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(54) Title: A WATER INGRESSION TEST DEVICE FOR TESTING WATER PROOFING PERFORMANCE OR A UNIT UNDER TEST (UUT)

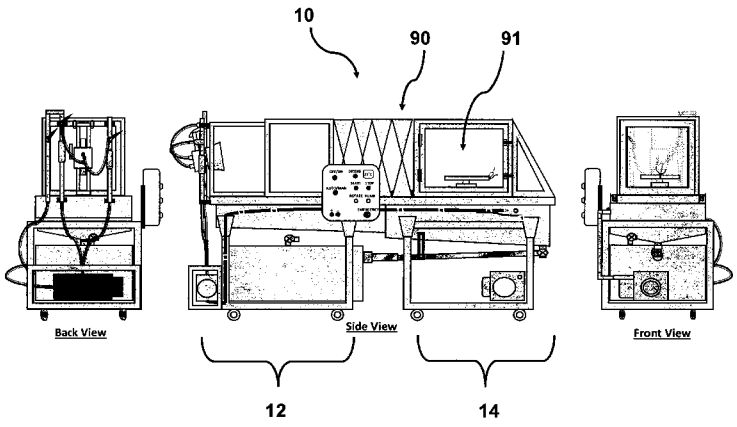


FIGURE 1

(57) Abstract: The present invention relates to a water ingression test device (10) for testing water proofing performance of a unit under test (UUT). One of the advantages of the water ingression test device for testing water proofing performance of a unit under test (UUT) of the present invention is it determines the capability of outdoor-rated product enclosures ingression protection. The water ingression test device (10) for testing water proofing performance of a unit under test (UUT) of the present invention is versatile with a heated chamber, adjustable water jet pressure flow-rate and ability to a variable test distance range for establishing the limit of enclosure ingression protection. The water ingression test device (10) for testing water proofing performance of a unit under test (UUT) of the present invention having advantage of a water jet pressure flow-rate can be controlled to set from 1 to 150 LPM, depend on compliance standard or engineering requirements. Furthermore, it can accommodate any enclosure (Unit Under Test) sizes since targeted station is detachable and the product under test can be automatically rotate to other surfaces after period of exposure time or can be manually rotate as per user defined.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

A WATER INGRESSION TEST DEVICE FOR TESTING WATER PROOFING PERFORMANCE OF A UNIT UNDER TEST (UUT)

FIELD OF THE INVENTION

The present invention relates to a water ingression test device for testing water proofing performance of a unit under test (UUT).

BACKGROUND OF THE INVENTION

Moisture intrusion is one of the common causes of damage done to parts and components inside electronic products. For outdoor-rated electronic devices or enclosures where the application in harsh wet environment, such as outdoor network access point, bathroom water heater, automotive lightings, sensors for field agriculture etc, the effectiveness of sealing or water-proofing protection is required to be validated. The most prominent water-proof testing conventionally is using pressurized water jet from any direction onto the device surfaces, edges, connector ports, ventilation panels etc.

The common testing standard that manufacturer generally refer to for ingression protection against water jet are International Electrotechnical Commission (IEC60529 - IPX5 and IPX6), Japanese Industrial Standard (JIS - JIS5 and JIS6) and National (U.S.) Electrical Manufacturers Association (NEMA Type 5 and 6). The water jet testing of rating IPX5 and IPX6 are more severe than rating IPX7 of 1 meter submerged in water in term of penetration pressure on specific location. For product design team, this testing is not only for meeting the above compliance standards but also to determine the limit or to qualify several designs by testing to various flow-rate, distance and prolong duration. For instance, in order to qualify suppliers for the ventilation membranes, qualify speaker port design or determine LCD face-display screw torque value is required for water-tightness.

Currently, no guidelines are provided on the test configuration. Thus, most manufacturers opt for conservative testing using fabricated hand-held water jet nozzles, i.e. manually mounted and rotated the test unit in specific distance, and then manually blow drying the test unit upon test completion for water ingression verification.

