54, the control unit 100 differentiates the storage containers 54.

15 [0174] The control unit 100 manages the measurement data table. The measurement data table is shown in FIG. 10. FIG. 10 is an image of the measurement data table in embodiment 2 of the Present Disclosure.

[0175] FIG. 10 shows, in order from the top, the measurement data table 101 after D1 measurement has been completed, the measurement data table 102 after D5 measurement has
20 been completed, and the measurement data table 103 after BOD measurement has been completed. The control unit 100 updates the measurement data table in this way each time measurement has been completed in each process.

[0176] The measurement data tables 101–103 contain identification information 110 which identifies the container in which the specified sample is held, D1 values 111, D5 values 112 and
25 BOD values 113. In the embodiments of the Present Disclosure, the identification information of the original water container 50 is entered in the control unit 100, and that identification information which identifies the storage container 54 is put on the storage container 54 by applying a seal or printing, for example. The identification information is obtained by at least an ID code, a bar code, a two-dimensional barcode and/or a distinguishing mark provided on the
30 container.

[0177] The control unit 100 is equipped with a mechanism which reads these codes, etc., on the loading stand of the storage container supply means 34 on which the storage container 54 is loaded, and it recognizes the identification information of the storage container 54 by this mechanism. By this recognition, the control unit 100 writes the identification information in the identification information 110 column of the measurement data table.

[0178] In FIG. 10, as an example, the identification information "A-1" of the water sample obtained by diluting the original water A has been written in the first column of the measurement data tables 101–103.

[0179] When the D1 measurement process has been completed, the control unit 100 writes in the measurement data table the D1 value of the water sample held in the D1 measurement container 53 obtained by diluting the original water container 50 identified by the identification information "A-1." By the D1 value being written, the measurement data table is updated to the measurement data table 101. In FIG. 10, the value "3.0" is written as the D1 value in the measurement data table 101.

[0180] Then, when the D5 measurement process has been completed, the control unit 100 writes in the measurement data table 101 the D5 value of the water sample held in the storage container 54 moved from the D1 measurement container 53 identified by this identification information "A-1." By the D5 value being written, the measurement data table 101 is updated to the measurement data table 102. In FIG. 10, the value "1.5" is written as the D5 value in the measurement data table 102.

[0181] Additionally, when the calculation process has been completed, the control unit 100 writes in the measurement data table 102 the BOD value of the storage container 54 identified by this identification information "A-1." By the BOD value being written, the measurement data table 102 is updated to the measurement data table 103. In FIG. 10, the value "0.75" is written as the BOD value in the measurement data table 103. The value "0.75" is that calculated from the D5 value and D1 value using the formula set forth in the JIS standard.

[0182] Finally, the control unit 100 updates the measurement data table in this way, and outputs the measurement data table 103 in which the BOD value was written as the final result.

[0183] Also, the control unit 100 stores the measurement data table in a memory unit 105. In this case, it is preferred that it is stored in the memory unit 105 each time the measurement data table is updated. Also, if necessary, the control unit 100 displays the measurement data table on a

display screen. By the measurement data table being displayed on a display screen, workers can visually check measurement results. Of course, the control unit 100 can also print the measurement data table on a recording form.

[0184] In this way, usability is increased due to the fact that the control unit 100 presents the measured BOD values (or the intermediate D1 values and D5 values) to the workers. As a result, workers can understand the results in alignment with the processes of the BOD automatic measurement device 1.

[0185] Also, the BOD automatic measurement device 1 described in embodiments 1 and 2 can be understood as a BOD automatic measurement system having the elements and processes described in embodiments 1 and 2.

[0186] That is, a BOD automatic measurement system is equipped with a repository which stores a water sample after a first value has been measured until a second value is measured, and a first measurement device which measures the D1 value which is an example of the first value of the water sample, and a second measurement device which retrieves the water sample from the repository and measures the second value. This repository has a plurality of day of the week racks which store water samples for each day of the week on which the first value was measured.

[0187] The first measurement device has a dilution means which dilutes the water sample to prescribed dilution ratios, a standby means which holds the water sample diluted by the dilution means in standby for at least a prescribed time, a first measurement means which measures the first value of the water sample which was held in standby by the standby means, and a supply means which pours the water sample measured by the first measurement means into a container and supplies the container to the day of the week rack.

[0188] The second measurement device has a retrieval means which retrieves the container from the rack corresponding to the day of the week on which the D5 value, which is an example of the second value, is to be measured, and a second measurement means which collects the water sample from the container retrieved by the retrieval means and measures the second value.

[0189] In addition, the second measurement device is equipped with a BOD calculation means which calculates the BOD value which expresses the water quality of a water sample based on the first value D1 and the second value D5.

[0190] A BOD automatic measurement system equipped with these elements can calculate the BOD value of a water sample by automatically executing all processes, merely by an original

water sample being loaded. The calculated result is provided to users together with other data elements.

[0191] Similarly, the BOD automatic measurement device 1 described in embodiments 1 and 2 can also be understood as a BOD automatic measurement method which measures BOD values while using the prescribed elements.

[0192] That is, a BOD automatic measurement method has a repository which stores a water sample after a first value has been measured until a second value is measured, and a first measurement device which measures the D1 value which is an example of the first value of the water sample, and a second measurement device which retrieves the water sample from the repository and measures the second value. This repository has a plurality of day of the week racks which store water samples for each day of the week on which the first value was measured.

[0193] The first measurement device has a dilution process which dilutes the water sample to prescribed dilution ratios, a standby process which holds the water sample diluted by the dilution process in standby for at least a prescribed time, a first measurement process which measures the first value of the water sample which was held in standby by the standby process, and a supply process which pours the water sample measured by the first measurement process into a container and supplies the container to the day of the week rack.

[0194] The second measurement device has a retrieval process which retrieves the container from the rack corresponding to the day of the week on which the D5 value, which is an example of the second value, is to be measured, and a second measurement process which collects the water sample from the container retrieved by the retrieval means and measures the second value.

[0195] In addition, the second measurement device has a BOD calculation process which calculates the BOD value which expresses the water quality of a water sample based on the first value D1 and the second value D5.

[0196] A BOD automatic measurement method equipped with these elements can calculate the BOD value of a water sample by automatically executing all processes, merely by an original water sample being loaded. The calculated result is provided to users together with other data elements.

