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(54) Title: SMART APPARATUS FOR WATER INGRESSION TEST AND METHOD THEREOF

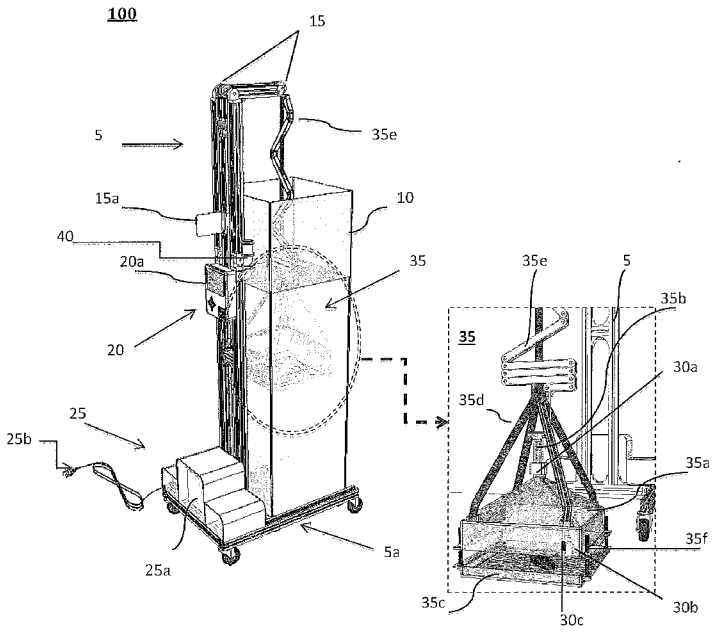


FIGURE 2A

(57) Abstract: An apparatus for use in a water ingression test of a device comprising: a controller 20 configured to control the movements of the apparatus 100 based on predefined parameters; a support frame 5 having one member being extendible vertically 5b and a support arm 5c being extendible horizontally; a water chamber 10; at least one sensor configured for detecting bubbles 30a and for sending data based on detection for further processing; a cage 35 adapted for accumulating and directing bubbles to the sensor 30a; and for carrying the device under test 1. The cage 35 is connected to the support arm 5c such that it can be automatically released into the water chamber 10 and lifted out from the water chamber with the aid of a pulley assembly 15 driven by a motor 15a. A method thereof is also disclosed.

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SMART APPARATUS FOR WATER INGRESSION TEST AND METHOD THEREOF

FIELD OF INVENTION

[0001] The present invention generally relates to protection testing, and more particularly to an automated apparatus for use in a water ingression test of a device, and method thereof.

BACKGROUND OF INVENTION

[0002] In any device development cycle, immersion testing is one of the arrays of protection type tests, which plays a crucial role in analysing the functional performance of the device in achieving superiority over other devices available in the market. The types of protection tests include for protection from water, dust, or chemical intrusion. Each of these tests has its own specific standards and requirements to be met so as to attain testing accreditations, which adds immense product value to the tested device.

[0003] For dust-proof and waterproof testing, the standard test is known as water immersion or water integrity test. In this test, hydrostatic pressure from duration and depth in water can cause water to penetrate through weakness points and thus jeopardizing the device's functionality. Perceptibly, if the device fails the test, and if failure detected is at a lower than compliant depth may indicate a major re-designing required, while failure at near compliant test duration may indicate a degradation within the device sealing or any form of insulation. It is common practice to conduct a test validation on real field application where the water density, pressure and temperature change over time. In order to achieve a considerably accurate outcome or result, which will be used for further studies, test performers needs to know the exact submersible depth and water environmental conditions.

[0004] Conventional testing methods are performed manually, in the sense that these tests are conducted under human monitoring and handling. Understandably,

such manual handling entails low-test integrity due to manual inaccuracies and shortcomings including in failure detection, low-test repeatability and erroneous measurements. Further, manual observation renders inability to detect any form of degradation of the respective enclosure of a device over time. **FIGURE 1** generally shows the steps involved in conventional manual testing methods in conducting a water immersion test of a device. In a manual testing method, the device under test is immersed manually, with a height control done manually at 1 meter. The user then waits for the test completion typically nearby the testing area. Upon completion of the testing process, the person in charge then pulls out the device under test manually for drying. Evidently conducting the test manually can become ridiculously cumbersome especially for the user.

[0005] Thus, there remains a considerable need for systems and methods that can conveniently address the above-discussed shortcomings of manual water immersion and ingression testing methods and systems.

SUMMARY

[0006] In one aspect of the present invention, there is provided an apparatus for use in a water ingression test of a device, wherein bubbles are released in the event of the device failure, the apparatus comprising: a controller configured to control the behaviour and movements of the apparatus based on predefined parameters; a support frame comprising at least one extendible vertical member and a support arm affixed at one end of the extendible vertical member; a cage being movably attached to the support arm; the cage comprising an accumulator for directing the bubbles to an open tip and a base section for carrying the device under test; a water chamber positioned adjacent to the support frame ; at least one bubble sensor affixed on one surface of the cage in a manner such that it is able to detect bubbles; wherein the cage is connected to the support arm such that it can be moved upwards and downwards within the water chamber.

[0007] In one embodiment, the support arm of the apparatus can be extended horizontally relative to the vertical member of the support frame.

[0008] In another embodiment, the section for directing bubbles comprises an open tip extending vertically from one surface of the means for directing bubbles the open tip is adapted such that directed bubbles can go through the tip.

[0009] In a further embodiment, wherein the sensor of the apparatus is positioned at the open tip such that each bubble that when each bubble goes through the tip it can be detected by the sensor.

[0010] In yet a further embodiment, the apparatus further comprising a temperature sensor and a pressure sensor, both of the sensors are mounted on the cage.

[0011] In yet another embodiment, base section of the cage is a perforated section and is attached to the means for directing bubbles by a plurality of fasteners such that there is a gap to insert the device within the cage.

[0012] In yet a further embodiment, the apparatus further comprising a sensor cables housing connected to the support arm.

[0013] In a further embodiment, the sensors cable housing is in the form of scissor-type extension cable housing.

[0014] In yet a further embodiment, the apparatus further comprising; an indication means to indicate failure of test, a display means for displaying the test results and a harness cord adapted for holding the cage.