Due to the nature of the testing methods, the testing activity normally performed outdoor or in dedicated wet area. However, this method resulted in a low repeatability, productivity and accuracy in the test integrity due to intra-individual variability, multiple handling, non-controlled and less replication of real-life environment. Moreover, the high volume of water for high pressure test is wasted during the test. Another common factor that is always neglected in the water ingression testing is the effect of high temperature environment that typically occur during real-life application where the tested product is placed under hot sun to deteriorate the waterproof sealing.

Therefore there is a need for a water ingression test device for testing water proofing performance of a unit under test (UUT) to overcome the above drawbacks. The present invention provides a considerable reduction of materials with even greater efficiency and economically during operation.

SUMMARY OF THE INVENTION

The present invention provides a water ingression test device for testing water proofing performance of a unit under test (UUT) comprising a water projectile station having a plurality of water jet nozzles for providing a pressurized water jet on the unit under test; and a unit under test station for mounting the unit under test in an enclosed environment wherein the distance between the water projectile station and the unit under test station according to predetermined test requirements.

In one embodiment of the present invention, the water projectile station further comprising a water tank for storing water; and a pump connected to the water tank for providing continuing water pressure to the water jet nozzles.

In yet another embodiment of the present invention, the water jet nozzles comprising two sets of nozzles at a different flow-rate.

In another embodiment of the present invention, the unit under test station further comprising a hot air blower to increase a temperature of the unit under test in the enclosed environment; and a temperature sensor to determine the temperature in the enclosed environment.

In yet another embodiment of the present invention, each nozzle affixed with an individual open-close valve and flow-rate meter and a programmable logic system for controlling the water projectile station and the unit under test station in an automation environment.

In another embodiment of the present invention, the distance between the water projectile station and the unit under test station is set according to water projectile distance requirements.

In yet another embodiment of the present invention, the water jet nozzles are movable vertically according to a water trajectory and directional flow and the unit under test further mounted on a turn-table assembly having a stepper motor for rotating the unit under test in the unit under test station and a mounting base platform designed with perforated frame for ease of product mounting.

In another embodiment of the present invention, the hot air blower comprising a set of pointing air blow tips facing the unit under test and in opposite direction of the pressurized water jet flow.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

Figure 1 illustrates an overview of a water ingression test device for testing water proofing performance of a unit under test (UUT) in accordance of the present invention.

Figure 2 illustrates a movability of the water ingression test device for testing water proofing performance of a unit under test (UUT) in accordance of an embodiment of the present invention.

Figure 3 illustrates a detachability of the water ingression test device for testing water proofing performance of a unit under test (UUT) in accordance of an embodiment of the present invention.

Figure 4 illustrates a water projectile station of the water ingression test device for testing water proofing performance of a unit under test (UUT) in accordance of an embodiment of the present invention.

Figure 5 illustrates a plurality of water jet nozzles assembly in water projectile station of the water ingression test device for testing water proofing performance of a unit under test (UUT) in accordance of an embodiment of the present invention.

Figure 6 illustrates a unit under test (UUT) station of the water ingression test device for testing water proofing performance of a unit under test (UUT) in accordance of an embodiment of the present invention.

Figure 7 illustrates a turn-table assembly in unit under test station of the water ingression test device for testing water proofing performance of a unit under test (UUT) in accordance of an embodiment of the present invention.

Figure 8 illustrates a water ingression test device for testing water proofing performance of a unit under test (UUT) in operation in accordance of the present invention.

Figure 9 illustrates a flow chart of water ingression test device for testing water proofing performance of a unit under test (UUT) in operation with comparison with standard testing method in accordance of the present invention.

Figure 10 illustrates a flow chart of water ingression test device for testing water proofing performance of a unit under test (UUT) in operation in accordance of the present invention.

DETAILED DESCRIPTIONS OF THE INVENTION

The present invention will now be described in detail in connection with specific embodiments with reference to the accompanying drawings.

