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(54) **Toilet device**

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(56) References cited:

WO-A1-2011/061478

DE-A1-102011 001 514

US-A1- 2009 217 445

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DescriptionFIELD

5 **[0001]** Embodiments described herein relate generally to a toilet device, and specifically to a toilet device capable of sterilizing or washing a toilet.

BACKGROUND

10 **[0002]** For instance, there is a toilet device capable of wetting the bowl surface of the toilet stool before the user uses the toilet stool. This toilet device can reduce dirt attached to the bowl surface. Here, in view of the recent trend of water saving, it is desirable to avoid using much water wherever possible.

15 **[0003]** In this context, there is a sanitary washing device including a metal ion elution means and an atomization means (JP-A-2008-163716). In the sanitary washing device described in JP-A-2008-163716, when a user entering the toilet room is sensed, atomized water is transported into the toilet stool. The atomized water is suspended in the toilet bowl. Thus, a water film can be formed on the inner surface of the toilet bowl before excretion by the user. Next, when a prescribed time comes, water containing sterilizing metal ions is supplied to the toilet bowl by the atomization means.

20 **[0004]** Further, DE 10 2011 001 514 A1 discloses a toilet device comprising a toilet stool including a bowl, a spray section a controller for controlling spray amount of water drops by controlling time, the toilet device further comprising a sensor for controlling spray time and the water drops having an average particle size of 100-300 μm .

25 **[0005]** Here, it is more desirable that water and sterilizing water sprayed on the bowl surface of the toilet stool be evenly attached to the bowl surface. Furthermore, when sterilizing water is sprayed, in order to achieve efficient sterilization, it is more desirable that the sterilizing water stay on the bowl surface. If the spray amount of water or sterilizing water is small, the dirt attached to the bowl surface is difficult to reduce. This causes the problem of failing to achieve efficient sterilization. On the other hand, if the spray amount of water or sterilizing water is large, the water or sterilizing water may mutually aggregate and flow down from the bowl surface. The flow down leaves a streaky region where no water drops are attached. This causes the problem of failing to reduce the dirt attached to the bowl surface relative to a longer spray time.

30 **[0006]** To solve the above problems, there is provided a toilet device comprising:

35 a toilet stool including a bowl;
 a spray section configured to spray water drops on a surface of the bowl;
 a controller configured to control spray amount of the water drops sprayed by the spray section, by controlling time for which the spray section sprays the water drops, before the toilet stool is used; and
 a casing provided with a sensor for controlling spray time, the sensor being selected amongst a room entry sensor, a human body sensor and a seating sensor,

wherein the water drop has an average particle diameter of 100-300 μm ;
 characterized in that:

40 the toilet device further comprises a sanitary washing device provided on the toilet stool and comprising the casing;
 the spray section is provided below said casing; and

45 said controller is configured to control occupancy ratio of the water drops attached to the surface of the bowl to 10-50% in a prescribed region of the surface of the bowl,
 wherein said prescribed region is located behind a center line (805c) of a pool water surface (805) formed in the bowl as viewed from a lateral side of the toilet stool (800).

50 **[0007]** Preferably, the controller controls the occupancy ratio of the water drops attached to the surface of the bowl to 10-20% in the prescribed region of the surface of the bowl.

55 **[0008]** Preferably still, the controller controls the occupancy ratio of the water drops attached to the surface of the bowl to 30-50% in the prescribed region of the surface of the bowl.

[0009] Suitably, the surface of the bowl has hydrophilicity.

[0010] Typically, the device further comprises a sterilizing water generator capable of generating sterilizing water, wherein the spray section sprays the sterilizing water on the surface of the bowl.

SUMMARY

[0011] A toilet device is provided according to one aspect of the invention, where the toilet device includes: a toilet

stool including a bowl; a spray section configured to spray water drops on a surface of the bowl; and a controller configured to control spray amount of the water drops sprayed by the spray section before the toilet stool is used, and to control occupancy ratio of the water drops attached to the surface of the bowl to 10-50% in a prescribed region of the surface of the bowl.

DETAILED DESCRIPTION

[0012] A first aspect of the invention is a toilet device comprising: a toilet stool including a bowl; a spray section configured to spray water drops on a surface of the bowl; and a controller configured to control spray amount of the water drops sprayed by the spray section before the toilet stool is used, and to control occupancy ratio of the water drops attached to the surface of the bowl to 10-50% in a prescribed region of the surface of the bowl.

[0013] In this toilet device, the controller controls the spray amount of water drops sprayed by the spray section, and controls the occupancy ratio of water drops attached to the surface of the bowl to 10-50% in a prescribed region of the surface of the bowl. Thus, the water drops attached to the surface of the bowl are distributed generally evenly on the bowl surface. This can reduce the risk of dirt being attached to the portion where no water drops are attached to the surface of the bowl. Thus, the dirt attached to the surface of the bowl can be reduced. Furthermore, the spray amount of water drops can be suppressed, and the spray time of water drops can be shortened.

[0014] Furthermore, the controller controls the occupancy ratio of water drops attached to the surface of the bowl to 10-50%. Thus, even if a water film is not formed on the surface of the bowl, the water drop is crushed by dirt and spread on the surface of the bowl. Hence, the water drop can be connected with other adjacent water drops to form a water film with a suitable thickness. This can suppress dirt attached to the bowl surface of the toilet stool while suppressing the spray amount.

[0015] A second aspect of the invention is the toilet device according to the first aspect of the invention, wherein the controller controls the occupancy ratio of the water drops attached to the surface of the bowl to 10-20% in the prescribed region of the surface of the bowl.

[0016] In this toilet device, the controller controls the occupancy ratio of water drops attached to the surface of the bowl to 10-20%. Thus, the density of the water drops attached to the surface of the bowl can be placed in a more stable state. This state can suppress mutual aggregation of a plurality of water drops. Thus, the size (amount) of the water drop increases. Furthermore, irrespective of the property of the surface of the toilet bowl, the occupancy ratio of water drops can be maintained more stably.

[0017] A third aspect of the invention is the toilet device according to the first aspect of the invention, wherein the controller controls the occupancy ratio of the water drops attached to the surface of the bowl to 30-50% in the prescribed region of the surface of the bowl.

[0018] In this toilet device, the controller controls the occupancy ratio of water drops attached to the surface of the bowl to 30-50%. This can achieve the state of suppressing a plurality of water drops mutually aggregating and slipping down from the surface of the bowl. In this state, the amount of water drops is larger. Thus, the thickness of the formed water film can be ensured. Accordingly, the effect of suppressing dirt being attached to the surface of the bowl is achieved more efficiently and stably.

[0019] In general, the dirt excreted by the user is more likely to be attached to the surface of the bowl behind the center line of the pool water surface formed in the bowl than to the surface of the bowl in front thereof as viewed from the lateral side of the toilet stool. In these toilet devices, the controller controls the occupancy ratio of water drops attached to the surface of the bowl behind the center line of the pool water surface formed in the bowl as viewed from the lateral side of the toilet stool to approximately 10-50%. Thus, the dirt attached to the surface of the bowl can be reduced more efficiently.

[0020] A fourth aspect of the invention is the toilet device according to the first aspect of the invention, wherein the surface of the bowl has hydrophilicity.

[0021] In this toilet device, the surface of the bowl has hydrophilicity. Thus, the water drop sprayed from the spray section is reliably attached to the surface of the bowl. Accordingly, the occupancy ratio of water drops can be favorably controlled in the high region. Thus, the dirt attached to the surface of the bowl can be reduced more effectively. Here, the hydrophilicity refers to one such that the water drop sprayed on the bowl and attached to its surface does not flow down. In particular, the bowl surface of the toilet stool often has a slope surface, although depending on the type of the toilet stool. Thus, the bowl surface is preferably such that the water drop does not slip down on the maximum slope surface thereof.

[0022] According to the invention the water drop has an average particle diameter of 100-300 μm .

[0023] With regard to the average particle diameter, the particle diameter distribution is determined by the Fraunhofer analysis using a He-Ne laser. The Sauter mean (total volume/total surface area) is used as the average particle diameter.

[0024] In these toilet devices, suspension of the water drops sprayed by the spray section can be suppressed. This can suppress attachment of water drops to e.g. the toilet seat and the buttocks or thighs of the user. Furthermore, this

can suppress aggregation of the water drops sprayed by the spray section during or after impinging on the surface of the bowl. Thus, the water drops can be held more efficiently on the surface of the bowl. Furthermore, the controller can control more easily the occupancy ratio of water drops attached to the surface of the bowl.

[0025] According to the invention, the toilet device

controls the occupancy ratio by controlling time for which the spray section sprays the water drops.

[0026] In this toilet device, the controller can control more easily the occupancy ratio of water drops attached to the surface of the bowl by controlling the particle diameter and spray time of the water drops sprayed by the spray section. For instance, the controller appropriately controls the spray time in view of the time from the user entering the toilet room until being seated on the toilet seat. Accordingly, the surface of the bowl of the toilet stool can be wetted before the user

uses the toilet stool. This can suppress attachment of water drops to e.g. the buttocks and thighs of the user.

[0027] A fifth aspect of the invention is the toilet device according to the first aspect of the invention, further comprising: a sterilizing water generator capable of generating sterilizing water, wherein the spray section sprays the sterilizing water on the surface of the bowl.

[0028] In this toilet device, the spray section can spray the sterilizing water generated by the sterilizing water generator on the surface of the bowl. This can sterilize bacteria existing on the surface of the bowl of the toilet stool. Furthermore, the controller controls the spray amount of the sterilizing water sprayed by the spray section, and controls the occupancy ratio of the sterilizing water attached to the surface of the bowl to 10-50% in the prescribed region of the surface of the bowl. This can suppress aggregation and flow down of the sterilizing water during or after impinging on the surface of the bowl. Thus, the sterilizing water can be held more efficiently on the surface of the bowl. Accordingly, the surface of the bowl can be sterilized more efficiently.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The above, and the other objects, features and advantages will be made apparent from the description of preferred embodiments of the invention described as non-limiting examples, with reference to the drawings in which:

FIG. 1 is a schematic view showing a toilet device according to an embodiment of the invention;

FIG. 2 is a block diagram showing the relevant configuration of the toilet device according to this embodiment;

FIG. 3 is a schematic plan view illustrating the measurement position of the particle diameter of the water drop sprayed by the spray nozzle;

FIG. 4 is a graph illustrating an example measurement result of the particle diameter of the water drop sprayed by the spray nozzle;

FIG. 5 is a schematic view for describing the condition of the experiment for the occupancy ratio of water drops performed by the inventor;

FIGS. 6A and 6B are schematic views for describing the condition of the experiment for the occupancy ratio of water drops performed by the inventor;

FIG. 7 is a result table illustrating an example result of this experiment;

FIG. 8 is a graph illustrating the example result of this experiment;

FIG. 9 is a result table illustrating an example result of the experiment for the nutrition residual ratio performed by the inventor;

FIG. 10 is a graph illustrating the example result of this experiment;

FIG. 11 is a graph illustrating an example relationship between the water drop occupancy ratio and the nutrition residual ratio;

FIG. 12 is a comparison table for describing the test piece of each sample;

FIGS. 13A to 13C are schematic plan views for describing the function of dirt removal;

FIGS. 14A and 14B are schematic perspective views for describing an experiment for water film formation performed by the inventor;

FIG. 15 an experimental result table illustrating an example result of this experiment;

FIG. 16 is a graph illustrating an example relationship between the water drop occupancy ratio and the water drop amount;

FIG. 17 is a data table illustrating an example of detailed data of the water drop occupancy ratio and the nutrition residual ratio;

FIG. 18 is a graph illustrating an example relationship between the water drop occupancy ratio and the water drop amount;

FIG. 19 is a graph illustrating an example relationship between the water drop occupancy ratio and the water drop density;

FIG. 20 is a result table illustrating the surface photograph and binarized image at prescribed water drop occupancy ratios; and

FIG. 21 is a schematic sectional view illustrating the example of the sterilizing water generator of this embodiment.

[0030] In the drawings, similar components are labeled with like reference numerals, and the detailed description thereof is omitted appropriately.

DETAILED DESCRIPTION OF PREFERENTIAL EMBODIMENTS

[0031] FIG. 1 is a schematic view showing a toilet device according to an embodiment of the invention.

[0032] FIG. 2 is a block diagram showing the relevant configuration of the toilet device according to this embodiment.

[0033] In FIG. 1, for convenience of description, the schematic view showing the sanitary washing device is a schematic plan view, and the schematic view showing the sit-down toilet stool is a schematic sectional view. In FIG. 2, the relevant configuration of the water channel system and the electrical system is shown together.

[0034] The toilet device 10 shown in FIG. 1 includes a sit-down toilet stool (hereinafter simply referred to as "toilet stool" for convenience of description) 800 and a sanitary washing device 100 provided thereon. The toilet stool 800 includes a bowl 801. The sanitary washing device 100 includes a casing 400, a toilet seat 200, and a toilet lid 300. The toilet seat 200 and the toilet lid 300 are each pivotally supported on the casing 400 in an openable/closable manner. Here, the toilet lid 300 is not necessarily needed.

[0035] For instance, below the casing 400 is provided a spray nozzle (spray section) 480 for spraying water and sterilizing water on the surface of the bowl 801 of the toilet stool 800. The spray nozzle 480 may be provided inside the casing 400, or may be attached to the outside of the casing 400.

[0036] Here, the term "water" used herein refers not only to cold water, but also to heated hot water. Furthermore, the term "sterilizing water" used herein refers to a liquid containing a sterilizing ingredient such as hypochlorous acid more than tap water (also simply referred to as "water").

[0037] As shown in FIG. 2, the toilet device 10 according to this embodiment includes a first flow channel 21 for guiding water supplied from a water supply source such as a water tap or a flush tank to the spray nozzle 480. On the upstream side of the first flow channel 21, a solenoid valve 431 is provided. The solenoid valve 431 is an openable/closable solenoid valve, and regulates water supply based on commands from a controller 405 provided inside the casing 400. Here, the first flow channel 21 refers to the downstream side or secondary side of the solenoid valve 431.

[0038] Downstream of the solenoid valve 431 is provided a sterilizing water generator 450 capable of generating sterilizing water. The sterilizing water generator 450 is described later in detail. Downstream of the sterilizing water generator 450 is provided a flow rate/flow channel switching valve 471 for adjusting the water force (flow rate) and for opening/closing and switching water supply to the spray nozzle 480 and the washing nozzle, not shown. The first flow channel 21 is branched in the flow rate/flow channel switching valve 471. The sterilizing water or clean water guided in the first flow channel 21 passes through the flow rate/flow channel switching valve 471 and then is guided to the spray nozzle 480. On the other hand, the sterilizing water or clean water branched in the flow rate/flow channel switching valve 471 and guided to a second flow channel 23 is guided to e.g. the washing nozzle or nozzle cleaning chamber, not shown. Based on commands from the controller 405, the flow rate/flow channel switching valve 471 can switch between the state of guiding the sterilizing water or clean water to the first flow channel 21 and the state of guiding the sterilizing water or clean water to the second flow channel 23.

[0039] For instance, the casing 400 is provided with a room entry sensor 402 for sensing entry of a user into the toilet room, a human body sensor 403 for sensing a user present in front of the toilet seat 200, and a seating sensor 404 for sensing seating of a user on the toilet seat 200.