[0197] Note that in this Specification, in the descriptions of the embodiments of the Present Disclosure, terminology that indicates a container as an original water container, dilution container, various measurement containers or storage container is used, but these are containers

that hold the respective water samples and do not have to be strictly differentiated. In measurement of the actual D1 value and D5 value, which container holds the target water sample is unrelated to the gist of the Present Disclosure, and it is acceptable as long as containers which can clearly separate at least the original water sample and the diluted water sample are used.

- 5 Also, the BOD automatic measurement device has a process in which the water samples in the various containers and pipes are discharged and the containers and pipes are washed using washing water, but any known technique can be used as the method of doing so.

[0198] The BOD automatic measurement device, BOD automatic measurement system and BOD automatic measurement method described in embodiments 1 and 2 are examples that
10 describe the spirit of the Present Disclosure, and include modifications so long as they do not deviate from the spirit of Present Disclosure.

[0199] While a preferred embodiment of the Present Disclosure is shown and described, it is envisioned that those skilled in the art may devise various modifications without departing from the spirit and scope of the foregoing Description and the appended Claims.

CLAIMS**WHAT IS CLAIMED IS:**

- 5 1. An automatic measurement device, comprising:
 a repository, the repository storing water samples after a first value has been
measured and until a second value is measured;
 a first measurement device, the first measurement device measuring the first value
of the water samples; and
10 a second measurement device, which retrieves said water samples from said
repository and measures said second value;
 wherein the repository includes a plurality of day of the week racks, each rack
storing the water samples for each day of the week after the first value has been measured.
- 15 2. The BOD automatic measurement device of Claim 1, wherein the first
measurement device includes a dilution means, which dilutes the water samples to prescribed
ratios.
- 20 3. The BOD automatic measurement device of Claim 2, wherein the first
measurement device includes a standby means, which holds the water samples which have been
diluted by the dilution means in standby for at least a prescribed time.
- 25 4. The BOD automatic measurement device of Claim 3, wherein the first
measurement device includes a first measuring instrument, which measures the first value of the
water samples which have been held in standby by the standby means.
- 30 5. The BOD automatic measurement device of Claim 4, wherein the first
measurement device includes a supply means, which pours the water samples which have been
measured by the first measuring instrument into containers and supplies the containers to the day
of the week racks.

6. The BOD automatic measurement device of Claim 5, wherein the second measurement device includes a retrieval means, which retrieves the containers from the day of the week racks corresponding to the days of the week on which the second value is measured.

5 7. The BOD automatic measurement device of Claim 6, wherein the second measurement device includes a second measurement instrument, which samples the water samples from the containers which were retrieved by the retrieval means and measures the second values.

10 8. The BOD automatic measurement device of Claim 7, wherein the first measurement device and the repository are connected in such a way that they can transfer the containers.

15 9. The BOD automatic measurement device of Claim 8, wherein the repository and the second measurement device are connected in such a way that they can transfer the containers.

10. The BOD automatic measurement device of Claim 9, wherein the supply means and the retrieval means automatically execute processes with the repository as a reference.

20 11. The BOD automatic measurement device of Claim 10, in which the repository moves the containers from the first measurement device to the second measurement device on the day of the week racks.

25 12. The BOD automatic measurement device of Claim 11, in which the repository is further provided with a discharge rack which classifies and holds the containers when the measurement of the second value has been completed.

13. The BOD automatic measurement device of Claim 12, in which the dilution means dilutes the water samples to prescribed ratios.

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14. The BOD automatic measurement device of Claim 13, in which the standby means has a conveyor which moves the water samples which have been diluted to the first measurement instrument, and the time which the conveyor requires for the movement is at least a prescribed time.

5

15. The BOD automatic measurement device of Claim 14, in which the first measurement device further has a container supply means which automatically supplies the containers to the supply means.

10

16. The BOD automatic measurement device of Claim 15, wherein the supply means is provided with a plugging mechanism which automatically inserts the plugs of the containers.

15

17. The BOD automatic measurement device of Claim 16, wherein the retrieval means is provided with an unplugging mechanism which automatically removes the plugs of the containers.

20

18. The BOD automatic measurement device of Claim 17, in which the second measurement means further has a discharge means which discharges the containers to the discharge rack when the measurement of the second value has been completed.

25

19. The BOD automatic measurement device of Claim 18, in which the second measurement device is further provided with a BOD calculation means, which calculates the BOD values of the water samples, which have been diluted, based on the first value and the second value.

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20. The BOD automatic measurement device of Claim 19, further comprising a control unit which controls at least part of the first measurement device, the repository, the second measurement device.

21. The BOD automatic measurement device of Claim 20, wherein the control unit updates a measurement data table corresponding to the containers.

22. The BOD automatic measurement device of Claim 21, wherein, in the measurement data table, the first value in the containers is added in the first measurement device.

5 23. The BOD automatic measurement device of Claim 22, wherein the second measurement values and BOD values in the containers are added in the second measurement device.

10 24. The BOD automatic measurement device of Claim 23, wherein the measurement data table further has identification information which identifies the containers.

15 25. The BOD automatic measurement device of Claim 24, wherein the identification information recognizes the containers by at least one of the following set of identification codes, bar codes, two-dimensional bar codes and identification tags provided to the containers.

20 26. A BOD automatic measurement method, comprising:
a repository, which stores water samples after the first value has been measured and until the second value is measured;

a first measurement device, which measures the first value of the water samples;

and

a second measurement device, which retrieves the water samples from the repository and measures the second value;

wherein:

said repository uses a plurality of day of the week racks, which store the water samples for each day of the week on which said first value was measured;

the following processes are executed in the first measurement device:

a dilution process, in which the water samples are diluted to prescribed ratios;

a standby process, in which the water samples which have been diluted in the dilution process are held in standby for at least a prescribed time;

a first measurement process, in which the first value of the water samples which have been held in the standby process is measured; and

a supply process, in which the water samples which have been measured in the first measurement process are poured into containers and the containers are supplied to the day of the week racks;

the following processes are executed in the second measurement device:

a retrieval process, in which the containers are retrieved from the day of the week racks corresponding to the days of the week on which the second value is measured; and

a second measurement process, in which water samples are collected from the containers which were retrieved in the retrieval process and the second value is measured; and

a BOD calculation process, in which the BOD values of the water samples are calculated based on the first and second values.