The present invention relates to a water ingression test device **(10)** for testing water proofing performance of a unit under test (UUT). The water ingression test device **(10)** for testing water proofing performance of a unit under test (UUT) having two main chambers mainly a water projectile station **(12)** having a plurality of water jet nozzles for providing a pressurized water jet on the unit under test and a unit under test station **(14)** for mounting the unit under test in an enclosed environment wherein the distance between the water projectile station

(12) and the unit under test station **(14)** according to predetermined test requirements. **Figure 1** shows a complete assembly of the water ingression test device **(10)** for testing water proofing performance of a unit under test (UUT). The housing **(91)** of the water ingression test device (10) for testing water proofing performance of a unit under test (UUT) is made from a transparent acrylic or any equivalent materials while the corrugated sleeve **(90)** is made from water-proof canvas.

Figure 2 illustrates a movability of the water ingression test device for testing water proofing performance of a unit under test (UUT) in accordance of an embodiment of the present invention. The water ingression test device for testing water proofing performance of a unit under test (UUT) is moveable either by retracting mechanism for storage purposes and for application of short range test distance. With extracting mechanism, a long range test distance is achieved with the assistance of the locking mechanism at a predetermined distance (e.g. 2.5 meter test distance compliance to IEC60529). The water ingression test device for testing water proofing performance of a unit under test (UUT) is designed on a rigid frame with casters for high mobility.

Figure 3 shows the detachability of the water ingression test device for testing water proofing performance of a unit under test (UUT) which is an integration of two chambers, a water projectile station **(32)** and a unit under test station **(34).** The water ingression test device is detachable to accommodate larger test unit and/or longer test distance (superior than ordinary size of Unit Under Test chamber).

Figure 4 illustrates a water projectile station of the water ingression test device for testing water proofing performance of a unit under test (UUT) in accordance of an embodiment of the present invention. The source of the incoming fresh water and recycle water coming through inlet hose connector **(41)** to the water tank **(42).** A pump **(43)** connected to the water tank **(42)** for providing continuing water pressure to the water jet nozzles preferably delivering high pressurize water to the jet nozzle assembly **(44).** A clear housing **(45)** as illustrated can be retracted to allow for higher water trajectory points. The water projectile station is controlled by a programmable logic system **(46)** in an automation environment.

The jet nozzle assembly **(44)** used in the water ingression test device of the present invention preferably a low pressure jet nozzle installed with low resolution (0.5LPM scale interval) flow-rate meter **(411)** for flow-rate ranging from 1 to 20 LPM. (IEC60529 - IPX5

setting at 12.5 LPM = 30KN/m^3) while a high pressure jet nozzle installed with high resolution (10LPM scale interval) flow-rate meter **(47)** for flow-rate ranging from 15 to 150 LPM. (IEC60529 - IPX6 setting at 100 LPM = 100KN/m^3). An open-close valve **(49)** is used to operate high pressure nozzle and another open-close valve **(410)** is used to operate low pressure nozzle **(410).** A by-pass valve **(48)** is added to the water flow line as to remove potential bubbles built up in the hoses.

Figure 5 illustrates a plurality of water jet nozzles assembly in water projectile station of the water ingression test device for testing water proofing performance of a unit under test (UUT) in accordance of an embodiment of the present invention. The jet nozzle assembly **(54)** comprises of splash cover **(4a),** attached to the two metal jet nozzles with approximately 6mm **(4b)** and 12.5 mm **(4c)** internal diameter. The nozzles are in a standard dimension and design as per stated in IEC60529 hose nozzle dimension. The nozzles fitted into the metal block holder. The block holder attached to a two alignment rods **(4d)** for allowing jet nozzles to move vertically, and then secure the position by press-tight mechanism **(4e).** The alignment rods are connected to pivot arm in one end, and to a trajectory slot in the other end **(4f)** for angle setting and locking which depends on trajectory motion requirement and impact to unit under test.