[0015] In another aspect, there is provided a method for operating a water ingression test for a device under test, wherein in the event of a failure, bubbles are released from the device, the method comprising providing at least one bubble detection sensor; providing at least one means for directing bubbles to the bubble sensor device; gathering and storing data associated to test profile; initiating the test and providing an indication for initiation of test; automatically immersing the device into a chamber of water at predetermined depth; activating the sensor and directing the bubbles which may be released from the device to the bubble detection sensor;

providing an indication for failure of test; detecting and storing all criteria of bubbles released from the device; automatically lifting the device from the chamber of water; fully removing the device from water; and halting the device for drying for a period of time; and displaying all test results.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The invention will be more understood by reference to the description below taken in conjunction with the accompanying drawings herein:

[0017] **FIGURE 1** shows a prior art system;

[0018] **FIGURE 2A** and **FIGURE 2B** show the apparatus for use in water ingression test in accordance with an embodiment of the present invention;

[0019] **FIGURE 2C** shows one view of the support frame in accordance with an embodiment of the present invention;

[0020] **FIGURE 3** illustrates an overall view of the cage of the apparatus in accordance with an embodiment of the present invention;

[0021] **FIGURE 4** illustrates the cage being attached to the support frame in accordance with an embodiment of the present invention;

[0022] **FIGURE 5** shows the cage of the apparatus during testing operation in accordance with an embodiment of the present invention;

[0023] **FIGURE 6** shows the overall method for operating the apparatus in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

[0024] In line with the above summary, the following description of a number of specific and alternative embodiments is provided to understand the inventive features of the present invention. It shall be apparent to one skilled in the art, however that this invention may be practiced without such specific details. Some of the details may not be described at length so as not to obscure the invention. For ease of reference, common reference numerals will be used throughout the figures when referring to the same or similar features common to the figures.

[0025] The present invention provides an automated testing apparatus, more particularly an automated water immersion test apparatus and method. In one embodiment, the present invention provides automated features in conducting a water immersion test, these features include submersion and lifting of device under test, automated device under test leak failure detection, analysis and alarm system. Further in one embodiment, the system of the present invention is an adaptable system that can be used for lab and real-field water submersion testing in addition to real-time hydrostatic pressure and underwater temperature monitoring capabilities.

[0026] The overall automated apparatus **100** for water immersion test in accordance with an embodiment of the present invention is shown as **FIGURE 2A** and **FIGURE 2B**. The system includes an extendible support frame **5**, water chamber **10,** a pulley assembly **15** driven by a motor **15a**, a controller **20,** a battery chamber **25,** a plurality of sensors **30a, 30b, 30c** and a cage **35** having a predetermined dimension sufficient and adapted to serve as a movable carriage for the device under test **1**. All of the components are operably interconnected and linked to the controller **20** in a manner such that the controller **20** serves as the central controller in providing automated effects of the apparatus **100**.

[0027] As seen in **FIGURE 2B,** in the operational aspect of the apparatus **100**, the controller **20** manages all components and is connected directly to the display means **20a**, the tower/warning light **40** the motor driver **15a**, and powered by direct power supply **25b** may be further equipped with a power or voltage regulator **20d** with wet-cell based battery **25a**. The motor **15a** may be equipped with a stepper motor

15b or any other suitable motor type. As mentioned briefly in the preceding paragraph, there are at least three sensors, the first one being the bubble sensor **30a**; the second is a temperature sensor **30b** and a pressure sensor **30c**. These sensors are adapted or configured to be in communication with the controller **20** for sending and receiving of signals based on detections.

[0028] The water chamber **10** according to one embodiment of the present invention is generally a rectangular shaped chamber formed with predetermined dimension, whereby the dimension is sufficient to accommodate the size of the cage **35,** so as to enable the cage **35** to be effortlessly immersed in the water contained by the water chamber **10**. The water chamber **10** may be in the form of various structural means, which is adapted to contain water. In one embodiment, the water chamber **10** is adapted to be removable from the support frame **5**. Such features, equipped with the wheels, allow portability of the apparatus **100**.

[0029] **FIGURE 2C** shows a view of the adaptable or extendible support frame **5** in accordance with an embodiment of the present invention. The support frame **5** in accordance with one embodiment of the present invention may be formed from aluminium-based materials. It comprises a base **5a** provided with wheels, a vertical support member **5b** extending from the base **5a,** and a support arm **5c** horizontally attached to the vertical support member **5b**. The vertical support member **5b** is adapted to be vertically extendable to a predetermined length. The support arm **5c** is also adapted to be extendable horizontally and pivotally connected at the top end of the vertical support member **5b.** The support arm **5c** enables the cage **35** to be fully dropped or immersed into the water chamber **10**. In order to permit this, the support arm **5c** is equipped with a pulley assembly **15** at a top end of the support arm **5c**. The base **5a** is further adapted to accommodate the water chamber **10** and the battery chamber **25**. The pulley assembly **15** is secured to the support frame **5** and is driven by a motor **15a.** The pulley assembly **15** and is adapted such that it is able to automatically drop and lift the cage **35** into and out from the water chamber **10** during operation, relative to the support arm **5c** of the support frame **5**. The movement of the pulley is affected by the motor **15a**, subject to the signals or instructions sent by the controller **20**.

[0030] The motor **15a** is configured to receive signals or instructions from the controller **20** and perform tasks based on the received signals. Upon received the signals, the motor **15a** automatically performs the relevant tasks during operation, such as to drop, lift, depth distance and staging time for the testing operation. Referring back to **FIGURE 2B**, the controller **20** in accordance with one embodiment of the present invention includes an electronic micro-controller board **20b**, a motor driver **15a**, voltage or power regulator **20d** and a display means **20a**. The controller **20** is attached to the vertical support member **5b** and is configured to provide and store user settings based on predetermined parameters and displays the result based on the test analysis outcome. The user settings and predetermined settings, which are inputted to the controller **20**, are used to control the behaviour and provide automated movements of the apparatus **100**. In one embodiment of the present invention, the apparatus 100 can be powered by way of batteries i.e. wet cell batteries **25a** that are contained within the battery chamber **25** or by way of direct current connection **25b**. The power or voltage regulator is configured to send voltage output of 5V and 12V to the micro-controller board and motor **15a**, respectively. The controller **20** is further configured to send signal to the motor **15a** in moving the cage **35** up and down during operation. All analogue and digital signals transmitted from the bubble, temperature and pressure sensors are converted into digital signal by the controller **20**, whereby the controller **20** records and process the digital signal data and display said data on the display means. Further in one embodiment of the present invention, the controller **20** is configured to store all information associated to testing operation, such as, depth, duration etc., apart from sending signals to a tower light in indicating status of operation which may include run, down, failure detected, test completed.