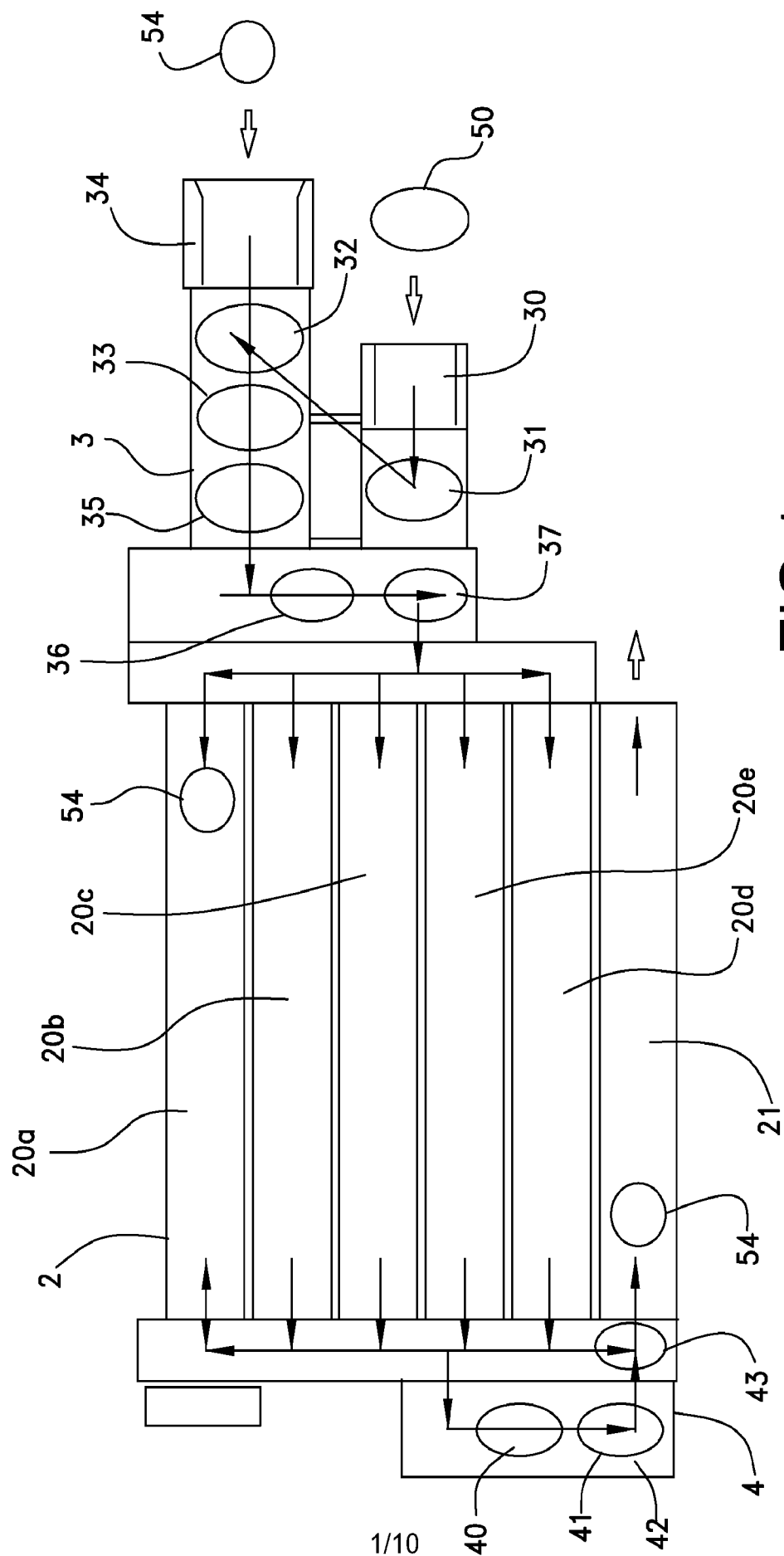


FIG.1

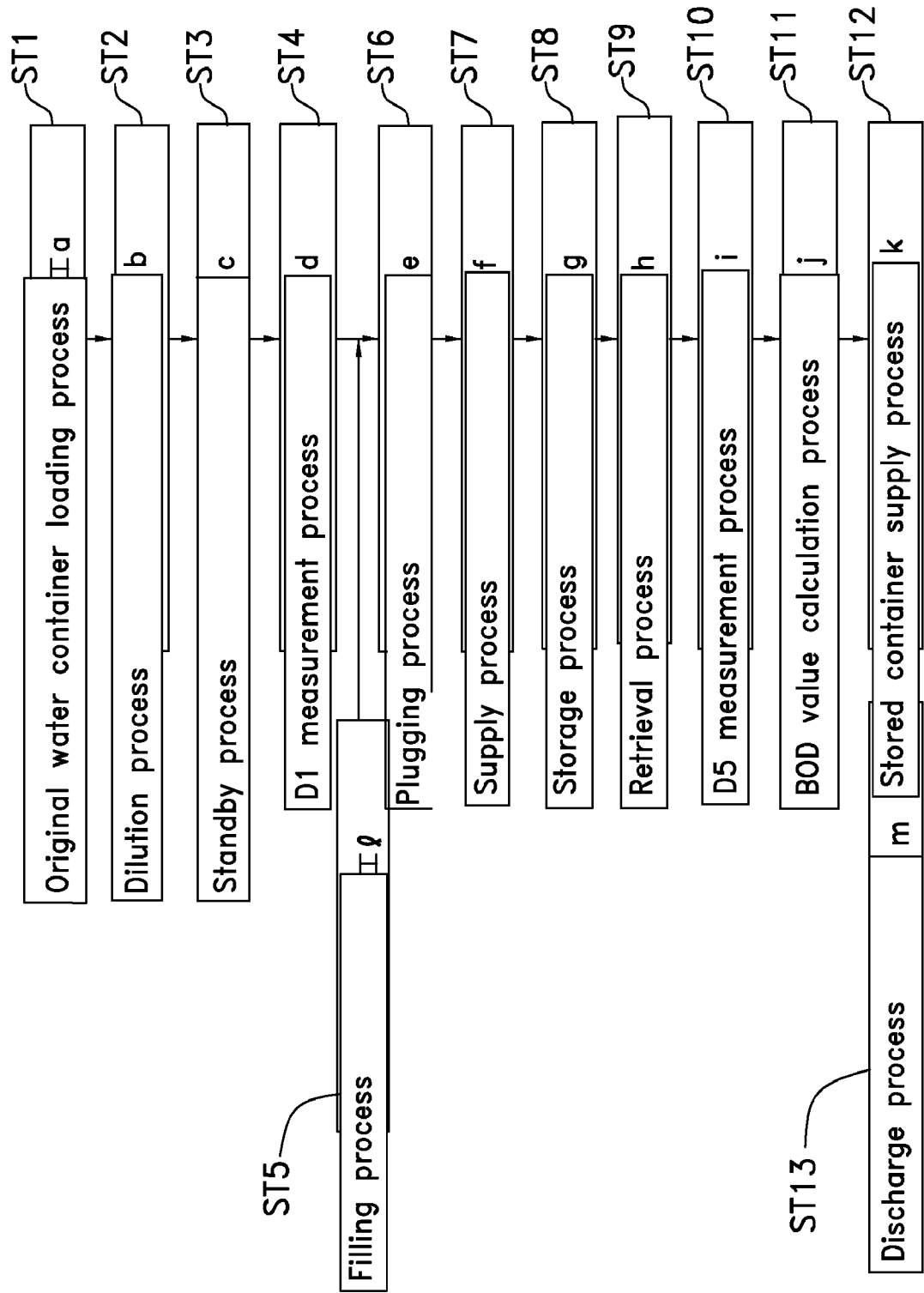