[0040] The room entry sensor 402 can sense a user who has just opened the door of the toilet room and entered the toilet room. Furthermore, the room entry sensor 402 can sense a user about to enter the toilet room and present in front of the door. That is, the room entry sensor 402 can sense not only a user who has entered the toilet room, but also a user who is yet to enter the toilet room, i.e., a user present in front of the door outside the toilet room. Such a room entry sensor 402 can be e.g. a pyroelectric sensor, or a microwave sensor such as Doppler sensor. The microwave sensor can be based on the microwave Doppler effect, or can transmit a microwave and detect an object based on the amplitude (intensity) of the reflected microwave. In the case of using such a sensor, the presence of a user can be sensed through the door of the toilet room. That is, such a sensor can sense a user before entering the toilet room.

[0041] The human body sensor 403 can sense a user present in front of the toilet stool 800, i.e., a user present at a position spaced in front of the toilet seat 200. That is, the human body sensor 403 can sense a user entering the toilet room and approaching the toilet seat 200. Such a human body sensor 403 can be e.g. an infrared transmit/receive range sensor.

[0042] The seating sensor 404 can sense a human body present above the toilet seat 200 immediately before the user is seated on the toilet seat 200. Furthermore, the seating sensor 404 can sense a user seated on the toilet seat 200. That is, the seating sensor 404 can sense not only a user seated on the toilet seat 200, but also a user present above the toilet seat 200. Such a seating sensor 404 can be e.g. an infrared transmit/receive range sensor.

[0043] In the toilet device 10 according to this embodiment, for instance, the room entry sensor 402 senses entry of a user into the toilet room. Then, the controller 405 performs control for spraying water drops on the surface of the bowl 801 of the toilet stool 800 from the spray nozzle 480. That is, the controller 405 can perform control for wetting the surface of the bowl 801 of the toilet stool 800 with water drops before the user uses the toilet stool 800. This can reduce dirt attached to the surface of the bowl 801.

[0044] The controller 405 controls the spray amount of water drops sprayed by the spray nozzle 480, and controls the occupancy ratio of water drops attached to the surface of the bowl 801 to approximately 10-50% in a prescribed region of the surface of the bowl 801. Here, the term "occupancy ratio of water drops" or "water drop occupancy ratio" used herein refers to the value derived by the conditional expression described later with reference to FIGS. 5 to 8. Typically, the "prescribed region of the surface of the bowl 801" is e.g. the surface of the bowl 801 behind the center line 805c of the pool water surface 805 as viewed from the lateral side of the toilet stool 800 as shown in FIG. 1. Here, in this description, of the horizontal directions perpendicular to the center line 805c of the pool water surface 805 as viewed from the lateral side of the toilet stool 800, the front side as viewed from the user seated on the toilet seat 200 is referred to by such terms as "front", and the rear side as viewed from the user seated on the toilet seat 200 is referred to by such terms as "behind".

[0045] In general, the dirt excreted by the user is more likely to be attached to the surface of the bowl 801 behind the center line 805c of the pool water surface 805 than to the surface of the bowl 801 in front thereof as viewed from the lateral side of the toilet stool 800. Accordingly, the controller 405 controls the occupancy ratio of water drops attached to the surface of the bowl 801 behind the center line 805c of the pool water surface 805 as viewed from the lateral side of the toilet stool 800 to approximately 10-50%. Thus, the dirt attached to the surface of the bowl 801 can be reduced more efficiently.

[0046] If the occupancy ratio of water drops attached to the surface of the bowl 801 is lower than 10%, the spacing between the water drops attached to the surface of the bowl 801 is relatively wide. This results in a higher risk of dirt being attached to the portion where no water drops are attached to the surface of the bowl 801, i.e., the unwetted portion. In this context, as a method for wetting the surface of the bowl 801, before use of the toilet stool 800, jetting part of the water like toilet bowl flushing is often utilized. In this case, the residual water remaining on the surface after spreading the water throughout the bowl surface is utilized. The occupancy ratio of water drops in this case is approximately 15%. However, compared with the case of spraying water drops, the attachment state of water drops on the bowl 801 surface is less uniform. Thus, regions with no water drops attached thereto are widely distributed. Hence, the dirt attachment suppression effect cannot be achieved stably. This increases the risk of dirt remaining on the bowl 801 surface. Furthermore, most of the jetted water flows down from the bowl 801 surface. Thus, the proportion of the residual water remaining on the bowl 801 surface that can contribute to dirt attachment suppression is small. This is less effective also from the viewpoint of water saving.

[0047] On the other hand, also in the case where the occupancy ratio of water drops attached to the surface of the bowl 801 is higher than 50%, the dirt attached to the surface of the bowl 801 cannot be reduced relative to the high occupancy ratio of water drops. Furthermore, the spray amount of water drops is wasted, and a longer spray time is required. Thus, in the case where the controller 405 sprays water drops before the user uses the toilet stool 800, water drops may be squirted also after the user is seated on the toilet seat 200. This may make the user uneasy.

[0048] In contrast, the controller 405 of this embodiment controls the occupancy ratio of water drops attached to the surface of the bowl 801 to approximately 10-50% in a prescribed region of the surface of the bowl 801. Thus, the water drops attached to the surface of the bowl 801 are evenly distributed. This can reduce the risk of dirt being attached to the portion where no water drops are attached to the surface of the bowl 801. Thus, the dirt attached to the surface of the bowl 801 can be reduced. Furthermore, the spray amount of water drops can be suppressed, and the spray time of water drops can be shortened.

[0049] When dirt falls on the water drop attached to the surface of the bowl 801, the dirt crushes the water drop. At this time, if the occupancy ratio of water drops attached to the surface of the bowl 801 is approximately 2% or more, the crushed water drop is spread on the surface of the bowl 801, and can be connected with other adjacent water drops to form a water film. Thus, attachment of dirt to the surface of the bowl 801 can be suppressed. This will be described in detail later.

[0050] The surface of the bowl 801 of the toilet stool 800 of this embodiment has hydrophilicity. Thus, the water drop sprayed from the spray nozzle 480 is reliably attached to the surface of the bowl 801. Accordingly, the water drop occupancy ratio can be favorably controlled even in the high region. Thus, the dirt attached to the surface of the bowl 801 can be reduced more effectively. Here, the hydrophilicity refers to one such that the water drop attached to the bowl does not flow down. For instance, the surface of the toilet bowl being glazed exhibits good hydrophilicity.

[0051] Furthermore, the controller 405 can perform control for spraying the sterilizing water generated in the sterilizing water generator 450 on the surface of the bowl 801 of the toilet stool 800 from the spray nozzle 480. The spray nozzle 480 sprays the sterilizing water on the surface of the bowl 801 of the toilet stool 800. This can sterilize bacteria existing on the surface of the bowl 801 of the toilet stool 800. Thus, the spray nozzle 480 can suppress the "muddiness" occurring

on the surface of the bowl 801, and can suppress the so-called "stain ring". Furthermore, if the sterilizing water has a bleaching effect, such as in the case of hypochlorous acid water, the surface of the bowl 801 can be further whitened.

[0052] Also in the case of spraying the sterilizing water from the spray nozzle 480, the controller 405 controls the spray amount of the sterilizing water, and controls the occupancy ratio of sterilizing water attached to the surface of the bowl 801 to approximately 10-50% in the prescribed region of the surface of the bowl 801. The controller 405 controls the particle diameter and spray time of the sterilizing water sprayed by the spray nozzle 480. Thus, the controller 405 can control more easily the occupancy ratio of the sterilizing water attached to the surface of the bowl 801. This can suppress aggregation and flow down of the sterilizing water from the surface of the bowl 801 to the pool water surface 805 during or after impinging on the surface of the bowl 801. Thus, the sterilizing water can be held more efficiently on the surface of the bowl 801. Accordingly, the surface of the bowl 801 can be sterilized more efficiently. Here, in the case of utilizing sterilizing water, in order to increase the opportunity of contact with bacteria, a higher occupancy ratio is preferable.

[0053] In the toilet device 10 according to this embodiment, for instance, if a prescribed time has elapsed after the room entry sensor 402 ceases to sense the user in the toilet room, the controller 405 can perform control for spraying the sterilizing water on the surface of the bowl 801 of the toilet stool 800 from the spray nozzle 480. That is, after the user flushes the dirt and finishes using the toilet stool 800, the controller 405 can perform control for wetting the surface of the bowl 801 with the sterilizing water. At this time, the sterilizing water sprayed by the spray nozzle 480 can stay on the surface of the bowl 801 for a longer time than in the case of being sprayed before the user uses the toilet stool 800. Thus, the surface of the bowl 801 can be sterilized more efficiently.

[0054] FIG. 3 is a schematic plan view illustrating the measurement position of the particle diameter of the water drop sprayed by the spray nozzle.

[0055] FIG. 4 is a graph illustrating an example measurement result of the particle diameter of the water drop sprayed by the spray nozzle.

[0056] As shown in FIG. 3, the inventor measured the particle diameter of the water drop sprayed by the spray nozzle 480 at a position separated approximately 25 millimeters (mm) from the tip of the spray nozzle 480. Here, by using the Fraunhofer analysis, the particle diameter of the water drop sprayed by the spray nozzle 480 was measured. An example of the particle diameter distribution of water drops sprayed by the spray nozzle 480 is as shown in FIG. 4.

[0057] As shown in FIG. 4, the particle diameter of the water drop sprayed by the spray nozzle 480 is e.g. approximately 10-1000 micrometers (μm). The average particle diameter of the water drops sprayed by the spray nozzle 480 is e.g. approximately 50-500 μm . In view of effectively adjusting the water drop occupancy ratio, the average particle diameter of the water drops sprayed by the spray nozzle 480 is preferably 100-300 μm . If the particle diameter of the water drop is smaller than 10 μm , the water drop may be suspended and attached to e.g. the toilet seat 200. This makes it difficult for the controller 405 to control the occupancy ratio of water drops attached to the surface of the bowl 801. Furthermore, for instance, if the suspended water drop is attached to the buttocks or thighs of the user, it may cause discomfort to the user. On the other hand, if the particle diameter of the water drop is larger than 500 μm , the water drops may aggregate during or after impinging on the surface of the bowl 801 and flow down from the surface of the bowl 801 to the pool water surface 805. Then, the formation of the water film or water drops for reducing more effectively the dirt attached to the surface of the bowl 801 may be failed. This makes it difficult for the controller 405 to control the occupancy ratio of water drops attached to the surface of the bowl 801. It is noted that as the average particle diameter used herein, the Sauter mean (total volume/total surface area) is used. The Sauter mean is based on the particle diameter distribution of the Fraunhofer analysis, which favorably indicates the particle diameter of the water drop at the time of spraying.

[0058] In contrast, the average particle diameter of the water drops sprayed by the spray nozzle 480 is e.g. approximately 50-500 μm . Thus, suspension of the water drops sprayed by the spray nozzle 480 can be suppressed. This can suppress attachment of water drops to e.g. the toilet seat 200 and the buttocks or thighs of the user. Furthermore, this can suppress aggregation of the water drops sprayed by the spray nozzle 480 during or after impinging on the surface of the bowl 801. Thus, the water drops can be held more efficiently on the surface of the bowl 801. Furthermore, the controller 405 can control more easily the occupancy ratio of water drops attached to the surface of the bowl 801. Here, more preferably, the average particle diameter of the water drops sprayed by the spray nozzle 480 is e.g. approximately 200 μm .

[0059] The controller 405 can control the spray amount of water drops by controlling the time for which the spray nozzle 480 sprays the water drops. The controller 405 can control more easily the occupancy ratio of water drops attached to the surface of the bowl 801 by controlling the particle diameter and spray time of the water drops sprayed by the spray nozzle 480. The particle diameter of the water drop can be adjusted by the opening diameter and flow rate of the spray nozzle. In view of the time from the user entering the toilet room until being seated on the toilet seat 200, the spray time of the water drops is more preferably suppressed to e.g. approximately 10 seconds or less. Then, the surface of the bowl 801 of the toilet stool 800 can be wetted before the user uses the toilet stool 800. This can suppress attachment of water drops to e.g. the buttocks and thighs of the user.

[0060] Like the particle diameter of the water drop, the particle diameter of the sterilizing water sprayed by the spray

nozzle 480 is e.g. approximately 10-1000 μm . Like the average particle diameter of the water drops, the average particle diameter of the sterilizing water sprayed by the spray nozzle 480 is e.g. approximately 50-500 μm .

[0061] Next, an example result of the experiment for the occupancy ratio of water drops performed by the inventor is described with reference to the drawings.

[0062] FIG. 5, 6A, and 6B are schematic views for describing the condition of the experiment for the occupancy ratio of water drops performed by the inventor.

[0063] FIG. 7 is a result table illustrating an example result of this experiment.

[0064] FIG. 8 is a graph illustrating the example result of this experiment.

[0065] Here, FIG. 5 is a schematic plan view of the toilet stool 800 of this embodiment as viewed from above. FIG. 6A is a schematic plan view of a device for photographing a test piece as viewed from above. FIG. 6B is a schematic plan view of the device for photographing a test piece as viewed laterally.

[0066] The inventor sprayed a solution on the glaze surface of the bowl 801 of the toilet stool 800, being a sanitary ware, from the spray nozzle 480. At the measurement locations A-H shown in FIG. 5, the occupancy ratio of water drops was measured. This experiment is described by taking as an example the occupancy ratio of water drops at the measurement location G among the measurement locations A-H.

[0067] The inventor first mounted a test piece 810 at the measurement location G. The property of the surface of the test piece 810 is similar to the property of the glaze surface of the bowl 801. Thus, the surface of the test piece 810 has hydrophilicity like the glaze surface of the bowl 801.

[0068] Next, the inventor sprayed a solution on the surface of the bowl 801 of the toilet stool 800 from the spray nozzle 480 for 1 second, 2 seconds, 3 seconds, 4 seconds, 5 seconds, and 6 seconds. For convenience of experiment, the inventor colored the solution sprayed from the spray nozzle 480 in a prescribed color (in this experiment, green). The solution sprayed from the spray nozzle 480 is as follows.

[0069] The spray solution used in this experiment contains water and an edible green pigment (produced by Ogura Foods Communication). The spray solution is prepared by adding the edible green pigment to water at 1 wt%. A rotator (magnet) was put in the solution. By a magnetic stirrer (TR-300 manufactured by Pasolina) with the speed setting set to "5", the solution was stirred for 5 minutes.

[0070] The color of the spray solution was verified by using a spectrophotometer (CM-600d manufactured by Konica Minolta Sensing, Inc.). More specifically, 100 microliters (μL) of the spray solution was taken by a micropipette, dropped generally at the center of a piece of filter paper, and dried. The filter used at this time has a diameter of 90 mm. The color of the filter is white (e.g., $L^*(D65) = 97.25$, $a^*(D65) = -0.35$, and $b^*(D65) = 2.85$). The color generally at the center of the dried filter was measured by the spectrophotometer. In performing this measurement, five sheets of the same filter (without dropping) as the filter on which the spray solution was dropped were laid below the filter (with dropping) to be measured. Then, the difference between the base material (test piece 810) and the spray solution was set so that $\Delta L^*(D65) = -5.8$ or more. For instance, the color of the spray solution used was such that $L^*(D65) = 85.17$, $a^*(D65) = -23.17$, and $b^*(D65) = 6.50$.

[0071] The color of the base material (test piece 810) is as follows. The color generally at the center of the test piece 810 was measured by the spectrophotometer. For instance, the color of the test piece 810 used was such that $L^*(D65) = 90.97$, $a^*(D65) = -0.52$, and $b^*(D65) = 0.76$.

[0072] Next, the inventor measured the occupancy ratio of water drops attached to the test piece 810. The method for measuring the occupancy ratio of water drops attached to the test piece 810 is as follows.