[0031] **FIGURE 3** illustrates the cage **35** of the apparatus in accordance with an embodiment of the present invention. The cage **35** may be formed from a lightweight, non-corrosive material, such as, but not limiting to, acrylic or plastic polymer. The cage **35** is adapted to be movably attached to the support frame **5;** whereby it is connected in a manner such that the cage **35** can move upwards and downwards relative to the support frame **5**. The cage **35** further includes two sections, one section adapted for directing bubbles which is referred herein as the accumulator **35a** having an open tip **35b** extending vertically from the accumulator **35a** and a second section being a base plate **35c.** There is further provided a harness-type cord

35d, a sensor cable housing **35e** and a plurality of fasteners **35f** provided at the perimeter of the base plate for attachment to the accumulator **35a**. In one embodiment, the accumulator **35a** generally resembles a pyramid shape member having an open tip **35b** extending vertically from the top surface of the accumulator **35a**. The accumulator **35a** is adapted to accumulate and direct bubbles of air released during the testing operation to the open tip **35b**. It should be mentioned at this juncture that the choice of the accumulator's overall geometry need not be limited to a pyramid structure or configuration, as it can be of any geometrical structure provided it can serve the purpose which deems fit in relation to accumulating and directing bubbles for the apparatus of the present invention. The open tip **35b** is generally a hollowed member extending vertically from a top surface of the accumulator **35a**. It is adapted with one open end attached to the surface of the accumulator **35a** such that bubbles from the accumulator may enter and the opposite end is equipped with a bubble sensor **30a** for detecting bubbles that enters the open tip **35b**.

[0032] The base plate **35c** in accordance with an embodiment of the present invention is a perforated member with a contour corresponding to that of the accumulator **35a**. The base plate **35c** is attached to the accumulator **35a** by way of adjustable fasteners **35f**. In this attachment, the fasteners are positioned at the perimeters of the base plate **35c**. The adjustable fasteners **35f** can be in the form of rod-like telescopic members. In one example, the fasteners are positioned at each corner of the base plate **35c.**

[0033] In terms of assembly and still referring to **FIGURE 3**, one end of the sensors cable housing **35e** is secured to the open tip **35b** and another end secured to the support arm **5c.** As discussed earlier, at least one sensor configured for bubble detection **30a**, one sensor configured for signals and data associated to temperature **30b** and one sensor configured for signals and data associated to pressure **30c**. These sensors can be of ultrasonic sensors type. All of the sensors are configured to receive and send signals from and to the controller **20**. The bubble detection sensor **30a** is positioned at the open tip **35b** of the accumulator **35a**, in a manner such that whenever a bubble enters the open tip **35b**, the sensor **30a** is triggered and generates a feedback. The temperature sensor 30b and hydrostatic pressure sensor **30c** are positioned on a surface of the accumulator **35a,** thus adjacent to the device under

testing. In one example, the pressure sensor **35b** and the temperature sensor **35b** are mounted on a peripheral surface of the accumulator **35a**, as shown in **FIGURE 3**. The pressure sensor **30c** is configured to monitor water pressure during testing operation, as hydrostatic pressure is correlated to the depth of the submersible. Further, the pressure sensor **30c** serves to send feedbacks to the micro-controller when the cage **35** reaches the water due to water pressure difference between water and atmosphere. The temperature sensor **30b** is configured to monitor and record underwater temperature, so as to detect any changes with temperature that may be affected by pressure.

[0034] **FIGURE 4** illustrates the cage **35** being movably attached to the support frame **5**. In one embodiment, the cage **35** may be secured to the support arm **5c** by way of harness-type cord **35d** adapted to hold the cage **35** and is connected to the pulley assembly **15**.The base plate **35c** is removably attached to the accumulator **35a** by the adjustable fasteners **35f** in a manner such that there is a gap formed between the parameter regions of the base plate **35c** and that of the accumulator **35a**. This is to enable the device **1** to be inserted or placed within the cage **35**. The adjustable fasteners **35f** allow the gap distance to be varied in accordance with the user's requirements.

[0035] The sensor cable housing **35e** is built to accommodate at least one of the sensors, which is the bubble detection sensor **30a**. In one embodiment, the sensor housing **35e** is in the form of an expandable and collapsible type housing, and thus can be extended up to 3 metres during use. In another embodiment, there is further provided an indicator or tower light **40 (shown in FIGURE 4)** secured to another surface of the vertical support member **5a**, the light is adapted to have two types of indications, whereby one indicates the initiation of the apparatus and a second indication on the detection of failure of the testing operation.

[0036] **FIGURE 5** illustrates the cage **35** in operation in accordance with an embodiment of the present invention. The device under test **1** is placed on the base plate **35c** of the cage. The cage **35** is lowered and thus submerged together with the device under test **1** in the water chamber **10**. In the event that the device under test **1**

has water protection flaws, the device under test **1** generates bubbles due to pressure differential. The released bubbles then rise to the surface and directed towards the open tip **35b** by the accumulator **35a**. The bubble sensor **30a** detects each bubble that goes through the open tip **35b** and sends analogue signals on failure severities i.e. frequency and volume bubbles to the controller **20**. The controller **20** is configured to record received information and trigger notifications or indication whenever necessary.

[0037] A system incorporating the method of the present invention is shown in **FIGURE 6** as a schematic flowchart generalizing the entire testing operation in accordance with an embodiment of the present invention. A pre-initialization step **600** may be conducted at any time prior to each testing operation, whereby the pre-initialization includes gathering and storing data associated to test profile, such as, depth, soak/dry duration, sequential process, drop/lift speed and etc. All information pertaining to the test and the device under test **1** is inputted to the controller **20**. The controller **20** then controls the movement and behaviour of the components in an automated manner based on the predefined parameters configured by the user in performing the test operation. Upon acquired all predefined settings and parameters entered as input at **600**, the operation is initiated and thus starts at **601**. Then at **602**, the controller **20** sends a signal for the tower light **40** to turn GREEN, to indicate that the apparatus is ready. At **603**, the device under test **1** cage **35** is released into the water chamber **10.** In this step, the controller **20** sends a signal to the motor **15a** of the pulley assembly **15** to move the cage **35** towards and into the water chamber **10.** The signal is picked up by the motor **15a**, to which the motor **15a** responded by moving the case downwardly and towards the water chamber **10**. As the cage **35** is affixed with the pressure sensor **30c**, upon entered the water, the sensor **30c** detects the water surface at **604** and thus resetting the cage's **35** motor **15a** to zero point level at **605**. At **606**, the device under test **1** cage **35** continues to drop and thereby fully submerged at **607**. At **608**, the cage **35** is halted for 10 seconds to release unwanted bubbles, which may come from the cage, cord or device under test **1** mounting means if any. While the cage **35** continues to drop to a desired depth, the bubble detection sensor **30a** is activated at **609**. At 610, in the event that there is failure with respect to the protection of device under test **1**, produced bubbles are directed to the open tip **35b** by the accumulator **35a** for the detection by the bubble sensor **30a**. In the event that there is