FIG.2

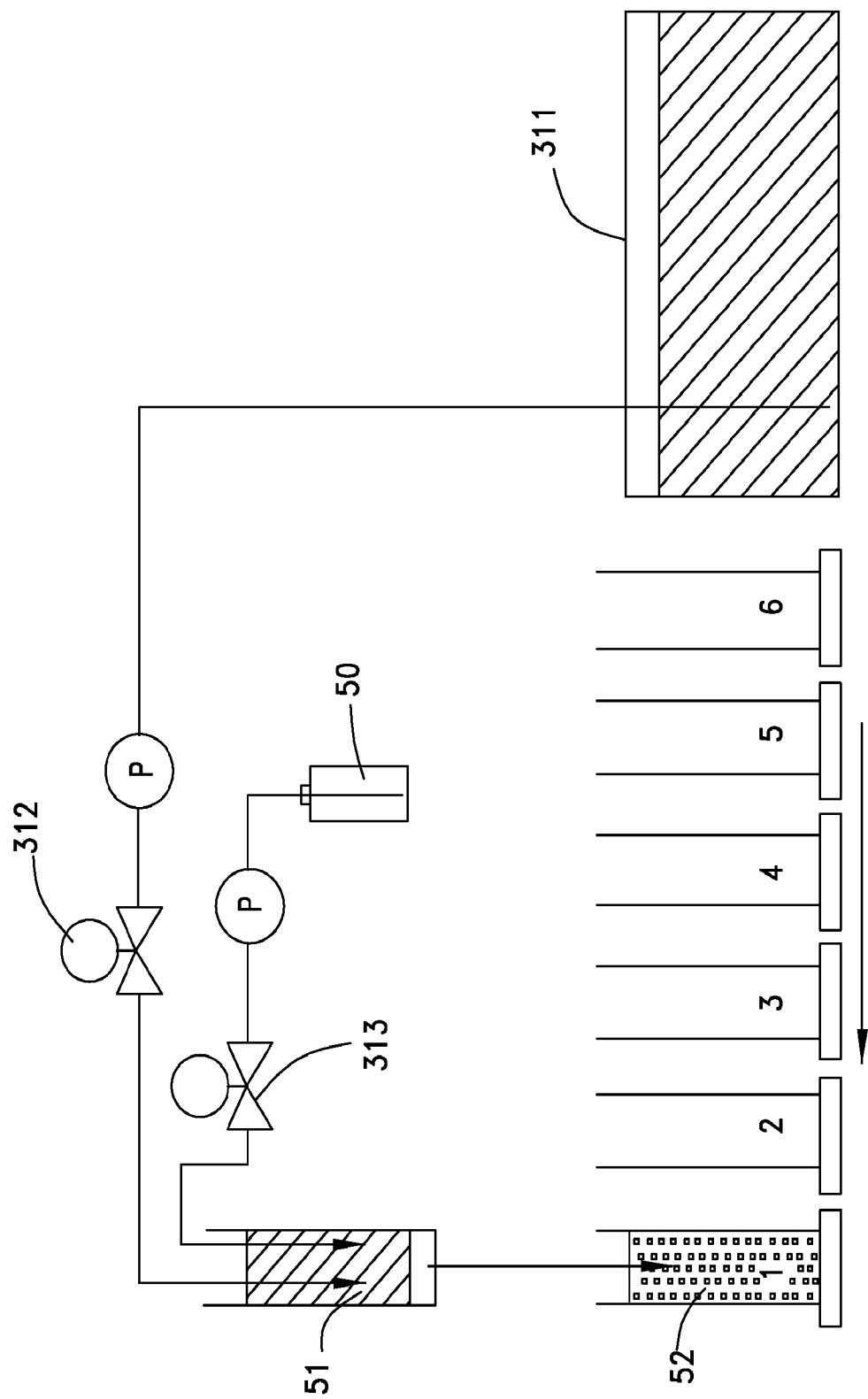


FIG.3