[0073] As shown in FIGS. 6A and 6B, the inventor first mounted the test piece 810 on a mounting stage 820. A light source 830 was placed at a position of generally 35° obliquely above the surface (photographed surface) of the test piece 810. The photographed surface was irradiated with light from the light source 830. In this experiment, light irradiation was performed from two light sources 830 symmetric with respect to the center line 810c of the test piece 810. Before light irradiation from the light source 830, the illuminance at the measurement locations P1-P5 was measured by an illuminometer (3423 LUX HiTESTER manufactured by HIOKI E.E. Corporation). In this measurement, the illuminance at the measurement locations P1-P5 was 200-250 lux (lx). During light irradiation from the light source 830 (during photographing), the illuminance at the measurement locations P1-P5 was 5700-6000 lx.

[0074] Next, the inventor photographed the surface of the test piece 810 with water drops attached thereto. The photographing was performed by using "DIGITAL MICROSCOPE VHX-100F manufactured by KEYENCE Corporation", based on 1-4 and 7-26 of the user's manual of "DIGITAL MICROSCOPE VHX-100F manufactured by KEYENCE Corporation". An example of the photographs taken is shown in FIG. 7 as "WATER DROP PHOTOGRAPH". In this case, the magnification of the lens was set to "5x". Before photographing, the "LIGHT CONTROL dial" for adjusting the amount of light of the halogen lamp attached to the "DIGITAL MICROSCOPE VHX-100F manufactured by KEYENCE Corporation" was set to "MIN", and the "brightness adjustment dial" for adjusting brightness was set to the position of 12 o'clock. Then, the "white balance button" was pushed. The "white balance button" is a button for enabling the function of automatically adjusting the color of the image. The photographed area is 1875 mm^2 (50 mm x 37.5 mm). The number of pixels of the photograph taken is 2 million pixels.

[0075] Next, in the photographed image of water drops, the area of the water drops was measured by using the area measurement function based on luminance. To this end, the portion of a preset luminance was extracted (binarization). The extraction of the portion of the luminance was performed based on 7-27 and 7-28 of the user's manual of "DIGITAL MICROSCOPE VHX-100F manufactured by KEYENCE Corporation". The luminance extraction condition is as follows.

In the case where the test piece 810 is made of a ceramic, the luminance range was set to "0-190". In the case where the test piece 810 is made of a resin, the luminance range was set to "0-170". In the case where the surface of the test piece 810 is treated with water repellent finish, the luminance range was set to "0-150". An example of the luminance extraction images is shown in FIG. 7 as "BINARIZED".

[0076] Next, a small particle removal treatment and a filling treatment were performed on the luminance extraction image based on 7-31, 7-32, and 7-33 of the user's manual of "DIGITAL MICROSCOPE VHX-100F manufactured by KEYENCE Corporation". The preset number of pixels during operation was set to "30". The small particle removal treatment is a function for removing small area portions in the binarized image. The filling treatment is a function for filling any hole to enable binarization if the measured region includes such holes having escaped the measurement. Next, the inventor calculated the occupancy ratio of water drops attached to the test piece 810 using the following conditional expression.

$$\text{Area of water drops} / \text{photographed area} \times 100 = \text{occupancy ratio of water drops (\%)}$$

[0077] An example of the occupancy ratio of water drops for each spray time is shown in FIG. 7 as "WATER DROP OCCUPANCY RATIO (%)" and in FIG. 8 as a graph. An example of the weight of water drops for each spray time is shown in FIG. 7 as "WATER DROP WEIGHT (g)" and in FIG. 8 as a graph. The term "water drop weight" used herein refers to the weight of water drops remaining on the test piece 810 after water drops are sprayed for a prescribed time on the surface of the bowl 801 of the toilet stool 800 from the spray nozzle 480.

[0078] According to this, the water drop occupancy ratio and the water drop weight increase with the passage of the spray time. On the other hand, the water drop occupancy ratio turns to decrease at approximately 50%. The water drop weight turns to decrease at approximately 0.16. This indicates that after the water drop occupancy ratio reaches approximately 50%, part of the water drops having impinged on the surface of the test piece 810 aggregate. Then, even if water drops are sprayed, a large proportion thereof falls down to the pool water surface 805. Accordingly, waste of water drops can be suppressed by spraying water drops at a water drop occupancy ratio in the range of approximately 50% or less.

[0079] According to this experimental result, more preferably, the spray time of water drops is e.g. approximately 5 seconds or less. Then, the controller 405 can control the occupancy ratio of water drops attached to the surface of the bowl 801 to approximately 50% or less. Thus, the water drops attached to the surface of the bowl 801 are evenly distributed. This can reduce the risk of dirt being attached to the portion where no water drops are attached to the surface of the bowl 801. Thus, the dirt attached to the surface of the bowl 801 can be reduced.

[0080] Furthermore, the spray amount of water drops can be suppressed, and water saving can be achieved. Even if the spray nozzle 480 sprays water drops for approximately 5 seconds or more, the occupancy ratio of water drops is not increased. Furthermore, water drops may start to aggregate. If water drops aggregate, the region where no water drops are attached to the surface of the bowl 801 is made larger than before the water drops start to aggregate. Then, the risk of dirt being attached to the portion where no water drops are attached to the surface of the bowl 801 is made higher than before the water drops start to aggregate. In contrast, the controller 405 controls the spray time of water drops to e.g. approximately 5 seconds or less, and controls the occupancy ratio of water drops attached to the surface of the bowl 801 to approximately 50% or less. This can reduce the risk of dirt being attached to the surface of the bowl 801 while shortening the spray time of water drops and suppressing the spray amount of water drops.

[0081] The spray time and occupancy ratio of water drops described above are only an example of this experimental result, and are not limited thereto. As described above with reference to FIGS. 1 and 2, the controller 405 of this embodiment controls the spray amount of water drops by controlling the time for which the spray nozzle 480 sprays water drops. Thus, the controller 405 can control the occupancy ratio of water drops attached to the surface of the bowl 801 to approximately 10-50% in a prescribed region of the surface of the bowl 801.

[0082] Next, an example result of the experiment for the nutrition residual ratio performed by the inventor is described with reference to the drawings.

[0083] FIG. 9 is a result table illustrating an example result of the experiment for the nutrition residual ratio performed by the inventor.

[0084] FIG. 10 is a graph illustrating the example result of this experiment.

[0085] The inventor attached artificial dirt to a test piece 810 having a prescribed spray time or water drop occupancy ratio. Subsequently, the artificial dirt was washed away. The artificial dirt contains dirt components such as carbohydrate,

protein, and lipid in a prescribed amount so as to have a property approximate to that of dirt. As shown in FIGS. 9 and 10, when the spray time of water drops is 1 second, the water drop occupancy ratio is approximately 10%. When the spray time of water drops is 3 seconds, the water drop occupancy ratio is approximately 30%. When the spray time of water drops is 5 seconds, the water drop occupancy ratio is approximately 50%. These are similar to the "WATER DROP OCCUPANCY RATIO (%)" shown in FIG. 7.

[0086] Next, the inventor photographed the surface of the test piece 810 after the artificial dirt was washed away. Furthermore, the nutrition residual ratio on the surface of the test piece 810 was measured. The inventor measured the nutrition residual ratio based on the amount of carbohydrate, protein, and lipid remaining on the surface of the test piece 810. An example of the surface photographs of the test piece 810 taken for each spray time or each water drop occupancy ratio is shown in FIG. 9 as "SURFACE PHOTOGRAPH". An example of the nutrition residual ratio on the surface of the test piece 810 for each spray time or each water drop occupancy ratio is shown in FIG. 9 as "NUTRITION RESIDUAL RATIO (ppm)" and in FIG. 10 as a graph. The time required to remove the artificial dirt attached to the test piece 810 for each spray time or each water drop occupancy ratio is shown in FIG. 9 as "REMOVAL TIME (sec)".

[0087] According to this experimental result, even for an occupancy ratio of approximately 10%, the removal time is 8 seconds. Thus, dirt is sufficiently removed within the typical range of toilet flushing time. Even if the dirt is removed, it is preferable to suppress the residual ratio of nutrition for bacteria wherever possible. The graph shown in FIG. 10 indicates that the nutrition residual ratio decreases with the increase of the water drop occupancy ratio. Furthermore, the result table shown in FIG. 9 indicates that the removal time of artificial dirt decreases with the increase of the water drop occupancy ratio.

[0088] In this experiment, the controller 405 controls the spray time of water drops to approximately 5 seconds, and controls the water drop occupancy ratio to approximately 50%. This can sufficiently reduce the nutrition residual ratio. Furthermore, it is found that the time required to remove the artificial dirt attached to the test piece 810 is shortest for a spray time of approximately 5 seconds, i.e., for a water drop occupancy ratio of approximately 50%, among the present experimental conditions.

[0089] Accordingly, the controller 405 controls the spray time of water drops to e.g. approximately 5 seconds, and controls the occupancy ratio of water drops attached to the surface of the bowl 801 to approximately 50%. This can suppress the nutrition residual ratio on the surface of the bowl 801 while shortening the spray time of water drops and suppressing the spray amount of water drops.

[0090] Next, the function and effect of suppressing attachment of dirt to the surface of the bowl are described with reference to the drawings.

[0091] FIG. 11 is a graph illustrating an example relationship between the water drop occupancy ratio and the nutrition residual ratio.

[0092] FIG. 12 is a comparison table for describing the test piece of each sample.

[0093] FIGS. 13A to 13C are schematic plan views for describing the function of dirt removal.

[0094] The shape, for instance, of the water drop attached to the surface of the bowl 801 depends on the property of the surface of the bowl 801. The inventor measured the relationship between the water drop occupancy ratio and the nutrition residual ratio for each test piece of samples (1)-(4) different in the property of the surface. First, artificial dirt is attached to a test piece having the same property as the surface of the bowl 801. Subsequently, the artificial dirt was washed away. The state of the artificial dirt being attached to the test piece is shown in FIG. 12 as "SURFACE PHOTOGRAPH". The artificial dirt in this experiment is such that the component ratio of the real dirt is reproduced. Then, the inventor measured the nutrition residual ratio based on the concentration of protein, carbohydrate, and lipid remaining on the surface of the test piece after the artificial dirt was washed away.

[0095] The surface of the test piece of sample (1) has hydrophilicity. The test piece of sample (1) has a glaze layer (amorphous layer) including a surface often called "ultra-smooth surface" having an arithmetic mean roughness Ra of e.g. approximately 0.07 μm . As the result of investigation by the inventor, it has turned out that the hydrophilicity of the surface tends to be higher as the smoothness of the surface becomes higher.

[0096] The contact angle θ of water on the surface of the test piece of sample (1) is e.g. approximately 38.4° (see FIG. 12). The term "contact angle" used herein refers to the angle that the solid surface and the liquid surface make at a given interface between the solid surface and the liquid surface, the angle being measured on the liquid side. The contact angle θ was measured by using a contact angle meter (automatic contact angle meter DM-500 manufactured by Kyowa Interface Science Co., LTD.). The underwater contact angle of oleic acid on the surface of the test piece of sample (1) is e.g. approximately 123.9° (see FIG. 12). The underwater contact angle is determined by measuring the contact angle of oleic acid on the surface of the test piece submerged in a water bath after oleic acid is dropped on the surface of the test piece. That is, the term "underwater contact angle" used herein refers to the contact angle in water.

[0097] The surface of the test piece of sample (2) has hydrophilicity. On the surface of the test piece of sample (2), zircon (opalizer) and unmelted SiO_2 exist. Thus, the hydrophilicity of the surface of the test piece of sample (2) is not as high as the hydrophilicity of the surface of the test piece of sample (1). The contact angle θ of water on the surface of the test piece of sample (2) is e.g. approximately 43.5° (see FIG. 12). The underwater contact angle of oleic acid on

the surface of the test piece of sample (2) is e.g. approximately 106.0° (see FIG. 12).

[0098] The surface of the test piece of sample (3) has water repellency. The term "water repellency" used herein refers to the property of having lower affinity to water or being more likely to repel water than e.g. the glazed bowl surface of the toilet stool. On the surface of the test piece of sample (3), a fluorine-based coating is formed on the glaze surface. Compared with the surface of the test piece of sample (1) and sample (2), oil-containing dirt tends to be attached more easily to the surface of the test piece of sample (3). The contact angle θ of water on the surface of the test piece of sample (3) is e.g. approximately 100.2° (see FIG. 12). The underwater contact angle of oleic acid on the surface of the test piece of sample (3) is e.g. approximately 33.6° (see FIG. 12).

[0099] The surface of the test piece of sample (4) is formed from acrylic resin. Thus, the surface of the test piece of sample (4) has lipophilicity. The term "lipophilicity" used herein refers to the property of having higher affinity to fat and oil than e.g. the glazed bowl surface of the toilet stool. Compared with the surface of the test piece of sample (1) and sample (2), oil-containing dirt tends to be attached more easily to the surface of the test piece of sample (4). The contact angle θ of water on the surface of the test piece of sample (4) is e.g. approximately 72.3° (see FIG. 12). The underwater contact angle of oleic acid on the surface of the test piece of sample (4) is e.g. approximately 2.5° (see FIG. 12).

[0100] As shown in FIG. 11, the nutrition residual ratio decreases with the increase of the water drop occupancy ratio. As described above with reference to FIGS. 1 and 2, this is because the increase of the water drop occupancy ratio can reduce the risk of artificial dirt being attached to the portion where no water drops are attached to the surface of the test piece. That is, the increase of the water drop occupancy ratio can reduce dirt attached to the surface of the test piece, and reduce the nutrition residual ratio on the surface of the test piece. In the case where the bowl 801 surface of the toilet stool 800 has hydrophilicity, i.e., in the case where the bowl 801 surface of the toilet stool 800 has a similar surface property to sample (1) or sample (2), the effect of suppressing residual nutrition is relatively high when the water drop occupancy ratio is in the range of approximately 20-50%. On the other hand, in the case where the bowl 801 surface of the toilet stool 800 has water repellency or lipophilicity, i.e., in the case where the bowl 801 surface of the toilet stool 800 has a similar surface property to sample (3) or sample (4), the effect of suppressing residual nutrition is relatively high when the water drop occupancy ratio is in the range of approximately 10-40%.

[0101] Thus, for various surfaces of toilet bowls, residual nutrition can be suppressed by the controller 405 controlling the occupancy ratio of water drops attached to the surface of the bowl 801 to approximately 10-50%. Furthermore, for the toilet bowl surface (in this experiment, the surface of sample (1)) having the performance of the lowest nutrition residual ratio, residual nutrition can be further suppressed by the controller 405 controlling the occupancy ratio of water drops attached to the surface of the bowl 801 to approximately 30-50%.

[0102] Here, as shown in FIGS. 13A and 13B, even if a water film is not previously formed on the surface of the bowl 801, the water drop 511 attached to the surface of the bowl 801 is crushed by dirt 521 and spread on the surface of the bowl 801. Thus, the water drop 511 may be connected with other adjacent water drops 511 to form a water film 513 with a suitable thickness. Also in this case, attachment of dirt 521 to the surface of the bowl 801 can be suppressed. Then, as indicated by arrow A1 in FIG. 13C, the dirt 521 can be flushed away with water of the toilet stool 800.

[0103] Even if a water film is not formed, in the case where water drops are crushed and can form a water film with a suitable thickness, discomfort of the user can be eliminated. More specifically, the user using the toilet stool 800 may perform e.g. "bottom washing" by the sanitary washing device. At this time, a relatively small and light piece of dirt may fly and be attached to the surface of the bowl 801. This may cause discomfort to the user. Such a relatively small and light piece of dirt is likely to fall on the sloped bowl 801 surface in the rear of the toilet stool 800 and to be attached thereto. In the conventional method of jetting water like toilet bowl flushing before use of the toilet stool 800, water drops on this portion flow down, and the risk of dirt remaining is high. In contrast, in this embodiment, even on the bowl 801 surface as described above, water drops are distributed at a prescribed occupancy ratio. The dirt falls on the water drops distributed on the bowl 801 surface. The water drops are crushed and can form a water film. This can suppress attachment of a relatively small and light piece of dirt to the surface of the bowl 801. Thus, the discomfort of the user can be eliminated.