no bubble released or produced by the device under test **1**, the step **609** may be repeated. Upon detected the bubbles, bubble sensor **30a** notifies the controller **20** to which the controller **20** automatically responds by switching the tower light **40** to RED to indicate failure at **611**. Next at **612**, all the bubbles criteria such as size, frequency and detected time are detected by the bubble sensor **30a**. All information pertaining the bubbles detected may be inputted to the controller **20**. Next at 613, the cage **35** is further released to desired depth for instance, at 1-meter depth. Meanwhile, the detection criteria are sent to the controller **20** for recording and to be displayed by the display means. At **614**, the cage **35** continues to be soaked at a desired duration. After being soaked at a predetermined duration, the cage **35** is lifted to the zero point level at **615**. The cage **35** is fully removed from the water at **616**. Then at **617**, the cage **35** is halted for drying at a predetermined duration, prior to notifying the user on the completion of the test. The operation ends at **618**.

[0038] The automated apparatus of the present invention further provides portability and adaptability, allowing tests to be conducted at the scene, in-situ, on-site or deployed for field-testing. The water chamber being removable allows the cage to be dropped directly into the water with sturdy support from the support frame. The apparatus further provides a time effective method as all components can be operated via the controller **20**.

[0039] As would be apparent to a person having ordinary skilled in the art, the afore-described methods and components may be provided in many variations, modifications or alternatives to existing testing systems. The principles and concepts disclosed herein may also be implemented in various manner which may not have been specifically described herein but which are to be understood as encompassed within the scope and letter of the following claims.

CLAIMS

1. An automated apparatus **100** for use in a water ingression test of a device, wherein bubbles are released in the event of the device failure, the apparatus comprising:

a controller **20** configured to control the behaviour and movements of the apparatus **100** based on predefined parameters;

a support frame **5** comprising at least one extendible vertical member **5b** and a support arm **5c** affixed at one end of the extendible vertical member **5b;**

a cage **35** being movably attached to the support arm **5c**; the cage **35** comprising an accumulator **35a** for directing the bubbles to an open tip **35b** and a base section **35c** for carrying the device under test **1;**

a water chamber **10** positioned adjacent to the support frame **5** ;

at least one bubble sensor **30a** affixed on one surface of the cage **35** in a manner such that it is able to detect bubbles;

wherein the cage **35** is connected to the support arm **5c** such that it can be moved upwards and downwards within the water chamber **10**.

2. An automated apparatus **100** further comprising a pulley assembly **15** driven by a motor **15a** secured at the support arm **5c** and to the cage **35** such that it provides upwards and downwards motion to the cage **35**; wherein said pulley assembly **15** is configured to receive signals from the controller **20** and responding to said signals by way of providing movements to the cage **35**.

3. An automated apparatus **100** as claimed in Claim 1 wherein the support arm **5c** can be extended horizontally relative to the vertical member **5b** of the support frame **5**.

4. An automated apparatus **100** as claimed in Claim 1 wherein the open tip **35b** is adapted such that directed bubbles can go through the tip **35b** and wherein the sensor **30a** is positioned at the open tip **35b**, such that each bubble that goes through the tip can be detected by the sensor **30a**.

5. An automated apparatus **100** as claimed in Claim 1 wherein the support member **5** further comprises a base section **5a**.

6. An automated apparatus **100** as claimed in Claim 1 further comprising a temperature sensor **30b** and a pressure sensor **30c**, both of the sensors are mounted on the cage **35**.

7. An automated apparatus **100** as claimed in Claim 1 wherein the base section **35c** is a perforated section and is attached to the accumulator **35a** by a plurality of fasteners **35f** such that there is a gap to insert the tested device **1** within the cage **35**.

8. An automated apparatus **100** as claimed in Claim 1 wherein the apparatus further comprising a sensor cables housing **35e** connected to the support arm **5c**.

9. An automated apparatus **100** as claimed in Claim 8 wherein the sensor cables housing **35e** is in the form of scissor-type extension cable housing.

10. An automated apparatus **100** as claimed in Claim 1 further comprising; an indication means **40** to indicate failure of test, a display means **20a** for displaying the test results and a harness cord **35d** adapted for holding the cage **35**.

11. A method for use in a water ingression test for a device under test **1**, wherein in the event of a failure, bubbles are released from the device under test **1**, the method comprising:

gathering and storing input associated to test profile **600;**
initiating the test **601** and automatically providing a light indication for initiation of test **602;**
automatically releasing the device to enter a chamber of water **603** at a predetermined depth;
detecting pressure differential **604**;
resetting the motion the device such that it reaches the water surface **605;**

further releasing the device into the water chamber until the device is fully submerged **606, 607**;

halting the device under water for a predetermined period of time **608**;

automatically activating the sensor **609** and directing the bubbles **610** which maybe released from the device to the bubble detection sensor;

providing an indication for failure of test **611**;

detecting and storing all criteria of bubbles released from the device **612;**

further releasing the device into a predetermined depth **613**;

soaking the device to a desired duration **614**;

automatically lifting the device from the chamber of water **615**;

fully removing the device from water **616**; and

halting the device for drying for a period of time **617**; and

displaying all test results.