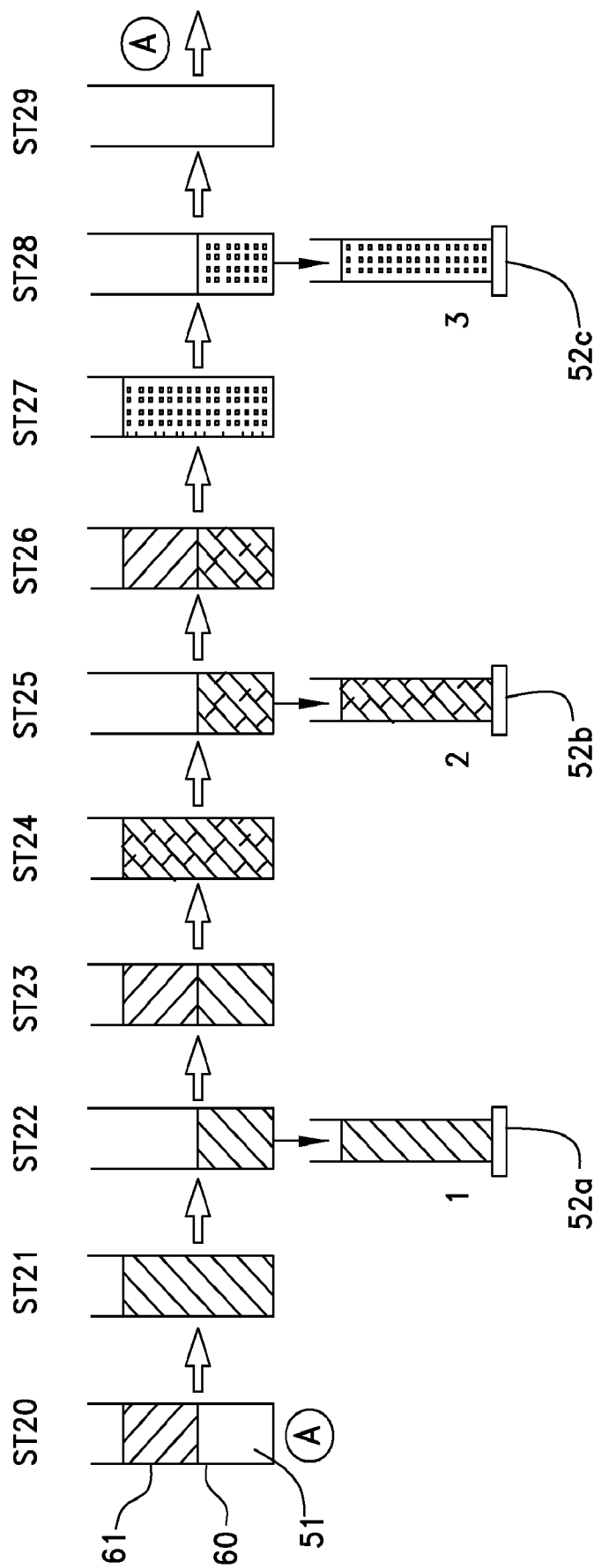
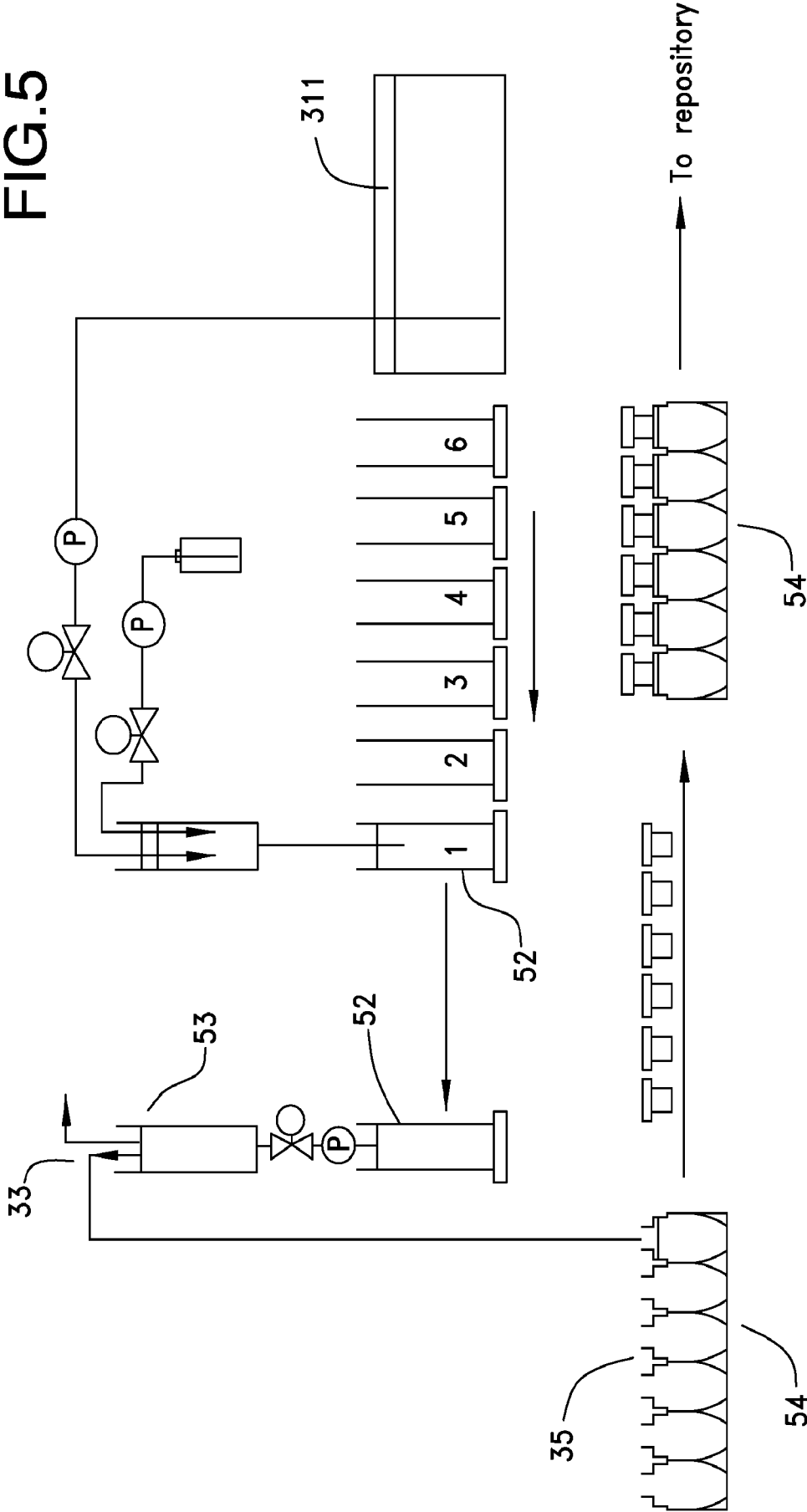