Figure 6 shows the unit under test (UUT) station of the water ingression test device of the present invention. The unit under test (UUT) station attaching to water projectile station through open slot frame with roller bearing **(62)** and joining the corrugated canvas sleeves **(63)** attached with metal support which is retractable. A turn-table base platform **(64)** is used to mount unit under test with a dedicated fixture together with a thermal couple sensor for temperature control **(65)** and a pre-installed power line **(66)** for product energizing/powering. A commercial hot air blower **(67)** is used to heat the chamber to the preset temperature setting and for drying. Used water from the water ingression test device of the present invention undergoes a standard porous filter **(68)** in a drain outlet. Then, a valve is used to either to drain out the water or recycle the water to the water tank using a flexible sliding tube by gravitational flow. For product mounting, a larger water-tight access door **(69)** is located on the side of the unit under test (UUT) station.

Figure 7 illustrates a turn-table assembly in unit under test station of the water ingression test device for testing water proofing performance of a unit under test (UUT) in accordance of an embodiment of the present invention. The turn-table assembly consist of a stepper motor **(79)** with sealed head for 360° rotation, a mounting base platform **(71),** designed with perforated frame for ease of product mounting, and pre-installed temperature sensor and

power-line cables **(72)** for temperature monitoring and product energizing, respectively. The cables and motor housed in a non-corrosive water-proofing metal housing that attached to the apparatus frame while the cables is terminated at the wall for connection to external line. The PVC hot air blower line is installed on the topmost of chamber and completed with a set of pointing air blow tip facing the unit under test and in opposite direction of the pressurized water jet flow **(70).**

Figure 8 shows an example of the test operation using low pressure nozzle with 12.5 LPM water flow-rate and 2.5m test distance compliance to IEC60529 IPX5 testing. The test product is mounted to the targeted surface and connected to the pre-installed power line cable by using any appropriate termination with temperature sensor attached to the product surface. The programmable power supply is used to energize the unit under test via DC biasing terminal **(83)** on the programmable logic system panel. Then, preset the temperature in temperature controller **(87),** typically at 35°C. For automated testing, an auto switch **(84)** is selected and press start **(85)** button. By default, the turn-table rotates to next 90° surface after 3 minutes (as per IEC60529). For manual testing especially for engineering evaluation, manual switch **(84)** is selected and pump **(88)** button is switched on to activate water jet. This is followed by pressing rotate **(89)** button to move the turn-table by 45° step. In auto mode, once the test is completed, the hot air blower is activated for few minutes for drying, and as for manual by pressing drying **(86)** button. **Figure 9** illustrates a flow chart of water ingression test device for testing water proofing performance of a unit under test (UUT) in operation with comparison with standard testing method in accordance of the present invention. **Figure 10** illustrates a flow chart of water ingression test device for testing water proofing performance of a unit under test (UUT) in operation in accordance of the present invention.

One of the advantages of the water ingression test device for testing water proofing performance of a unit under test (UUT) of the present invention is it determines the capability of outdoor-rated product enclosures ingression protection. The water ingression test device for testing water proofing performance of a unit under test (UUT) of the present invention is versatile with a heated chamber, adjustable water jet pressure flow-rate and ability to a variable test distance range for establishing the limit of enclosure ingression protection. The water ingression test device for testing water proofing performance of a unit under test (UUT) of the present invention having advantage of a water jet pressure flow-rate can be controlled to set from 1 to 150 LPM, depend on compliance standard or engineering

requirements. Furthermore, it can accommodate any enclosure (Unit Under Test) sizes since targeted station is detachable and the product under test can be automatically rotate to other surfaces after period of exposure time or can be manually rotate as per user defined. Moreover, the water ingression test device for testing water proofing performance of a unit under test (UUT) of the present invention is fully automated. Another advantage of the water ingression test device for testing water proofing performance of a unit under test (UUT) of the present invention is economical, consistent and replicate real-life or in a severe environment.

The foregoing embodiment and advantages are merely exemplary and are not to be construed as limiting the present invention. The description of the embodiments of the present invention is intended to be illustrative and not to limit the scope of the claims and many alternatives, modifications and variations will be apparent to those skilled in the art.

CLAIMS

1. A water ingression test device (10) for testing water proofing performance of a unit under test (UUT) comprising

a water projectile station (12) having a plurality of water jet nozzles for providing a pressurized water jet on the unit under test; and

a unit under test station (14) for mounting the unit under test in an enclosed environment wherein the distance between the water projectile station (12) and the unit under test station (14) according to predetermined test requirements.