[0104] As the result of investigation by the inventor, it has turned out that if the occupancy ratio of water drops 511 attached to the surface of the bowl 801 is 2% or more, the water drops 511 attached to the surface of the bowl 801 are crushed by dirt 521 and can form a water film 513. However, because the thickness of this water film is thin, the dirt attachment suppression effect cannot be sufficiently achieved. For dirt attachment suppression, it has turned out that the occupancy ratio of water drops needs to be 7% or more. This is further described with reference to the drawings.

[0105] FIGS. 14A and 14B are schematic perspective views for describing an experiment for water film formation performed by the inventor.

[0106] FIG. 15 is an experimental result table illustrating an example result of this experiment.

[0107] First, the inventor prepared a base material 501 and a cover material 503. The base material 501 and the cover material 503 are formed from e.g. glass. As viewed perpendicular to the major surface of the cover material 503, the vertical and horizontal lengths are each approximately 18 mm. The thickness of the cover material 503 is approximately 0.12-0.17 mm. The weight of the cover material 503 is approximately 0.12 grams (g).

[0108] As shown in FIG. 14A, the inventor dropped and attached a prescribed water drop amount of water drop 511

onto the surface of the base material 501. As indicated by arrow A2, the cover material 503 was put on the water drop 511. Then, as shown in FIG. 14B, the inventor determined whether the water drop 511 is crushed by the cover material 503 and can form a water film 513. The determination result is as shown in FIG. 15.

[0109] As shown in FIG. 15, it has turned out that if the water drop amount is 0.50 microliters/square centimeter ($\mu\text{l}/\text{cm}^2$) or more, the water drop 511 is crushed by the cover material 503 and can form a water film 513. The determination result shown in FIG. 15 shows the determination result in the case where one water drop 511 is attached to the base material 501. Here, in the case where three water drops 511 each having a water drop amount of 0.20 $\mu\text{l}/\text{cm}^2$ exist per unit area (cm^2), the amount of water drops attached to the base material 501 is 0.60 $\mu\text{l}/\text{cm}^2$. In this case, it can be considered that the water drops 511 are crushed by the cover material 503 and can form a water film 513.

[0110] FIG. 16 is a graph illustrating an example relationship between the water drop occupancy ratio and the water drop amount.

[0111] The shape of the water drop 511 attached to the surface of the test piece or the base material 501 depends on the property (such as hydrophilicity and water repellency) of the test piece or the base material 501. Thus, the inventor investigated the relationship between the water drop occupancy ratio and the water drop amount for the surface of the test piece of sample (1), the test piece of sample (3), and the test piece of sample (4).

[0112] On the surface having water repellency, the water drop 511 is spread less easily than in the case of being attached to the surface having hydrophilicity. Thus, the contact area of one water drop 511 in contact with the surface of e.g. the base material 501 is smaller than the contact area with the surface having hydrophilicity.

[0113] On the other hand, on the surface having hydrophilicity, the water drop 511 is spread more easily than in the case of being attached to the surface having water repellency. Thus, the contact area of one water drop 511 in contact with the surface of e.g. the base material 501 is larger than the contact area with the surface having water repellency.

[0114] Accordingly, as shown in FIG. 16, the water drop occupancy ratio of a prescribed amount of water drops attached to the surface of the test piece of sample (3) is lower than the water drop occupancy ratio of that prescribed amount of water drops attached to the surface of the test piece of sample (1). The water drop occupancy ratio of a prescribed amount of water drops attached to the surface of the test piece of sample (4) is lower than the water drop occupancy ratio of that prescribed amount of water drops attached to the surface of the test piece of sample (1), and higher than the water drop occupancy ratio of that prescribed amount of water drops attached to the surface of the test piece of sample (3). That is, compared with the test piece having a hydrophilic surface, on the test piece having a water repellent surface, at a lower water drop occupancy ratio, a water film 513 can be formed, and attachment of dirt to the surface of the bowl 801 can be suppressed.

[0115] When the water drop amount is 0.50 $\mu\text{l}/\text{cm}^2$, i.e., when the water drop 511 is crushed and can form a water film 513, the water drop occupancy ratio is 0.7% on the surface of the test piece of sample (3), 1.2% on the surface of the test piece of sample (4), and 2.0% on the surface of the test piece of sample (1). Accordingly, it has turned out that even on the test piece of sample (1) having a surface often called "ultra-smooth surface" and a hydrophilic surface, if the water drop occupancy ratio is 2.0% or more, the water drop attached to the surface of the bowl 801 is crushed by dirt and can form a water film. That is, it has turned out that irrespective of the property of the surface of the bowl 801, if the water drop occupancy ratio is 2.0% or more, the water drop attached to the surface of the bowl 801 is crushed by dirt and can form a water film.

[0116] FIG. 17 is a data table illustrating an example of detailed data of the water drop occupancy ratio and the nutrition residual ratio.

[0117] More specifically, FIG. 17 shows the plot data of the graph shown in FIG. 11.

[0118] As described above with reference to FIG. 16, if the water drop occupancy ratio is 2% or more, the water drop attached to the surface of the bowl 801 is crushed by dirt and can form a water film.

[0119] Here, as shown in FIG. 11, in order to make the nutrition residual ratio lower, it is more preferable to make the water drop occupancy ratio higher. In other words, in order to further enhance the effect of suppressing attachment of dirt to the surface of the bowl 801, it is more preferable to make the water drop occupancy ratio higher. Consider the test piece of sample (3) and sample (4) to the surface of which dirt is attached relatively easily. As shown in FIG. 17, it is found that if the water drop occupancy ratio is increased from 0% to approximately 10%, the nutrition residual ratio decreases. That is, it is found that even in the test piece of sample (3) and sample (4) to the surface of which dirt is attached relatively easily, the effect of suppressing attachment of dirt to the surface of the bowl 801 is further enhanced if the water drop occupancy ratio is increased from 0% to approximately 10%.

[0120] Accordingly, the controller 405 of this embodiment controls the lower limit of the occupancy ratio of water drops attached to the surface of the bowl 801 to approximately 10%. Then, the effect of suppressing attachment of dirt to the surface of the bowl 801 is further enhanced.

[0121] FIG. 18 is a graph illustrating an example relationship between the water drop occupancy ratio and the water drop amount.

[0122] FIG. 19 is a graph illustrating an example relationship between the water drop occupancy ratio and the water drop density.

[0123] FIG. 20 is a result table illustrating the surface photograph and binarized image at prescribed water drop occupancy ratios.

[0124] The graphs shown in FIGS. 18 and 19 are graphs for the test piece of sample (1). FIG. 20 shows the surface photograph and binarized image for the test piece of sample (1). "BINARIZED" is as described above with reference to FIG. 7.

[0125] As shown in FIG. 18, there is a correlation between the water drop occupancy ratio and the water drop amount. With the increase of the water drop occupancy ratio, the water drop amount increases, and the effect of suppressing attachment of nutrition is improved. Here, as shown in FIGS. 18 and 19, in the case where the water drop occupancy ratio is 10-20%, the water drop amount increases with the increase of the water drop occupancy ratio. On the other hand, the water drop density is substantially saturated at a water drop occupancy ratio of approximately 10%, and decreases when the water drop occupancy ratio exceeds approximately 20%. The term "water drop density" used herein refers to the number of water drops existing per unit area (cm^2).

[0126] That is, up to a water drop occupancy ratio of approximately 20%, the water drops exist stably. On the other hand, if the water drop occupancy ratio exceeds 20%, for instance, the water drops are mutually combined and grow in the state of easily falling.

[0127] In the case where the water drop occupancy ratio is 10-20%, the amount of water drops attached to the surface of the test piece increases, but the number of water drops does not increase relative to the amount of water drops. In this state, the sprayed water drop is attached onto the water drop already attached to the surface of the test piece, and the size (amount) of the water drop attached to the surface of the test piece is increasing (see FIG. 20). In other words, in this state, water drops exist throughout the test piece, i.e., water drops are distributed generally uniformly on the surface of the test piece (see FIG. 11). Thus, in this state, a water film with a suitable thickness is efficiently formed. Hence, the effect of suppressing attachment of dirt to the surface of the bowl 801 is achieved more efficiently.

[0128] In the case where the water drop occupancy ratio is 13-19%, the water drop density is constant and further stabilized even if the water drop occupancy ratio increases. Mutual aggregation of a plurality of water drops is not noticeably observed. Thus, flow down of water drops to the pool water surface 805 by aggregation is suppressed. Furthermore, as shown in FIG. 18, the water drop amount at a water drop occupancy ratio of 13-19% is three times or more of the lower limit ($0.50 \mu\text{l}/\text{cm}^2$) of the water drop amount capable of forming a water film. Thus, a water film can be formed more stably.

[0129] Next, an example of the sterilizing water generator 450 of this embodiment is described with reference to the drawings.

[0130] FIG. 21 is a schematic sectional view illustrating the example of the sterilizing water generator of this embodiment.

[0131] The sterilizing water generator 450 of this embodiment is e.g. an electrolytic cell unit including electrodes.

[0132] As shown in FIG. 21, the sterilizing water generator 450 of this example includes therein an anode plate 451 and a cathode plate 452. Under energization controlled by the controller 405, the sterilizing water generator 450 can electrolyze tap water flowing therein. Here, the tap water contains chloride ions. Such chloride ions are contained as salt (NaCl) and calcium chloride (CaCl_2) in water sources (e.g., groundwater and water in dams and rivers). Thus, hypochlorous acid is produced by electrolysis of the chloride ions. Consequently, the water electrolyzed in the sterilizing water generator 450 (electrolyzed water) turns into a liquid containing hypochlorous acid.

[0133] Hypochlorous acid functions as a sterilizing ingredient. A liquid containing hypochlorous acid, i.e., sterilizing water, can efficiently remove or decompose and sterilize dirt such as resulting from ammonia and oil.

[0134] Here, the sterilizing water (electrolyzed water) generated in the sterilizing water generator 450 may be a liquid containing metal ions such as silver ions or copper ions. Alternatively, the sterilizing water generated in the sterilizing water generator 450 may be a liquid containing electrolytic chlorine or ozone. Alternatively, the sterilizing water generated in the sterilizing water generator 450 may be acid water or alkaline water. Furthermore, the sterilizing water generator 450 is not limited to an electrolytic cell unit. That is, the sterilizing water may be sterilizing water generated by dissolving a bactericide and a sterilizing liquid in water. Among the foregoing, the solution containing hypochlorous acid has a stronger sterilizing power.

[0135] As described above, according to this embodiment, the controller 405 controls the spray amount of water drops sprayed by the spray nozzle 480, and controls the occupancy ratio of water drops attached to the surface of the bowl 801 to approximately 10-50% in a prescribed region of the surface of the bowl 801. Thus, the water drops attached to the surface of the bowl 801 are evenly distributed. This can reduce the risk of dirt being attached to the portion where no water drops are attached to the surface of the bowl 801. Thus, the dirt attached to the surface of the bowl 801 can be reduced. Furthermore, the spray amount of water drops can be suppressed, and the spray time of water drops can be shortened. Furthermore, the controller 405 controls the occupancy ratio of water drops attached to the surface of the bowl 801 to approximately 10-50%. Thus, even if a water film is not formed on the surface of the bowl 801, the water drop is crushed by dirt and spread on the surface of the bowl. Hence, the water drop can be connected with other adjacent water drops to form a water film with a suitable thickness. This can suppress dirt attached to the bowl surface

of the toilet stool while suppressing the spray amount.

[0136] Furthermore, hypochlorous acid has the function of decomposing dirt. Thus, as described above, dirt attachment is suppressed by controlling the occupancy ratio of water drops before use of the toilet stool, and then furthermore, after the use of the toilet stool, hypochlorous acid can be sprayed. This can decompose nutrition, and further reduce the nutrition residual ratio. Thus, desirable sterilization can be performed. The timing of spraying may be arbitrary, such as immediately after the user leaves the toilet stool, or after the lapse of a prescribed time.

[0137] The embodiment of the invention has been described above. However, the invention is not limited to the above description. Those skilled in the art can suitably modify the above embodiment, and such modifications are also encompassed within the scope of the invention as long as they include the features of the invention. For instance, the shape, dimension, material, layout and the like of various components in e.g. the toilet device 10, and the installation configuration and the like of the spray nozzle 480 are not limited to those illustrated, but can be suitably modified.

[0138] Furthermore, various components in the above embodiment can be combined with each other as long as included in the appended claims.

Claims

1. A toilet device (10) comprising:

a toilet stool (800) including a bowl (801);
a spray section (480) configured to spray water drops on a surface of the bowl;
a controller (405) configured to control spray amount of the water drops sprayed by the spray section, by controlling time for which the spray section sprays the water drops, before the toilet stool is used; and
a casing (400) provided with a sensor for controlling spray time, the sensor being selected amongst a room entry sensor (402), a human body sensor (403) and a seating sensor (404),

wherein said water drop has an average particle diameter of 100-300 μm ;

characterized in that:

the toilet device further comprises a sanitary washing device (100) provided on the toilet stool and comprising the casing;
the spray section is provided below said casing; and

said controller is configured to control occupancy ratio of the water drops attached to the surface of the bowl to 10-50% in a prescribed region of the surface of the bowl,
wherein said prescribed region is located behind a center line (805c) of a pool water surface (805) formed in the bowl as viewed from a lateral side of the toilet stool (800).

2. The device according to claim 1, wherein the controller controls the occupancy ratio of the water drops attached to the surface of the bowl to 10-20% in the prescribed region of the surface of the bowl.

3. The device according to claim 1 or 2, wherein the controller controls the occupancy ratio of the water drops attached to the surface of the bowl to 30-50% in the prescribed region of the surface of the bowl.

4. The device according to any one of claims 1 to 3, wherein the surface of the bowl has hydrophilicity.

5. The device according to any one of claims 1 to 4, further comprising a sterilizing water generator capable of generating sterilizing water,
wherein the spray section sprays the sterilizing water on the surface of the bowl.

Patentansprüche

1. Toilettenvorrichtung, die umfasst:

einen Toilettenstuhl (800) mit einer Schüssel (801);
einen Sprühabschnitt (480), der aufgebaut ist, um die Sprühmenge der Wassertropfen, die von dem Sprühabschnitt gesprüht wird, zu steuern, indem die Zeit gesteuert wird, über welche der Sprühabschnitt die Wasser-

tropfen sprüht, bevor der Toilettenstuhl verwendet wird; und
ein Gehäuse (400), das mit einem Sensor zum Steuern der Sprühzeit versehen ist, wobei der Sensor aus einem Raumeintrittssensor (402), einem Sensor (404) für einen menschlichen Körper und einem Sitzsensor (404) ausgewählt wird,

wobei der Wassertropfen einen mittleren Partikeldurchmesser von 100 - 300 μm hat;
dadurch gekennzeichnet, dass:

die Toilettenvorrichtung ferner eine Sanitärwaschvorrichtung (100) umfasst, die auf dem Toilettenstuhl bereitgestellt ist und das Gehäuse umfasst;
der Sprühabschnitt unterhalb des Gehäuses bereitgestellt ist; und
die Steuerung konfiguriert ist, um den Belegungsanteil der Wassertropfen, die an der Oberfläche der Schüssel haften, in einem vorgeschriebenen Bereich der Oberfläche der Schüssel auf 10 - 50% zu steuern,

wobei der vorgeschriebene Bereich von einer seitlichen Seite des Toilettenstuhls (800) gesehen hinter einer Mittellinie (805c) einer in der Schüssel ausgebildeten Beckenwasseroberfläche (805) angeordnet ist.