FIG.4



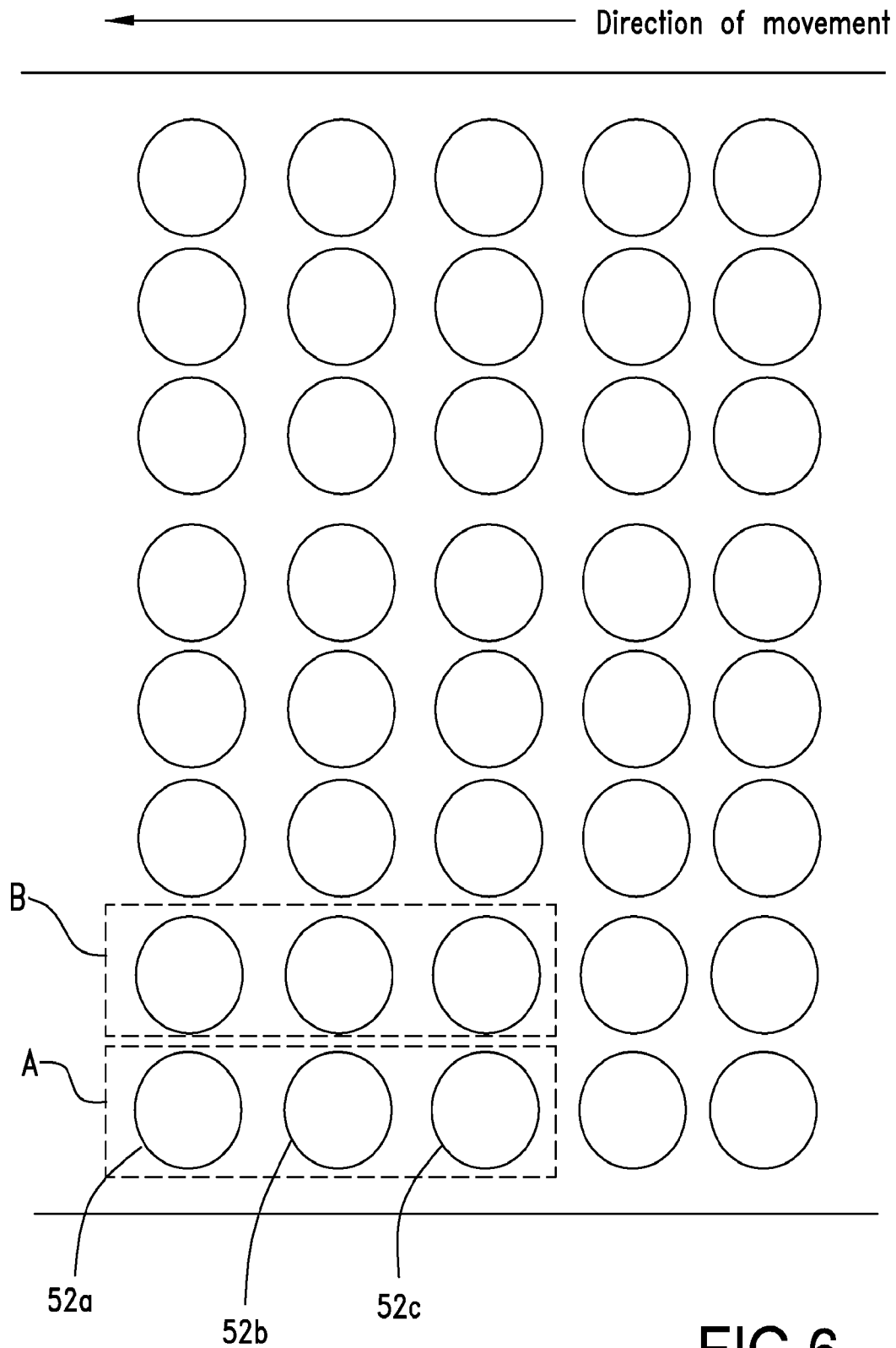


FIG.6