2. The water ingression test device (10) as claimed in Claim 1 wherein the water projectile station (12) further comprising
a water tank (42)for storing water; and
a pump (43) connected to the water tank (42) for providing continuing water pressure to the water jet nozzles.

3. The water ingression test device (10) as claimed in Claim 1 wherein the water jet nozzles comprising two sets of nozzles at a different flow-rate.

4. The water ingression test device (10) as claimed in Claim 1 wherein the unit under test station (14) further comprising
a hot air blower (67) to increase a temperature of the unit under test in the enclosed environment; and
a temperature sensor to determine the temperature in the enclosed environment.

5. The water ingression test device (10) as claimed in Claim 3 wherein each nozzle affixed with an individual open-close valve and flow-rate meter.

6. The water ingression test device (10) as claimed in Claim 1 wherein a programmable logic system for controlling the water projectile station (12) and the unit under test station (14) in an automation environment.

7. The water ingression test device (10) as claimed in Claim 1 wherein the distance between the water projectile station (12) and the unit under test station (14) is set according to water projectile distance requirements.

8. The water ingression test device (10) as claimed in Claim 1 wherein the water jet nozzles are movable vertically according to a water trajectory and directional flow.

9. The water ingression test device (10) as claimed in Claim 1 wherein the unit under test further mounted on a turn-table assembly having a stepper motor for rotating the unit under test in the unit under test station (14) and a mounting base platform designed with perforated frame for ease of product mounting.

10. The water ingression test device (10) as claimed in Claim 4 wherein the hot air blower (67) comprising a set of pointing air blow tips facing the unit under test and in opposite direction of the pressurized water jet flow.