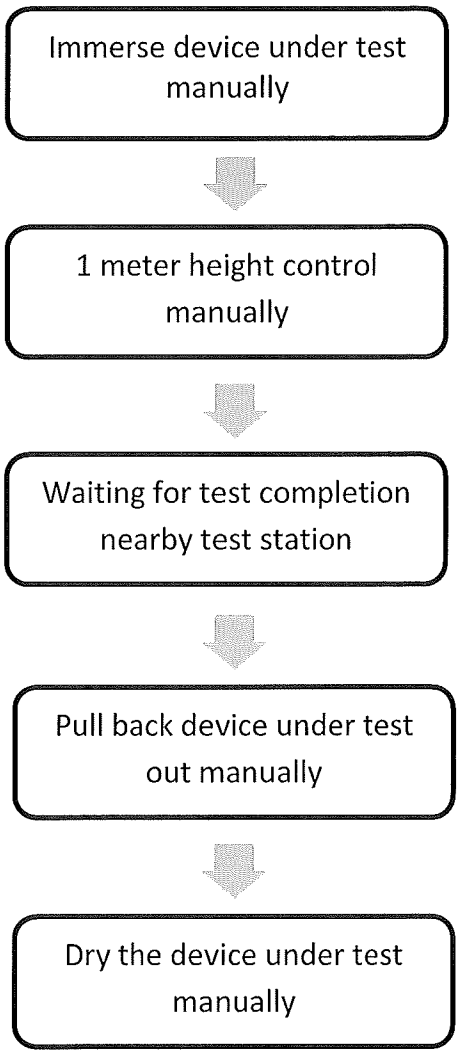

Immerse device under test manually
1 meter height control manually
Waiting for test completion nearby test station
Pull back device under test out manually
Dry the device under test manually