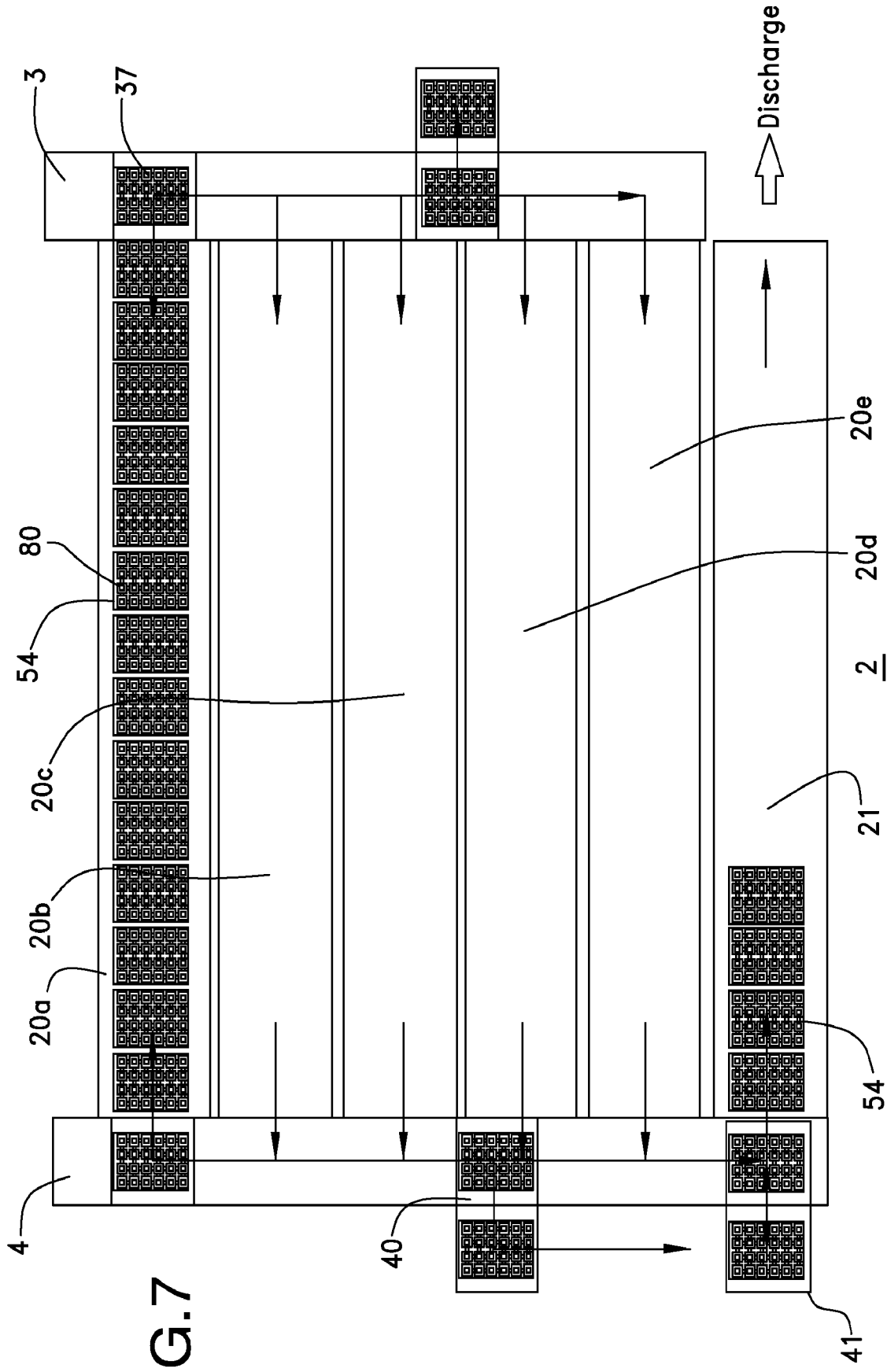
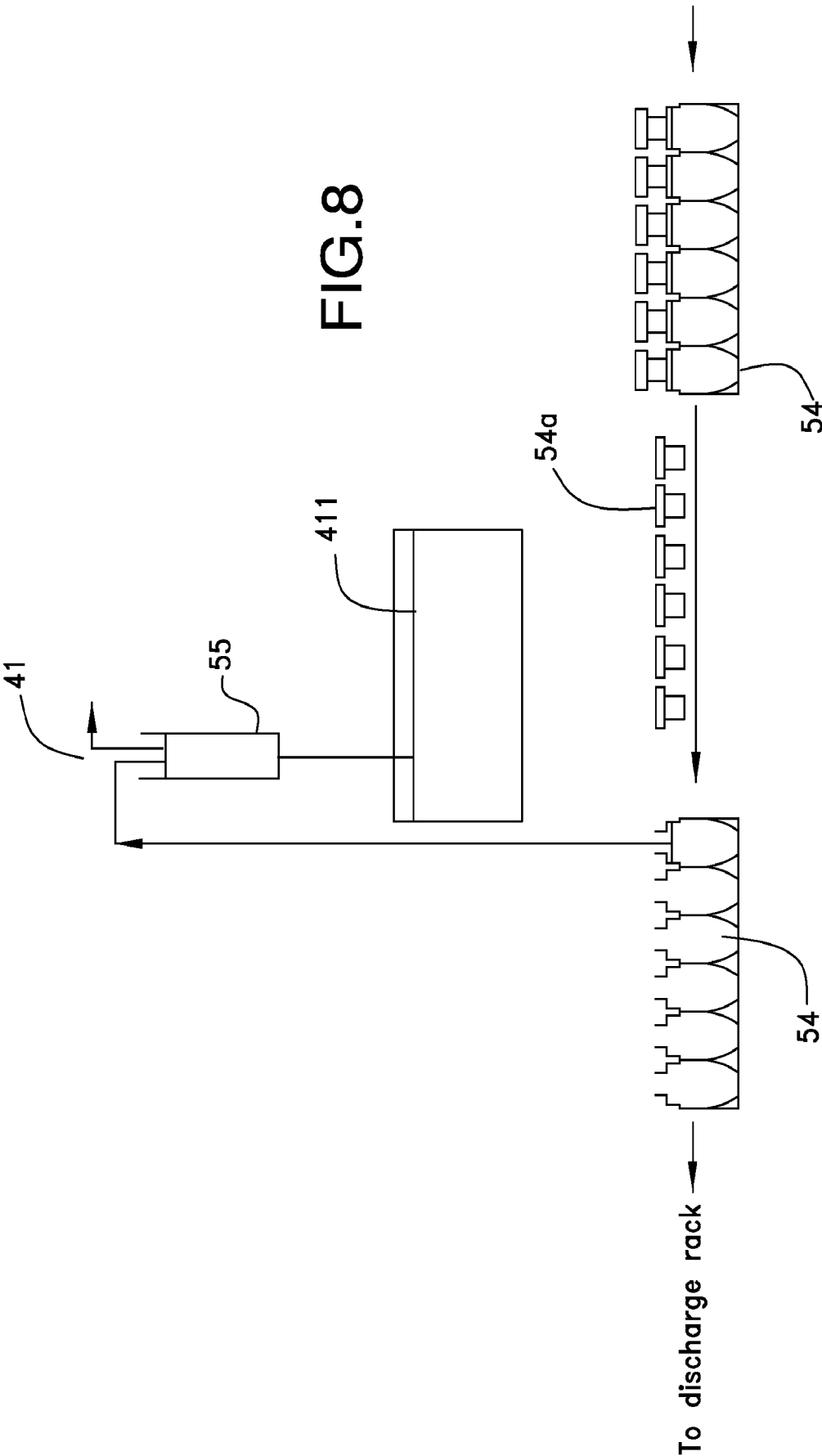