2. Vorrichtung nach Anspruch 1, wobei die Steuerung den Belegungsanteil der Wassertropfen, die an der Oberfläche der Schüssel haften, in dem vorgeschriebenen Bereich der Oberfläche der Schüssel auf 10 - 20% steuert.
3. Vorrichtung nach Anspruch 1, wobei die Steuerung den Belegungsanteil der Wassertropfen, die an der Oberfläche der Schüssel haften, in dem vorgeschriebenen Bereich der Oberfläche der Schüssel auf 30 - 50% steuert.
4. Vorrichtung nach einem der Ansprüche 1 bis 3, wobei die Oberfläche der Schüssel hydrophil ist.
5. Vorrichtung nach einem der Ansprüche 1 bis 4, die ferner einen Sterilisationswassergenerator aufweist, der fähig ist, sterilisierendes Wasser zu erzeugen,
wobei der Sprühabschnitt das sterilisierende Wasser auf die Oberfläche der Schüssel sprüht.

Revendications

1. Dispositif de toilette (10) comprenant :

un siège de toilette (800) comportant une cuvette (801) ;
une section de pulvérisation (480) configurée de manière à pulvériser des gouttes d'eau sur une surface de la cuvette ;
une unité de commande (405) configurée de manière à commander une quantité pulvérisée des gouttes d'eau pulvérisées par la section de pulvérisation, en commandant la durée pendant laquelle la section de pulvérisation pulvérise les gouttes d'eau, avant que le siège de toilette soit utilisé ; et
un boîtier (400) comportant un capteur destiné à commander une durée de pulvérisation, le capteur étant sélectionné parmi un capteur d'entrée de pièce (402), un capteur de corps humain (403) et un capteur d'occupation de siège (404),

dans lequel lesdites gouttes d'eau présentent un diamètre moyen de particules de 100 à 300 μm ;
caractérisé en ce que :

le dispositif de toilette comprend, en outre, un dispositif de lavage sanitaire (100) agencé sur le siège de toilette et comprenant le boîtier ;
la section de pulvérisation est agencée au-dessous dudit boîtier ; et

ladite unité de commande est configurée de manière à commander le facteur d'occupation des gouttes d'eau liées à la surface de la cuvette entre 10 et 50 % dans une zone prédéfinie de la surface de la cuvette,
dans lequel ladite zone prédéfinie est située derrière une ligne centrale (805c) d'une surface d'eau collectée (805) formée sur la cuvette telle que vue d'un côté latéral du siège de toilette (800).

2. Dispositif selon la revendication 1, dans lequel l'unité de commande commande le facteur d'occupation des gouttes d'eau liées à la surface de la cuvette entre 10 et 20% dans la zone prédéfinie de la surface de la cuvette.

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3. Dispositif selon la revendication 1 ou 2, dans lequel l'unité de commande commande le facteur d'occupation des gouttes d'eau liées à la surface de la cuvette entre 30 et 50% dans la zone prédéfinie de la surface de la cuvette.
4. Dispositif selon l'une quelconque des revendications 1 à 3, dans lequel la surface de la cuvette présente un aspect hydrophile.
5. Dispositif selon l'une quelconque des revendications 1 à 4, comprenant, en outre, un générateur d'eau de stérilisation permettant de produire de l'eau de stérilisation, dans lequel la section de pulvérisation pulvérise l'eau de stérilisation sur la surface de la cuvette.

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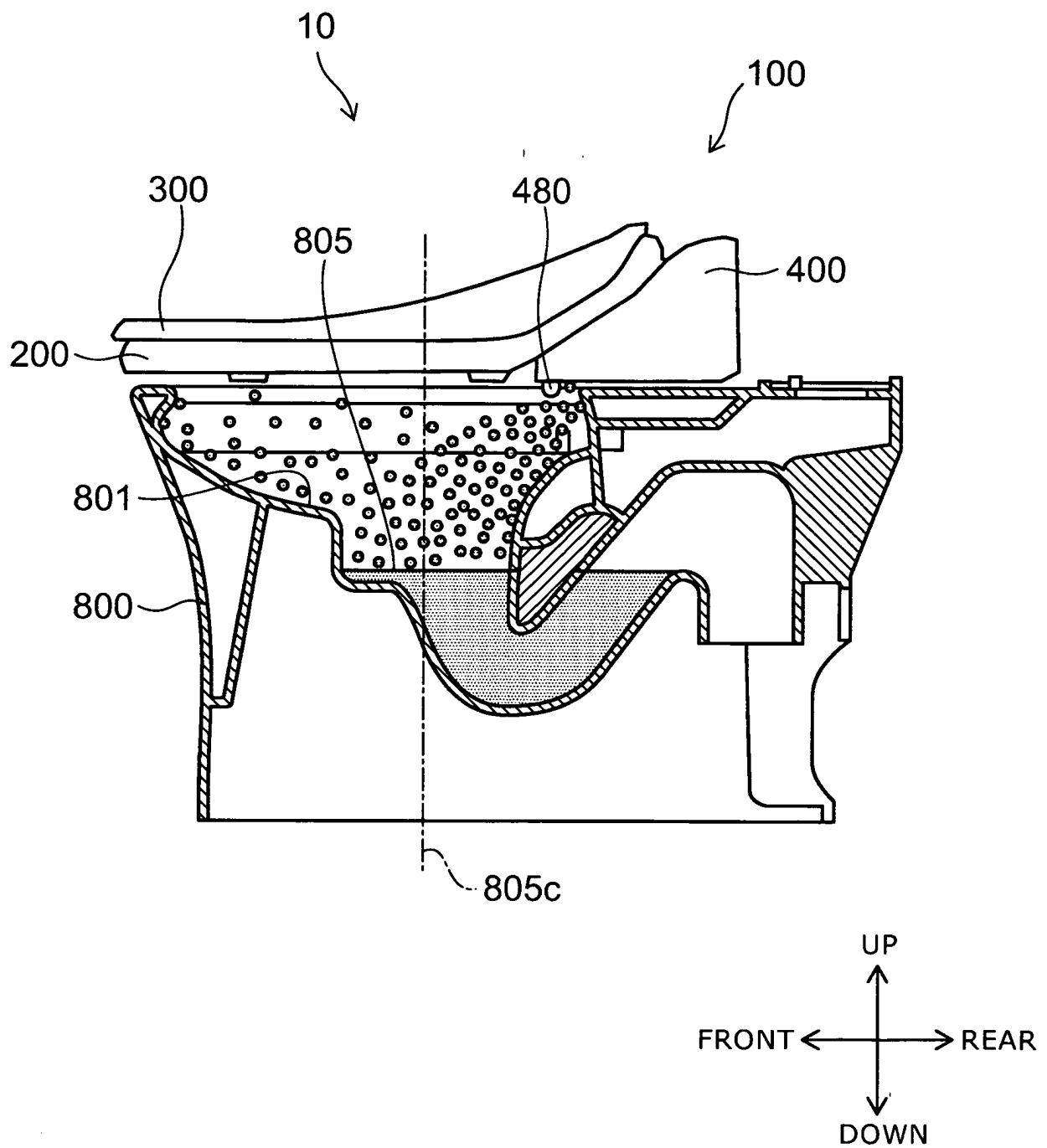