FIGURE 1

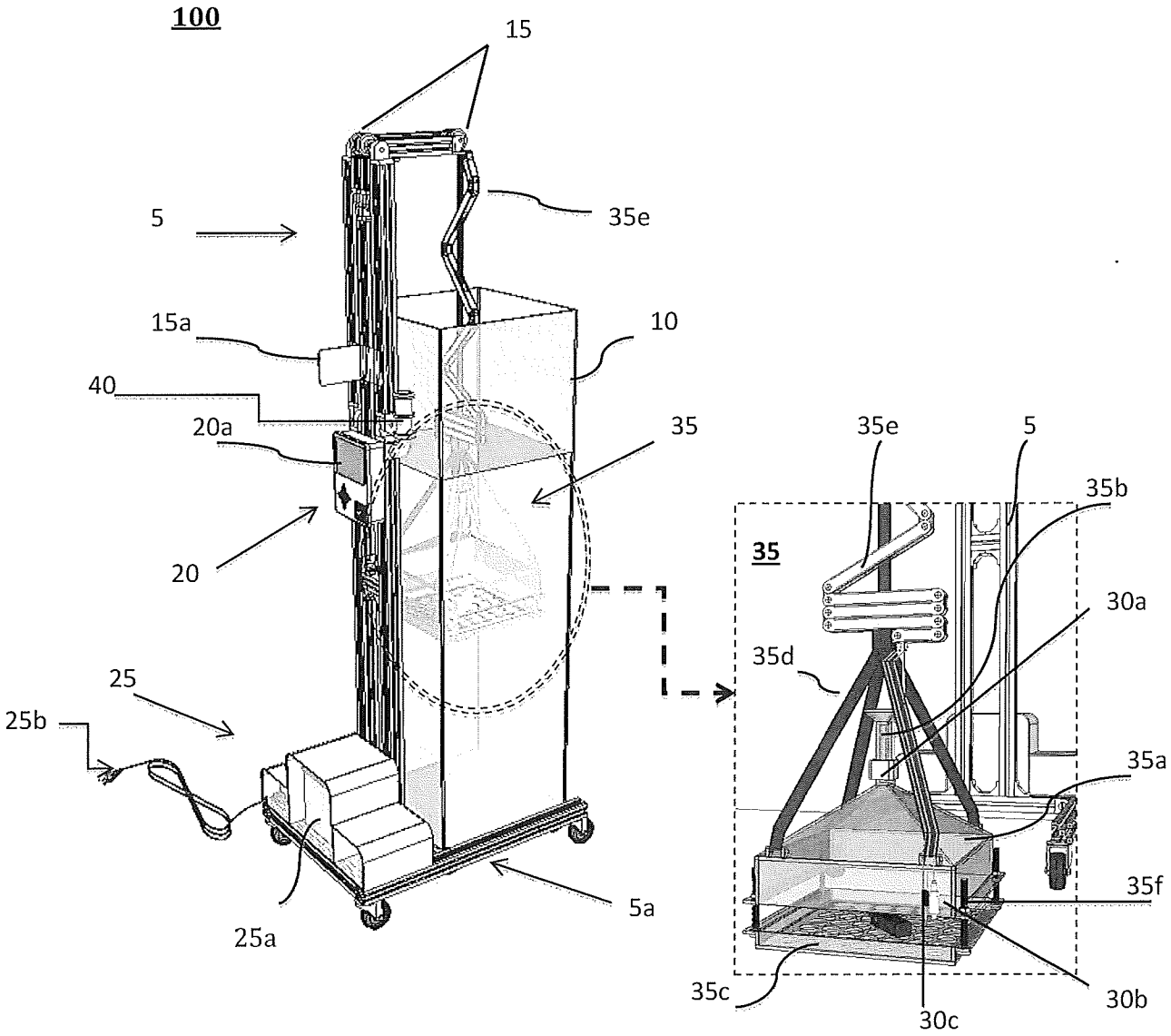

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35d
30a
35a
35f
35c
30b
30c

FIGURE 2A

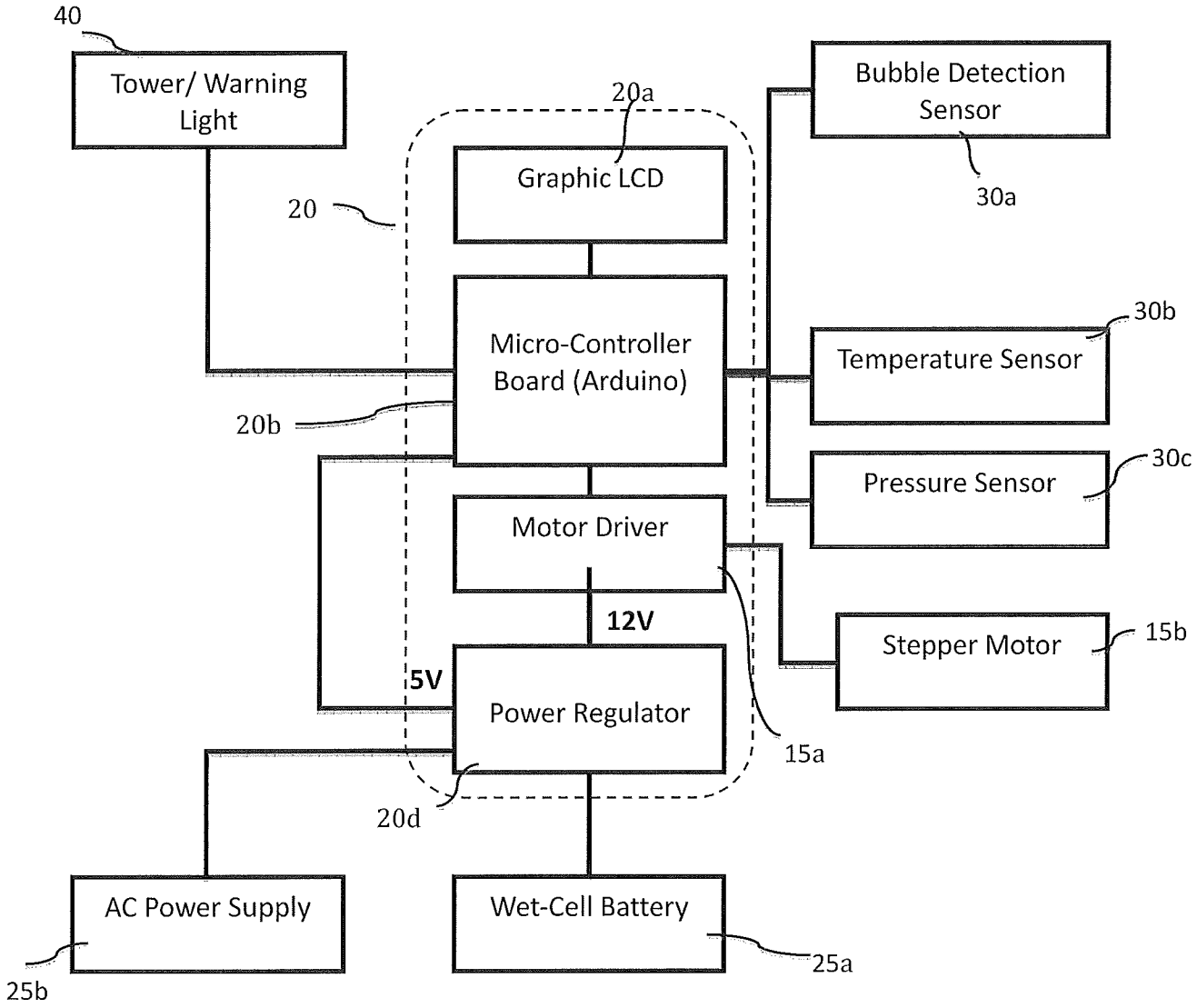

40
Tower/ Warning Light
20a
Graphic LCD
20
Bubble Detection Sensor
30a
Micro-Controller Board (Arduino)
30b
Temperature Sensor
20b
Pressure Sensor
30c
Motor Driver
12V
Stepper Motor
15b
5V
Power Regulator
15a
20d
AC Power Supply
Wet-Cell Battery
25a
25b