FIG. 7



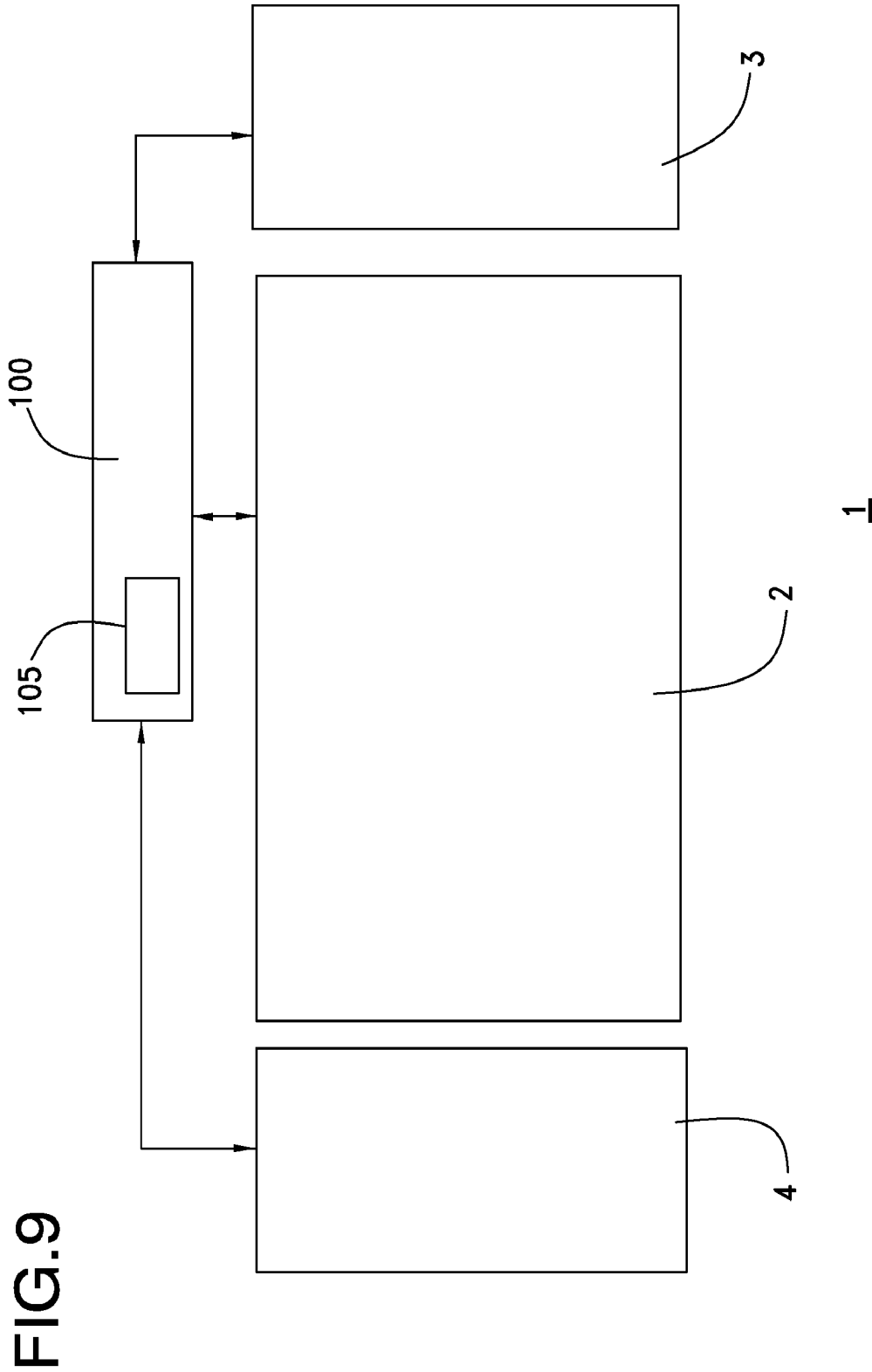


FIG. 9

FIG.10

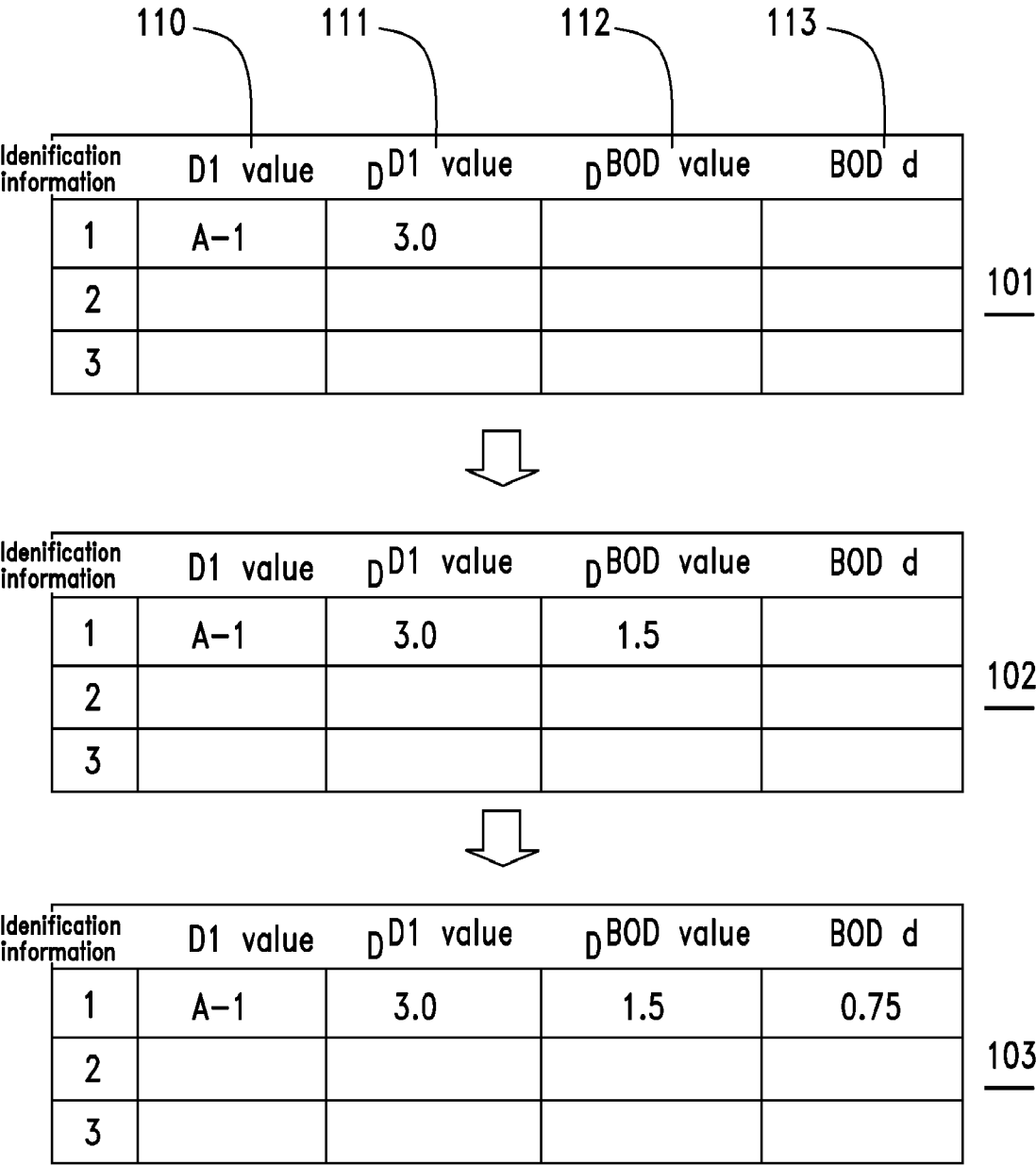


FIG.10