FIG. 1

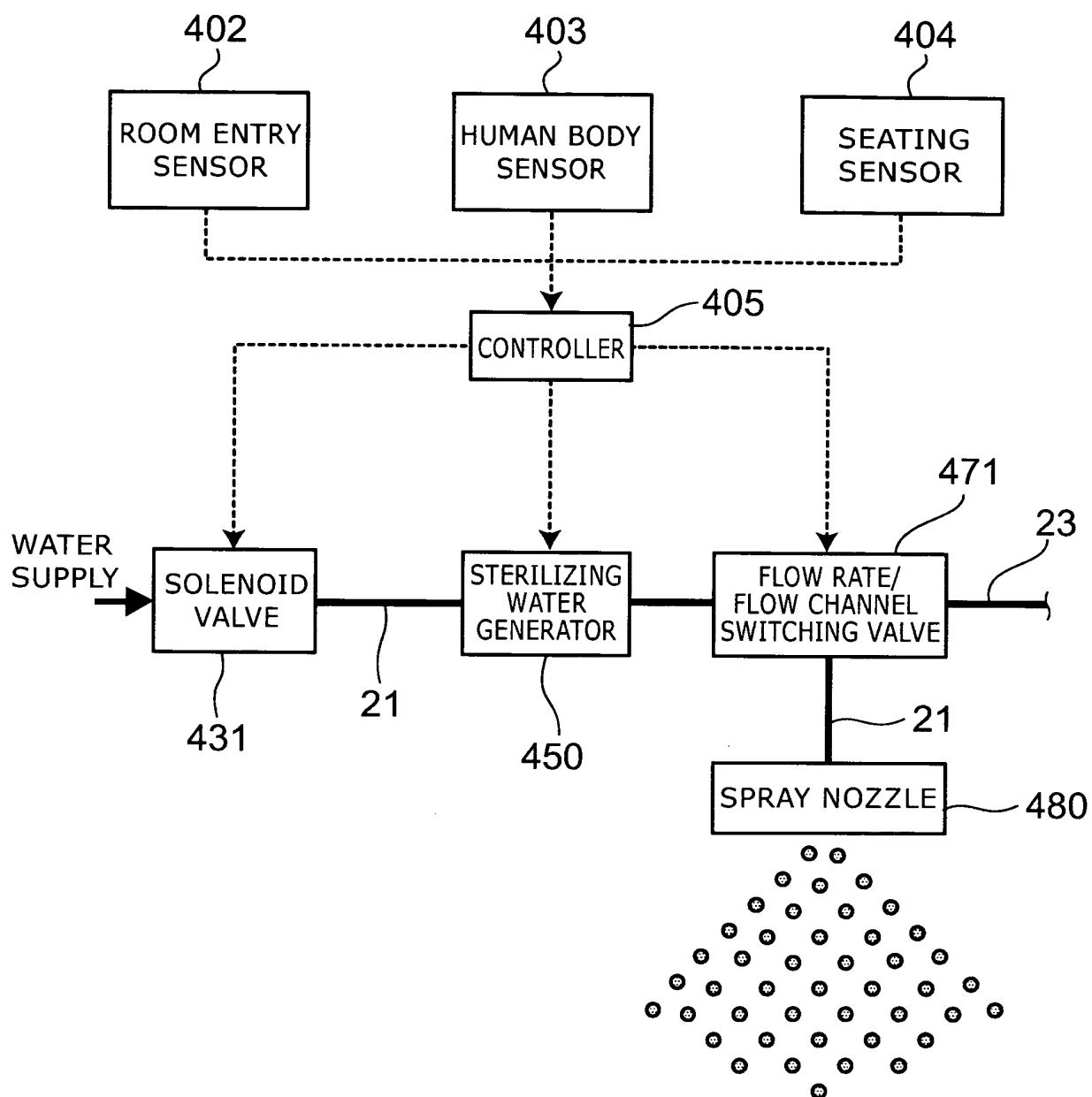


FIG. 2

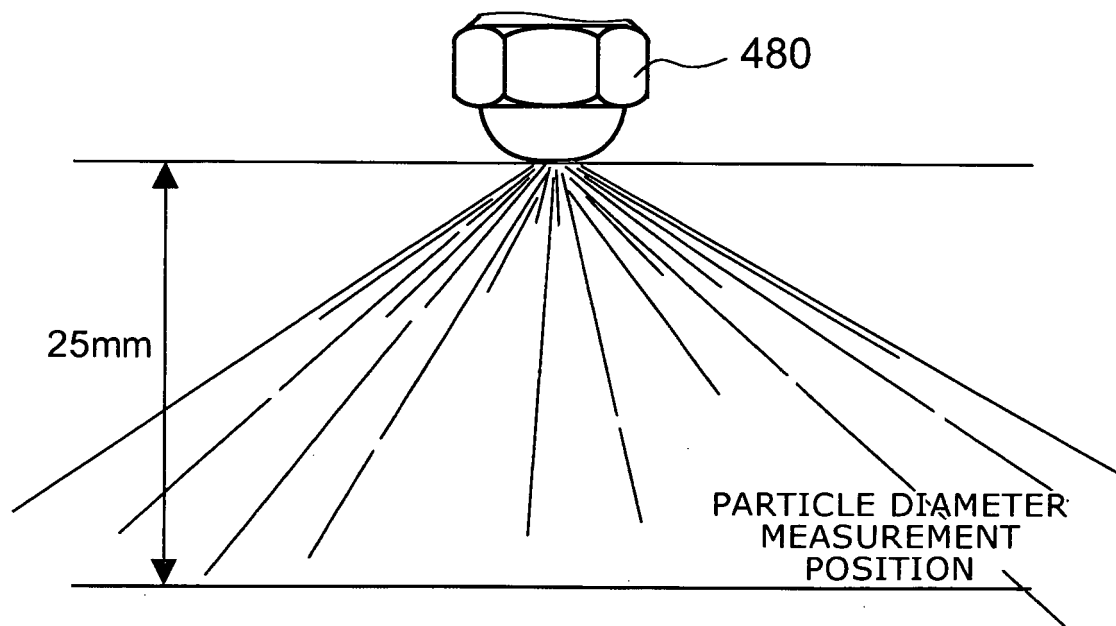


FIG. 3

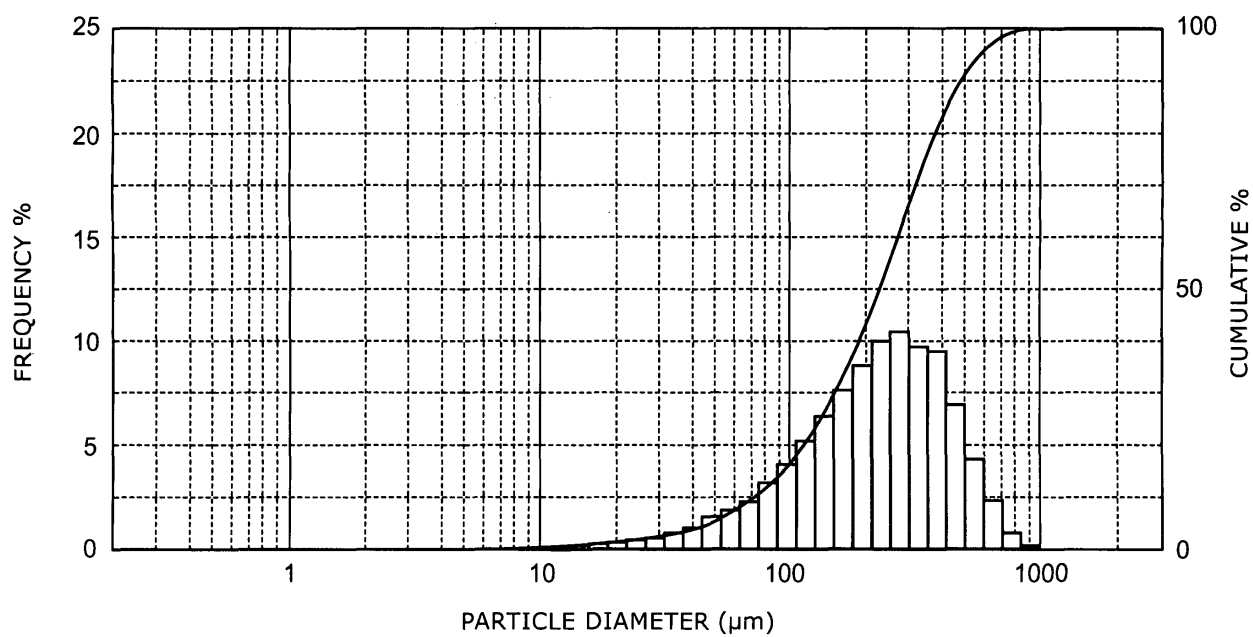


FIG. 4

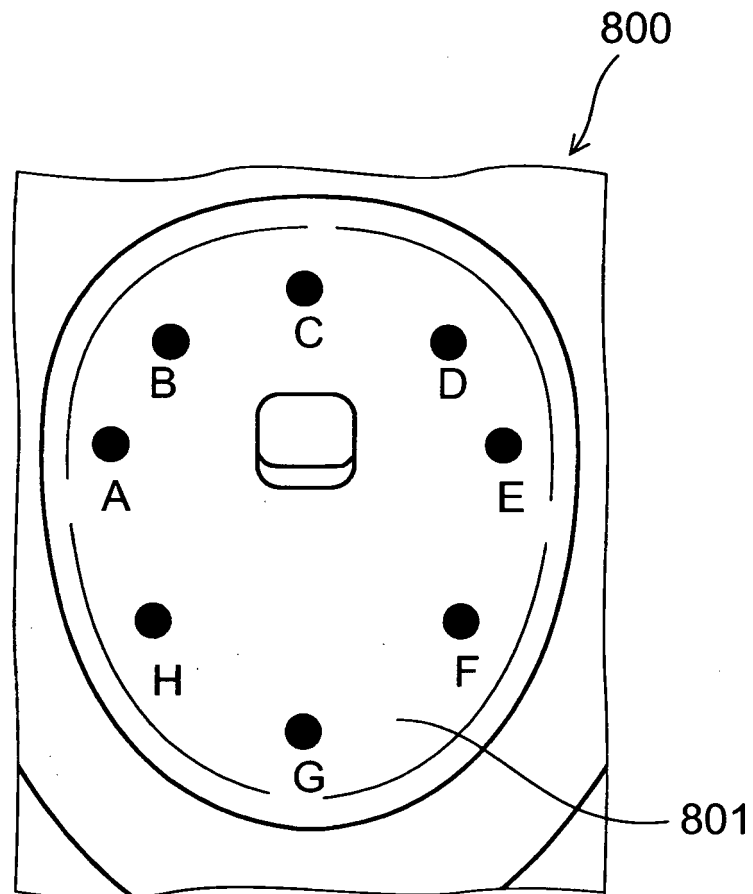


FIG. 5

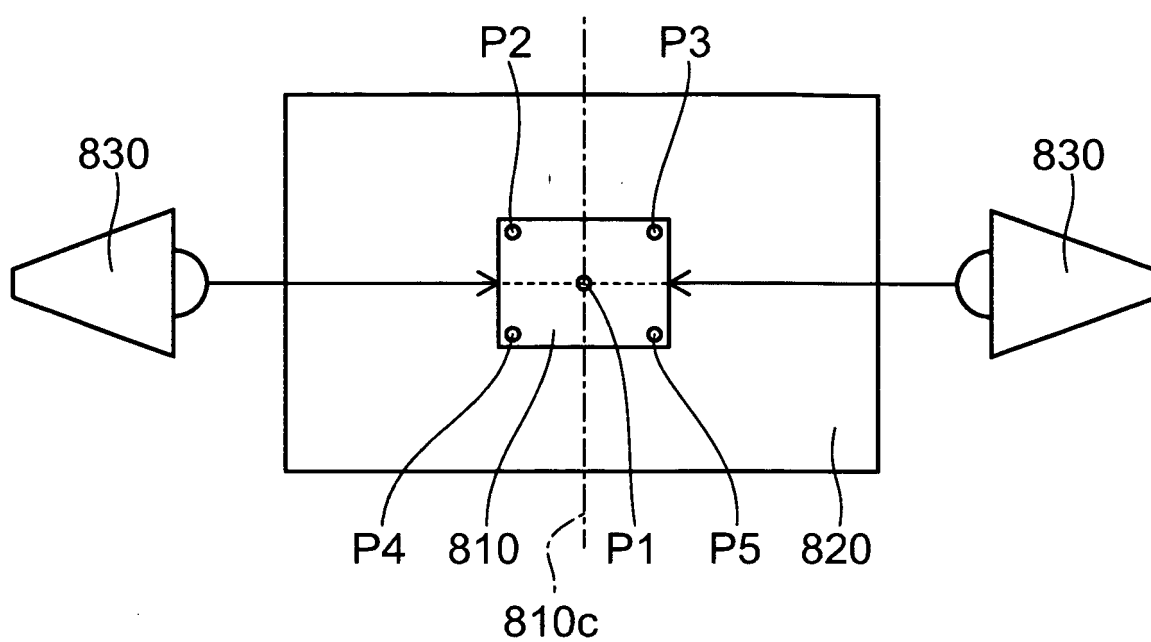


FIG. 6A

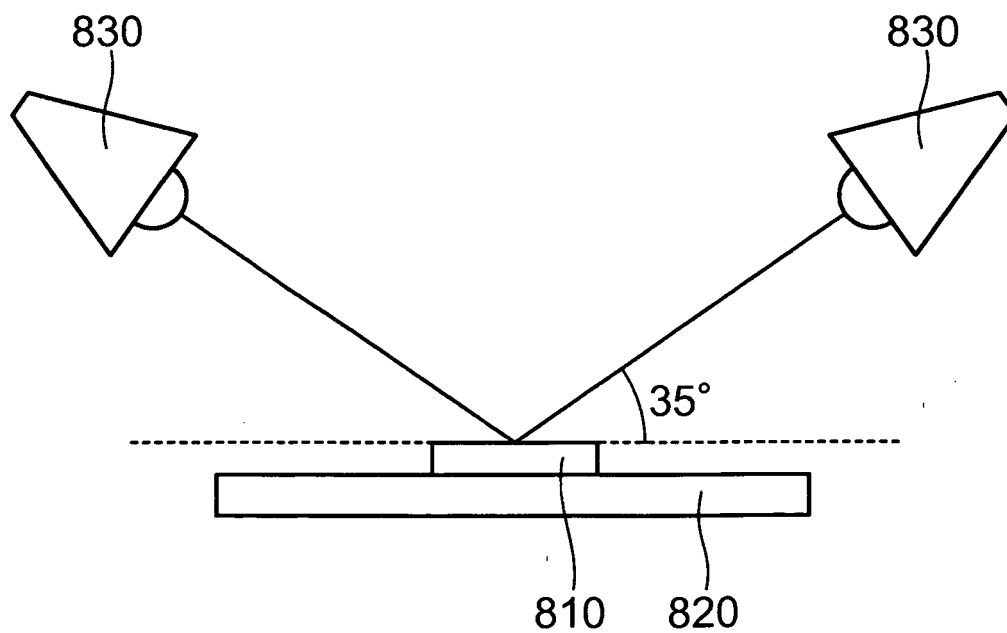


FIG. 6B

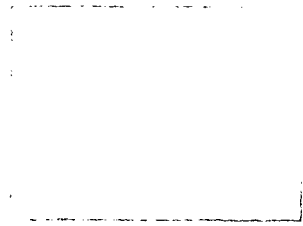
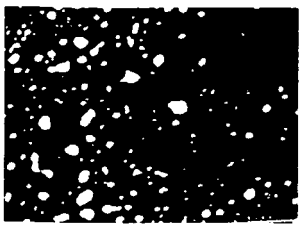
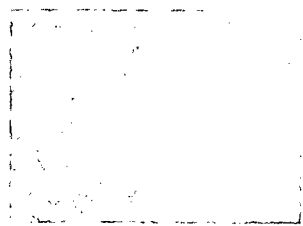
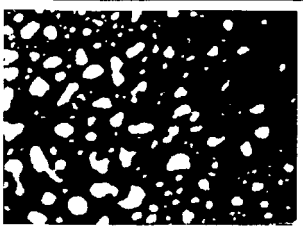
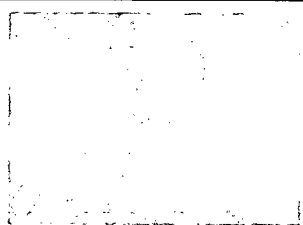
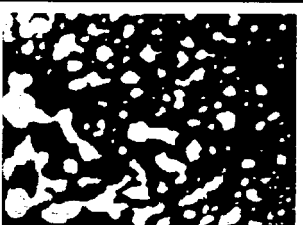
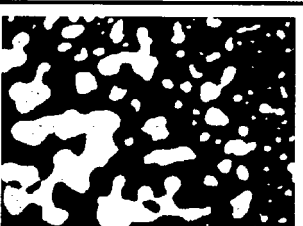
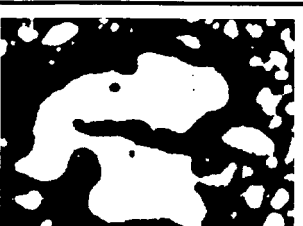
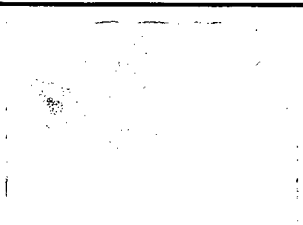
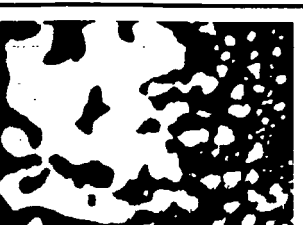
		WATER DROP PHOTOGRAPH	BINARIZED	WATER DROP OCCUPANCY RATIO (%)	WATER DROP WEIGHT (g)
SPRAY TIME [sec]	1			10.2	0.015
	2			19.3	0.038
	3			27.9	0.057
	4			32.8	0.113
	5			49.4	0.137
	6			44.9	0.162

FIG. 7

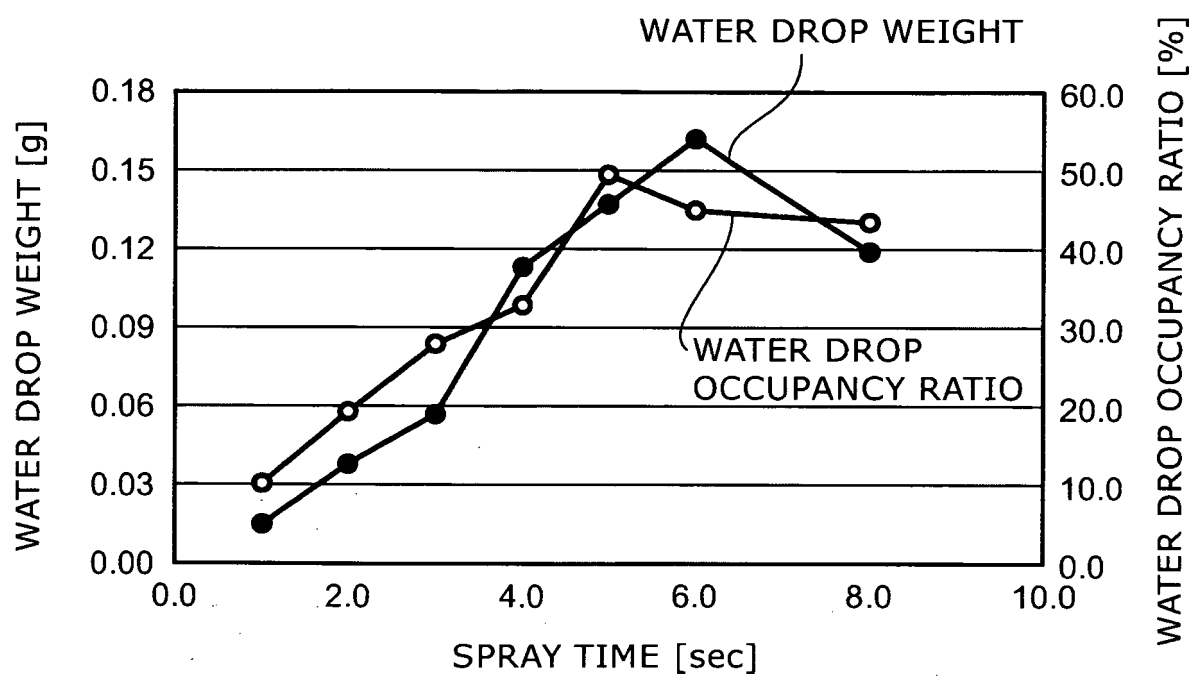


FIG. 8

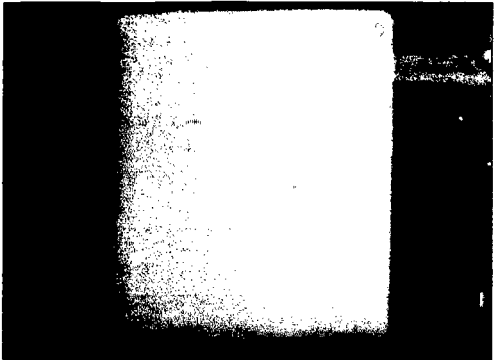
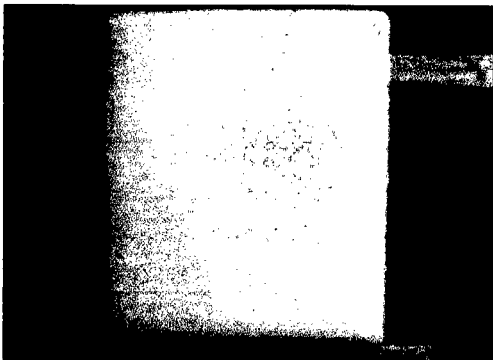
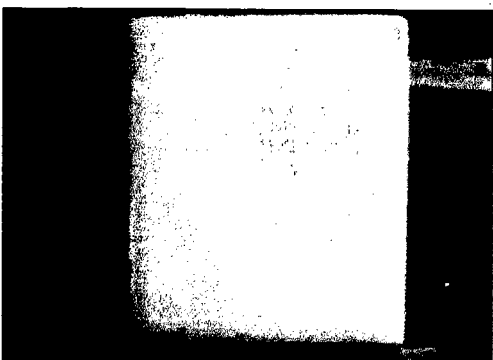
		SURFACE PHOTOGRAPH	NUTRITION RESIDUAL RATIO (ppm)	REMOVAL TIME (sec)
SPRAY TIME (sec)	1		867	8
	3		607	6.5
	5		285	4