FIGURE 2B

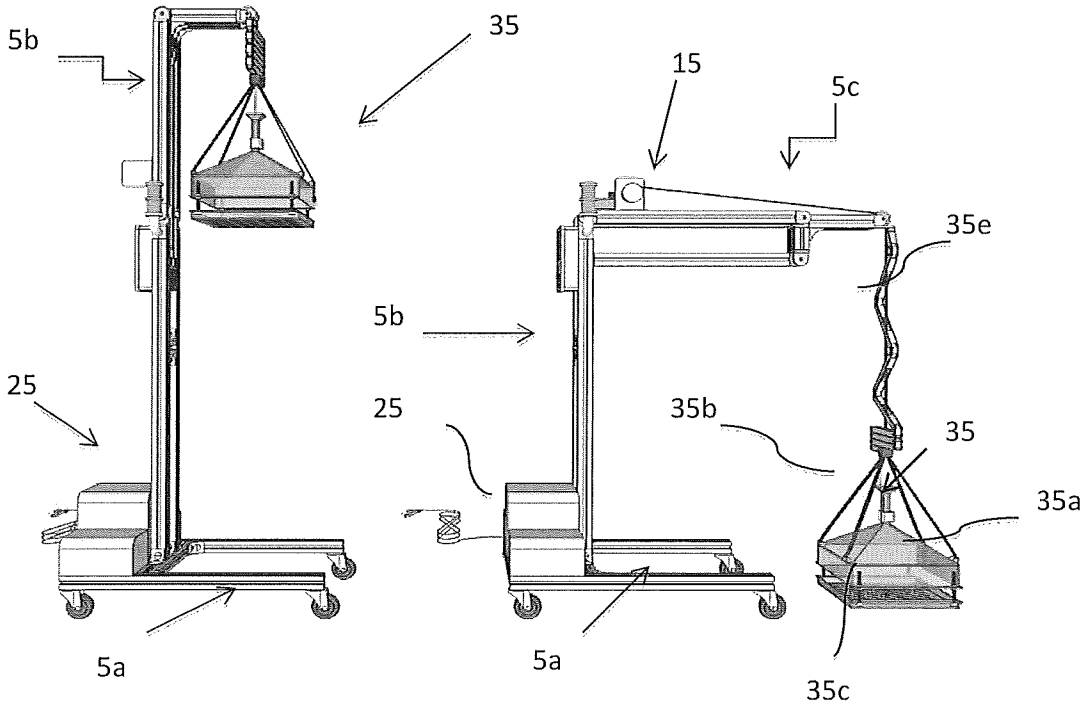


FIGURE 2C

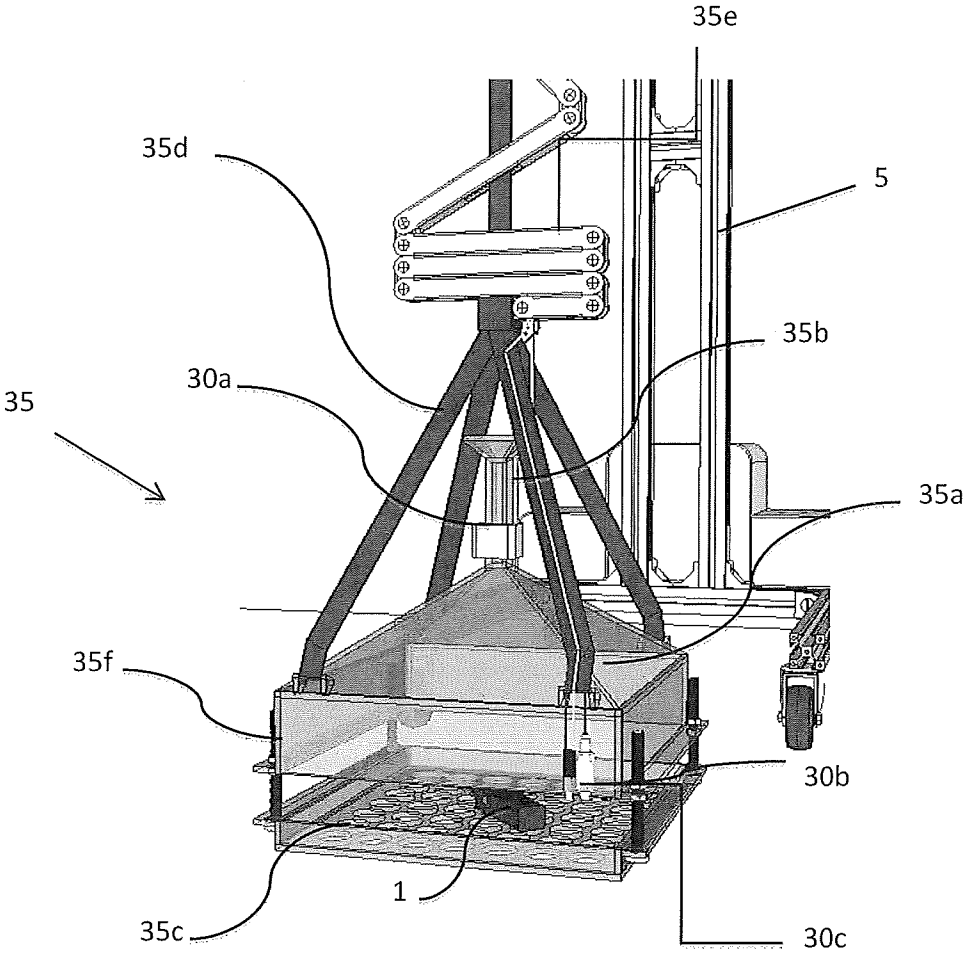


FIGURE 3

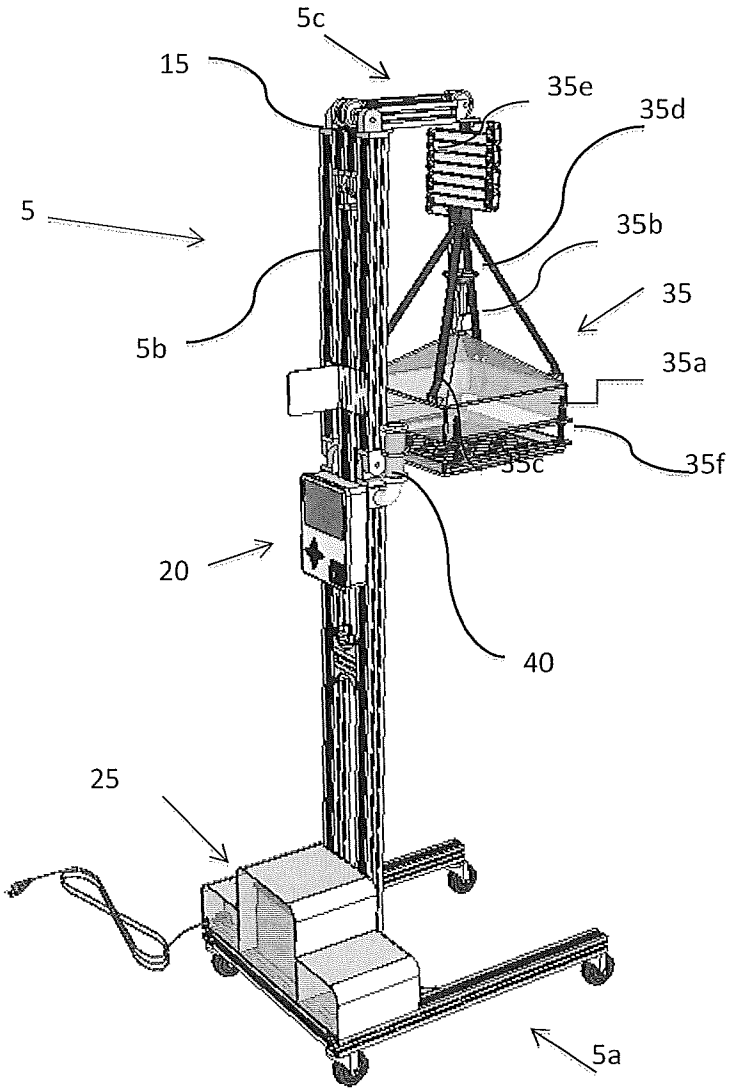


FIGURE 4

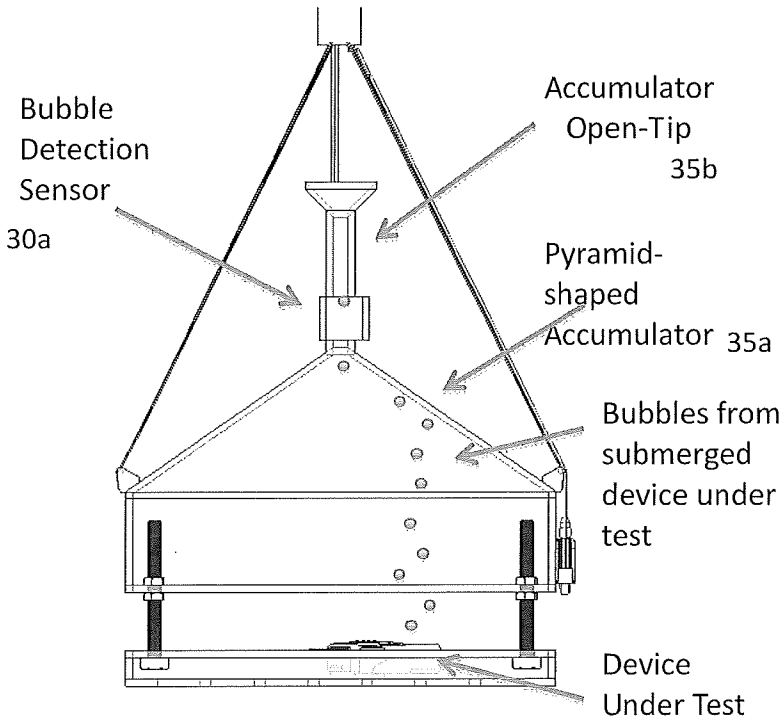

Bubble
Detection
Sensor
30a
Accumulator
Open-Tip
35b
Pyramid-
shaped
Accumulator 35a
Bubbles from
submerged
device under
test
Device
Under Test
1