FIG. 9

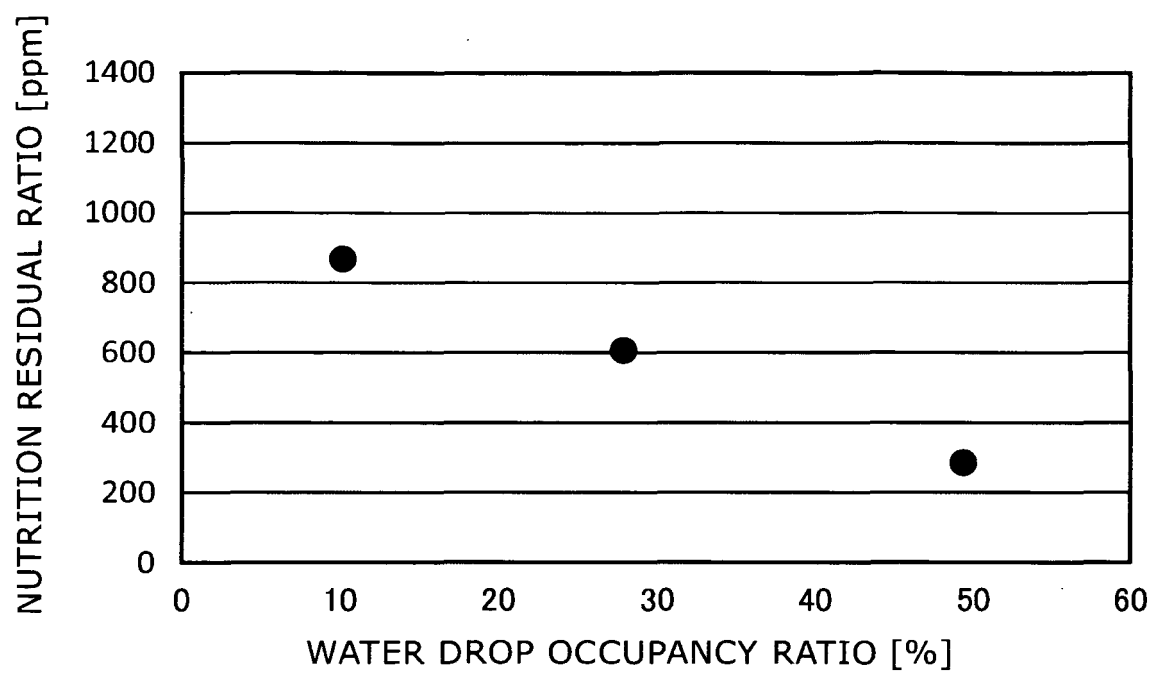


FIG. 10

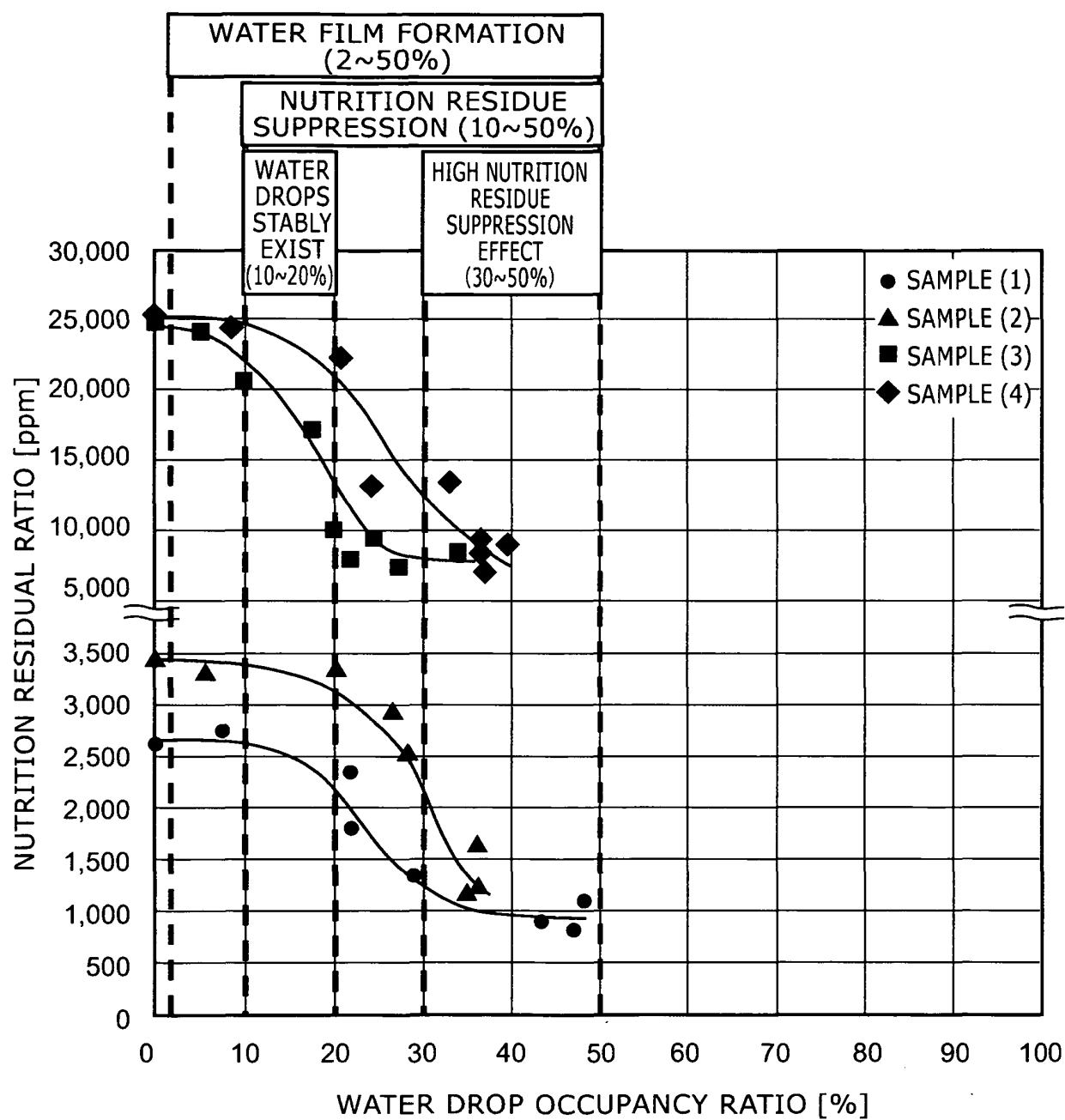


FIG. 11

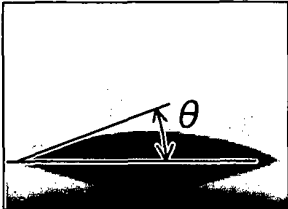
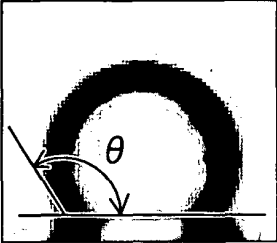
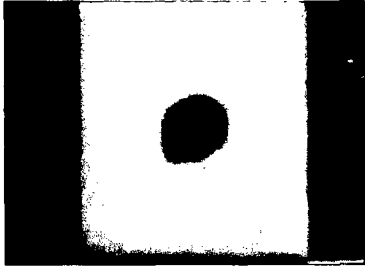
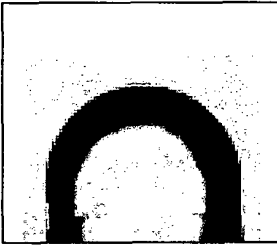
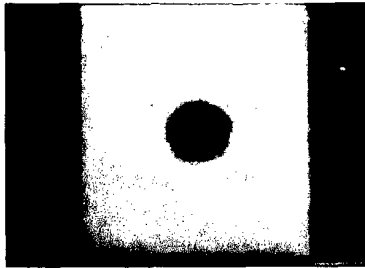
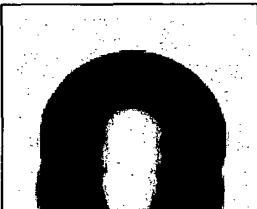
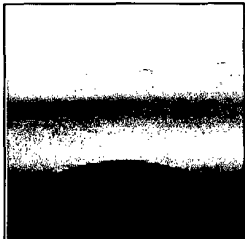
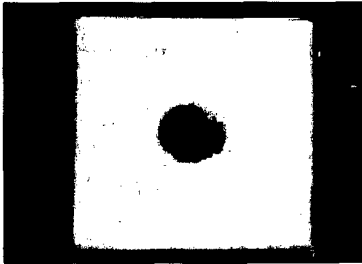
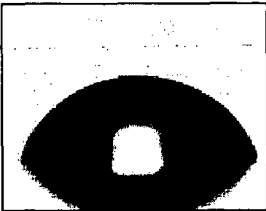
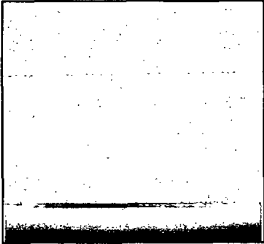
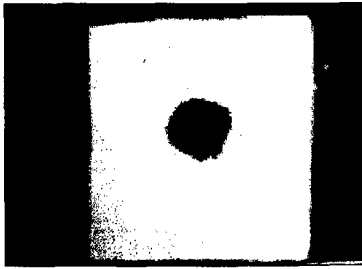
SAMPLE	WATER	OLEIC ACID (IN WATER)	SURFACE PHOTOGRAPH
(1)			
(2)			
(3)			
(4)			

FIG. 12

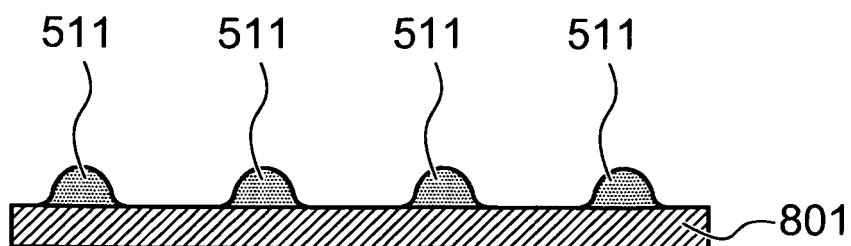


FIG. 13A

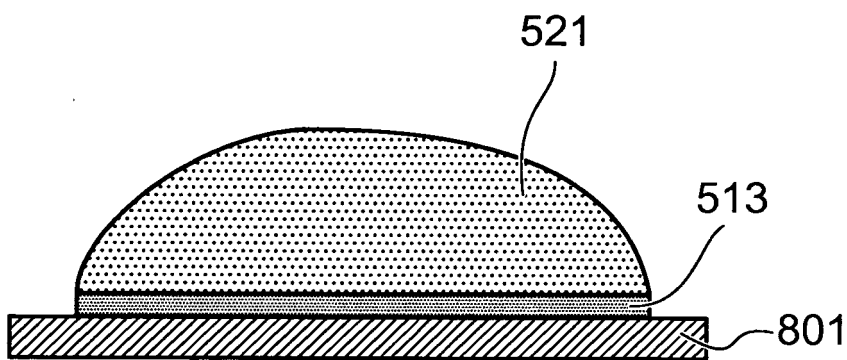


FIG. 13B

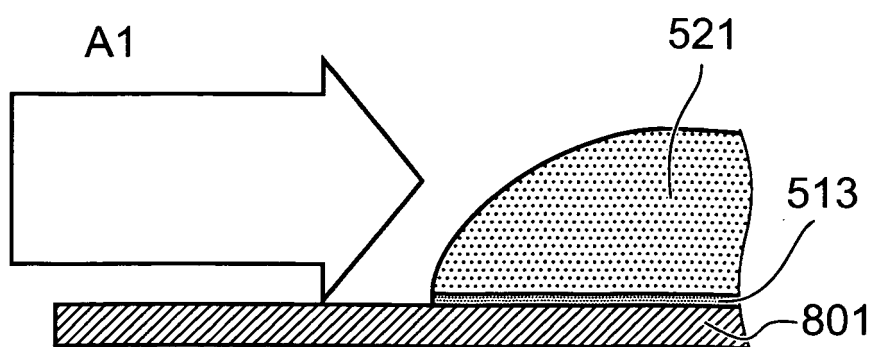
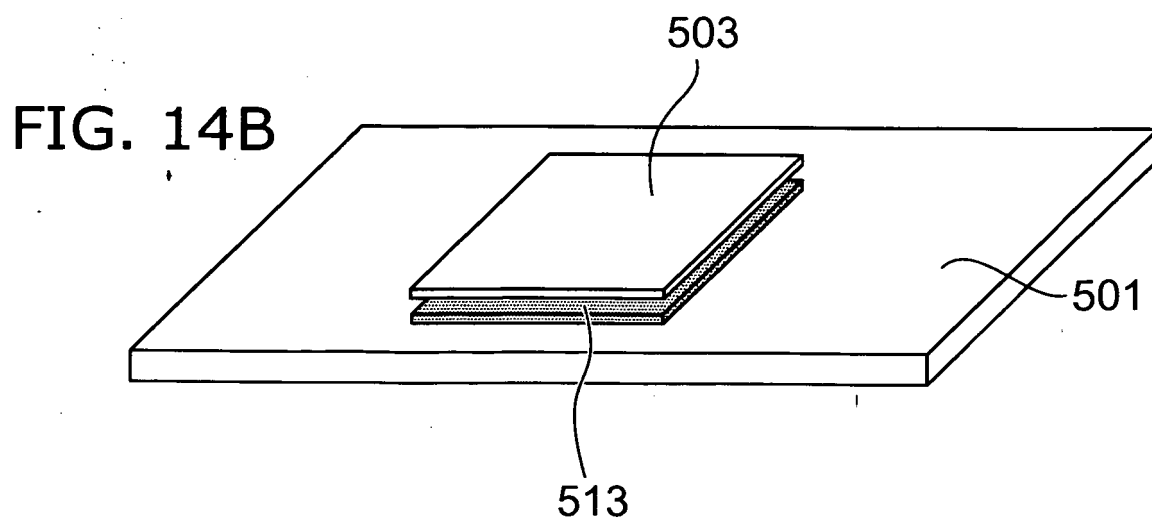
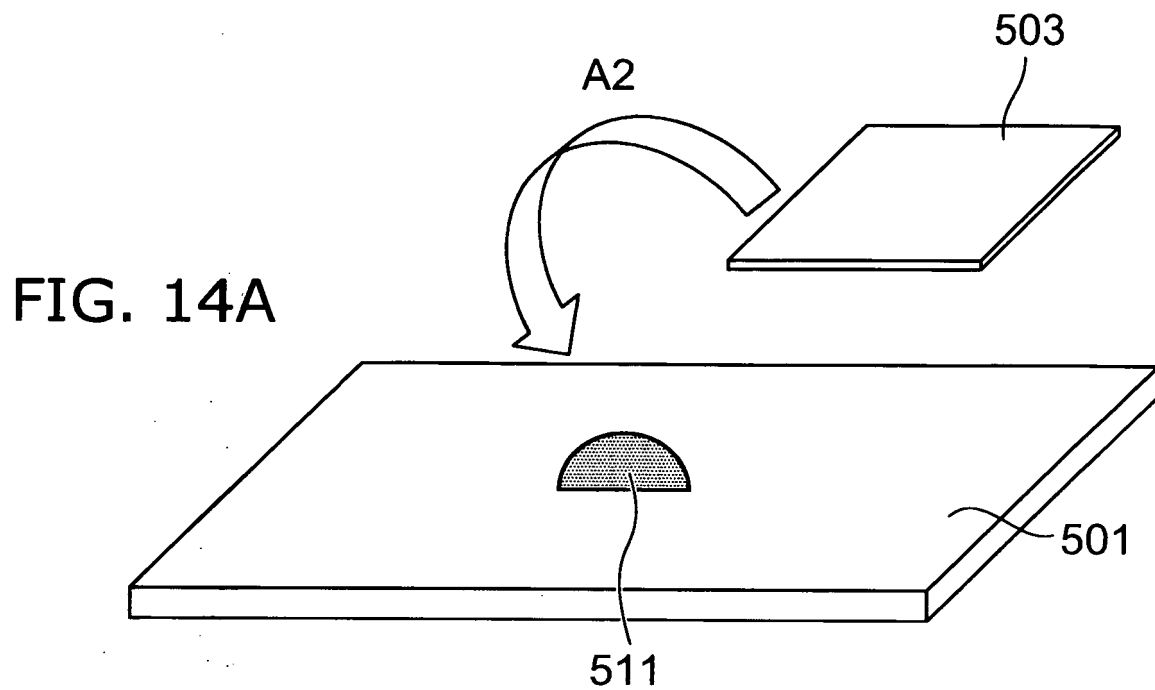


FIG. 13C



WATER DROP AMOUNT [$\mu\text{l}/\text{cm}^2$],	WATER FILM FORMATION DETERMINATION
0.10	×
0.20	×
0.33	×
0.41	×
0.45	×
0.47	×
0.50	○
0.55	○
0.56	○
0.61	○
0.66	○
0.78	○
1.13	○
2.14	○