FIGURE 5

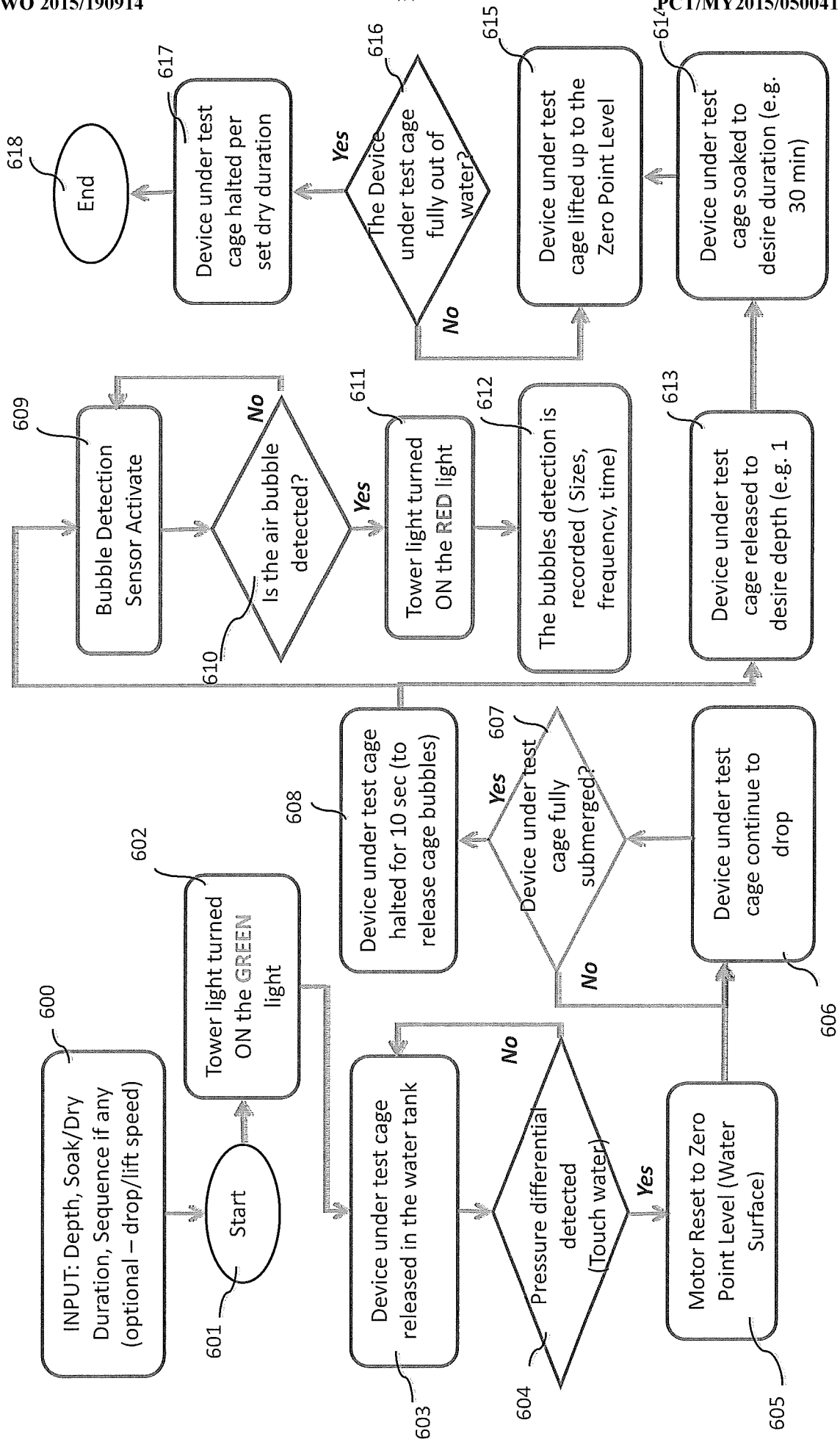

INPUT: Depth, Soak/Dry Duration, Sequence if any (optional – drop/lift speed)
600
Start
601
Tower light turned ON the GREEN light
602
Device under test cage released in the water tank
603
Pressure differential detected (Touch water)
604
Yes
No
Motor Reset to Zero Point Level (Water Surface)
605
Device under test cage continue to drop
606
Device under test cage fully submerged?
607
Yes
No
Device under test cage halted for 10 sec (to release cage bubbles)
608
Bubble Detection Sensor Activate
609
Is the air bubble detected?
610
Yes
No
Tower light turned ON the RED light
611
The bubbles detection is recorded (Sizes, frequency, time)
612
Device under test cage released to desire depth (e.g. 1
613
Device under test cage soaked to desire duration (e.g. 30 min)
614
Device under test cage lifted up to the Zero Point Level
615
The Device under test cage fully out of water?
616
Yes
No
Device under test cage halted per set dry duration
617
End
618

FIGURE 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2015/050041

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. G01M3/06(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. G01M3/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2015
Registered utility model specifications of Japan 1996-2015
Published registered utility model applications of Japan 1994-2015

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3646804 A (ELECTRONIC COMMUNICATIONS, INC) 1972.03.07, columns 2,3 (No Family)	1, 3-11
Y	JP 7-198525 A (TOYOTA MOTOR CORPORATION) 1995.08.01, [0007]-[0013] (No Family)	1, 3-11
Y	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No.84749/1990(Laid-open No.43243/1992) (SHIN-OHTSUKA Co.,Ltd.) 1992.04.13, whole Document (No Family)	1, 3-11

☑ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16.10.2015	27.10.2015

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2015/050041

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2003-129656 A (NIHON BISOH Co.,Ltd) 2003.05.08, [0010]-[0052] & CN 1414199 A	2 3, 7
Y	JP 3046203 U (FUJIKOGYO & Co.,Ltd) 1997.12.03, Page. 1 (No Family)	8, 9
Y	JP 2001-165801 A (KEIHIN CORPOTAION) 2001.06.22, [0021] (No Family)	10