FIG. 15

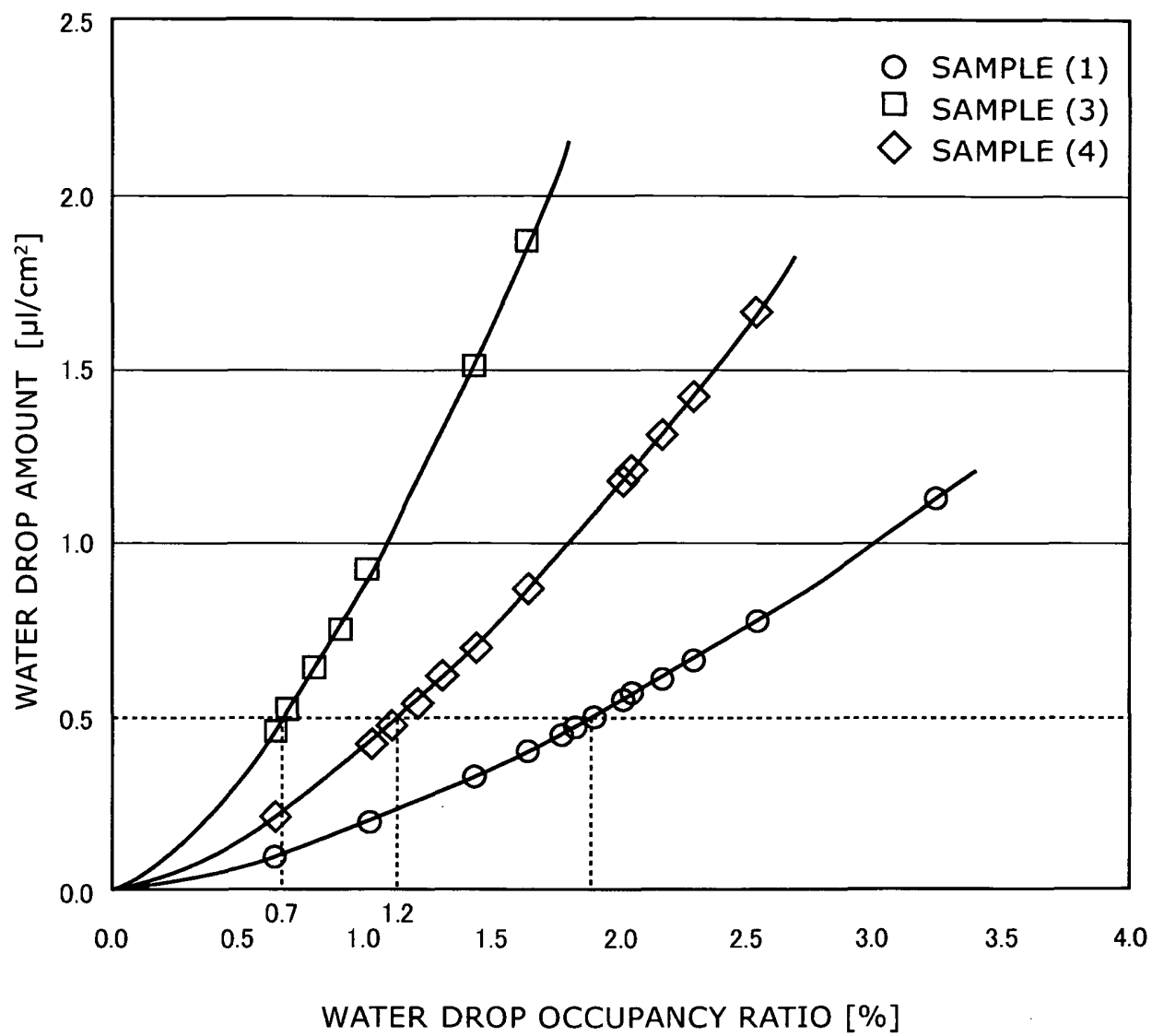


FIG. 16

SAMPLE (1)		SAMPLE (2)		SAMPLE (3)		SAMPLE (4)	
WATER DROP OCCUPANCY RATIO [%]	NUTRITION RESIDUAL RATIO [ppm]	WATER DROP OCCUPANCY RATIO [%]	NUTRITION RESIDUAL RATIO [ppm]	WATER DROP OCCUPANCY RATIO [%]	NUTRITION RESIDUAL RATIO [ppm]	WATER DROP OCCUPANCY RATIO [%]	NUTRITION RESIDUAL RATIO [ppm]
0	2624	0	3423	0	25017	0	25550
8	2750	6	3283	5	24317	9	24462
22	2344	20	3317	10	20658	21	22384
22	1797	26	2922	18	17245	24	13223
29	1351	28	2513	20	10109	33	13478
48	1098	36	1632	34	8550	37	9428
47	820	35	1174	22	8004	40	9010
43	909	36	1238	25	9571	37	8438
45	805	35	1068	27	7464	37	7156

FIG. 17

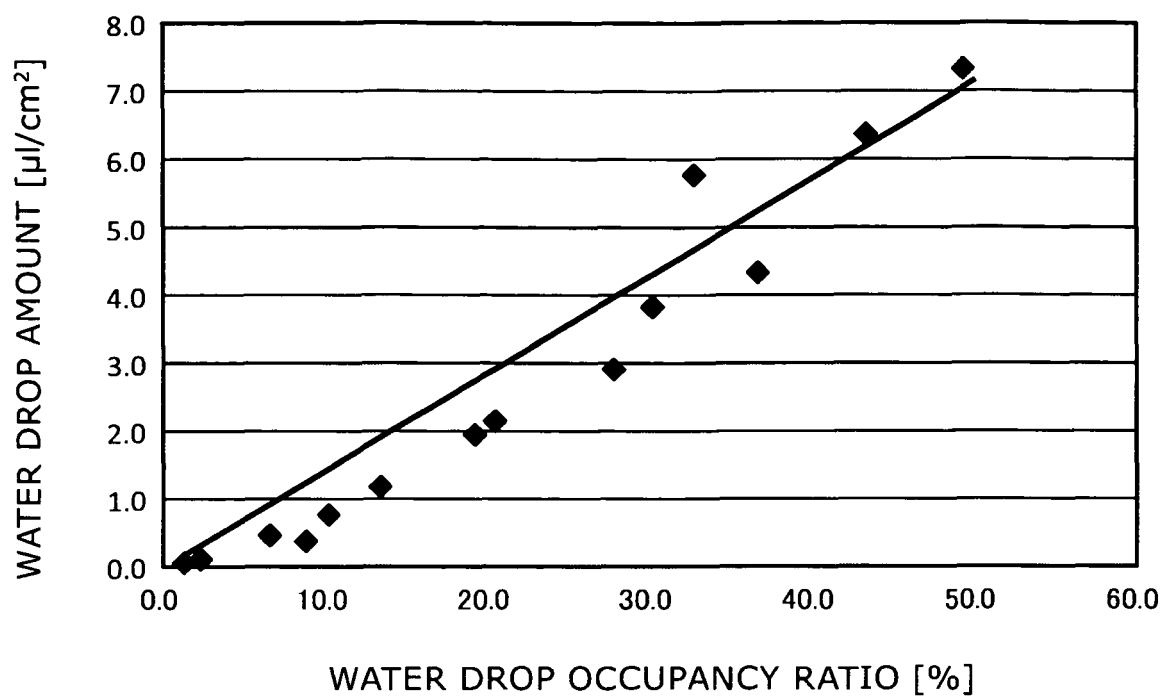


FIG. 18

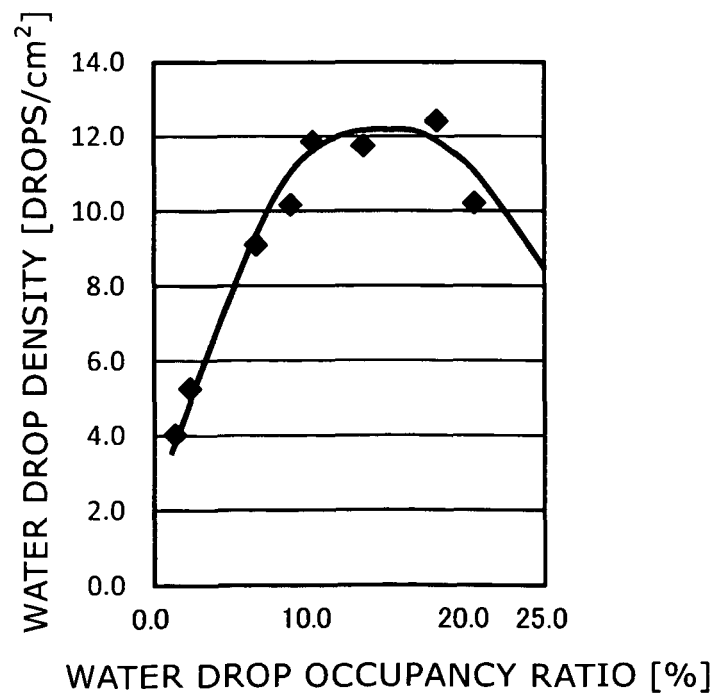


FIG. 19

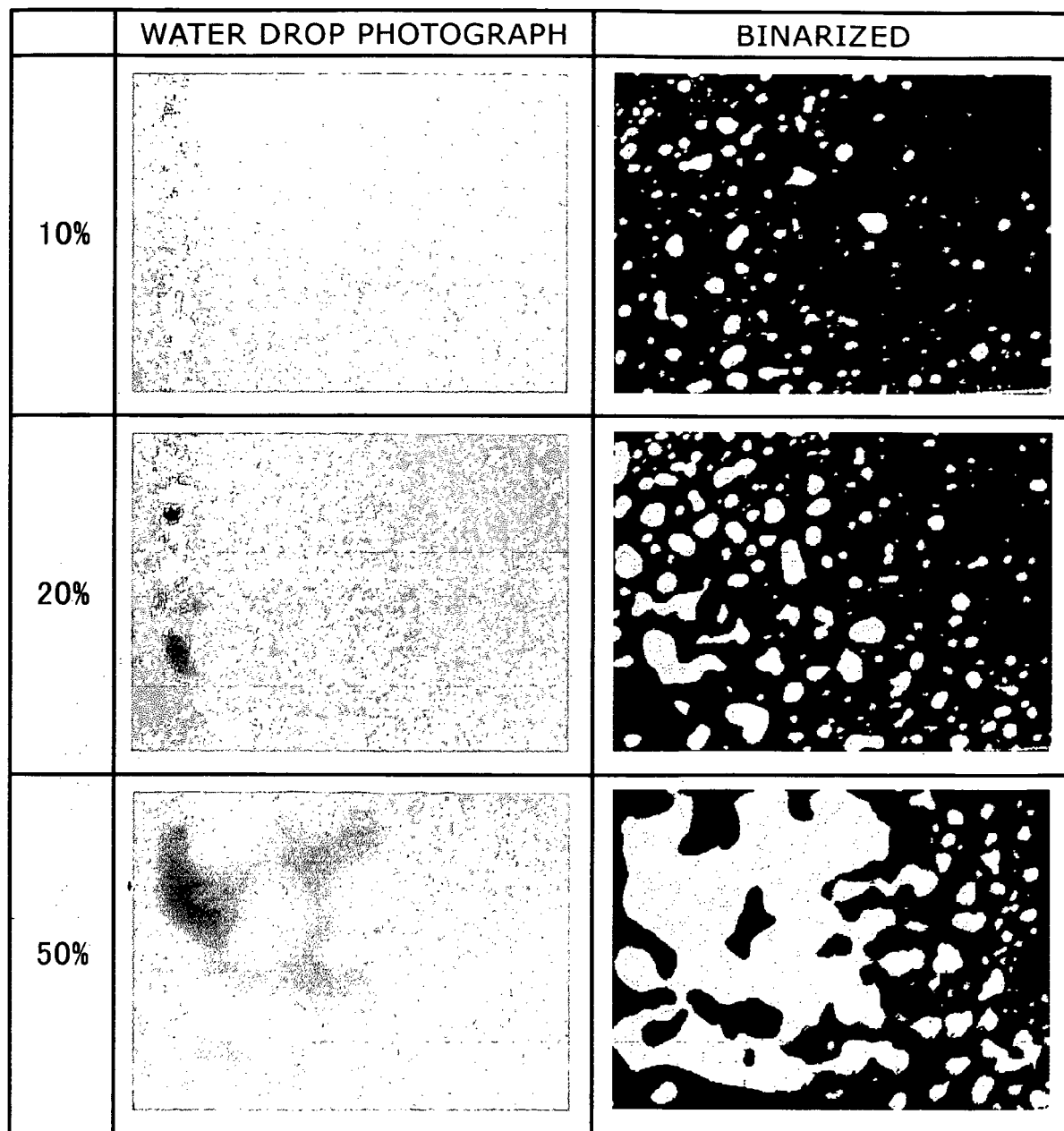


FIG. 20

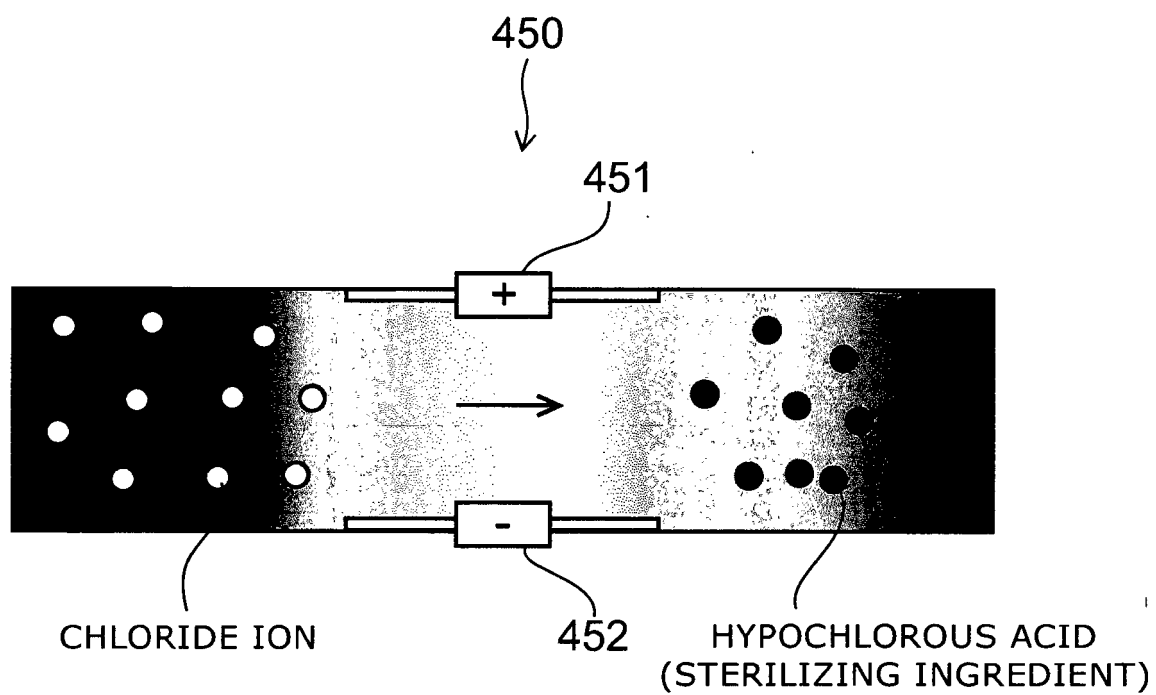


FIG. 21

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008163716 A [0003]
- DE 102011001514 A1 [0004]