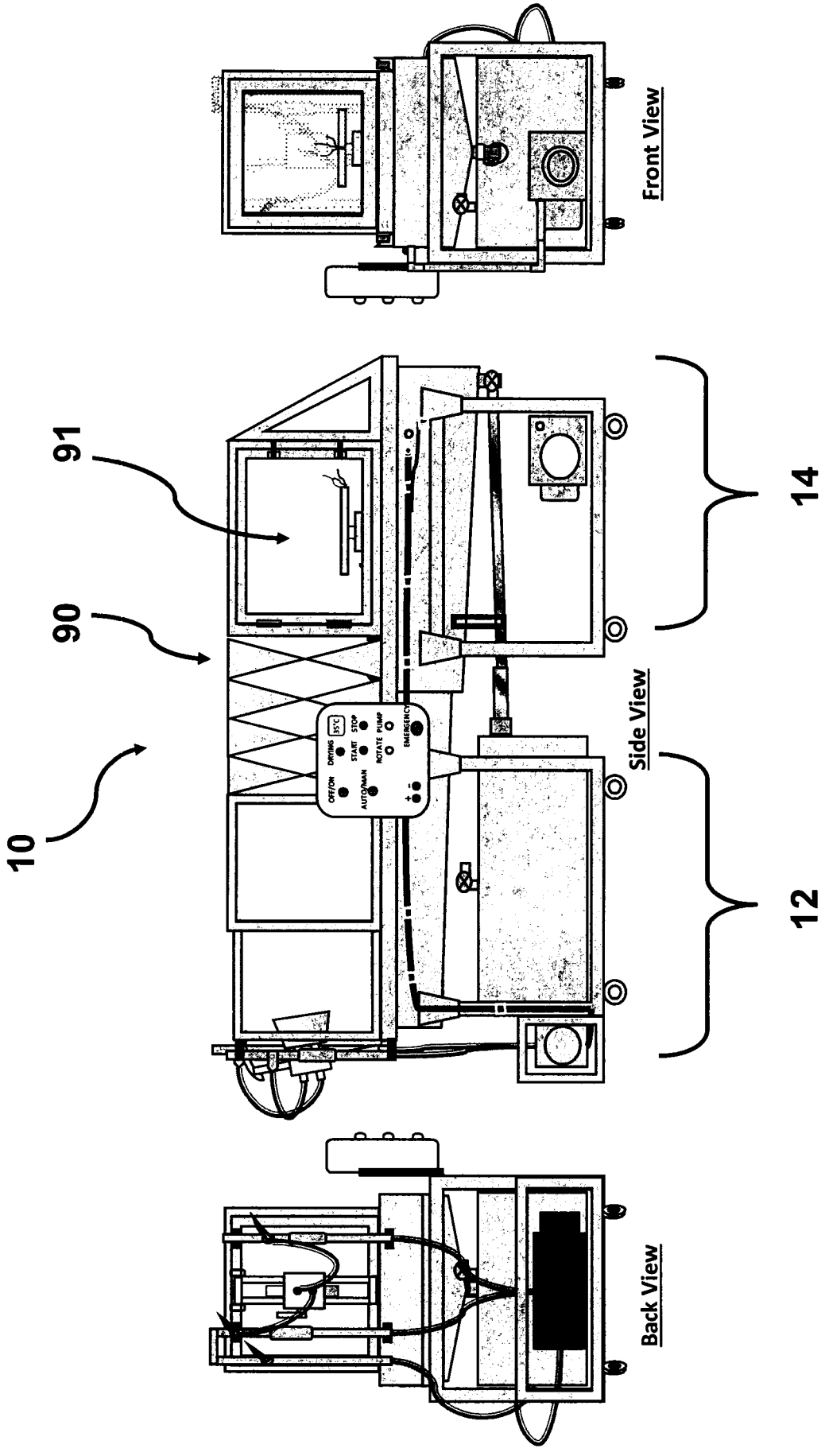


FIGURE 1

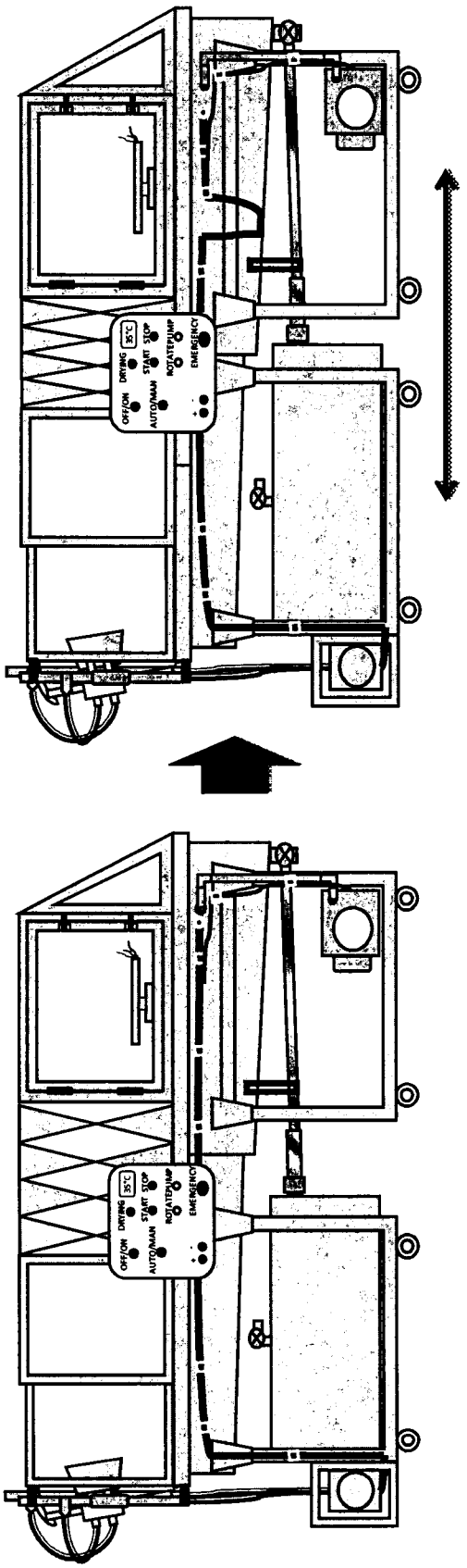


FIGURE 2

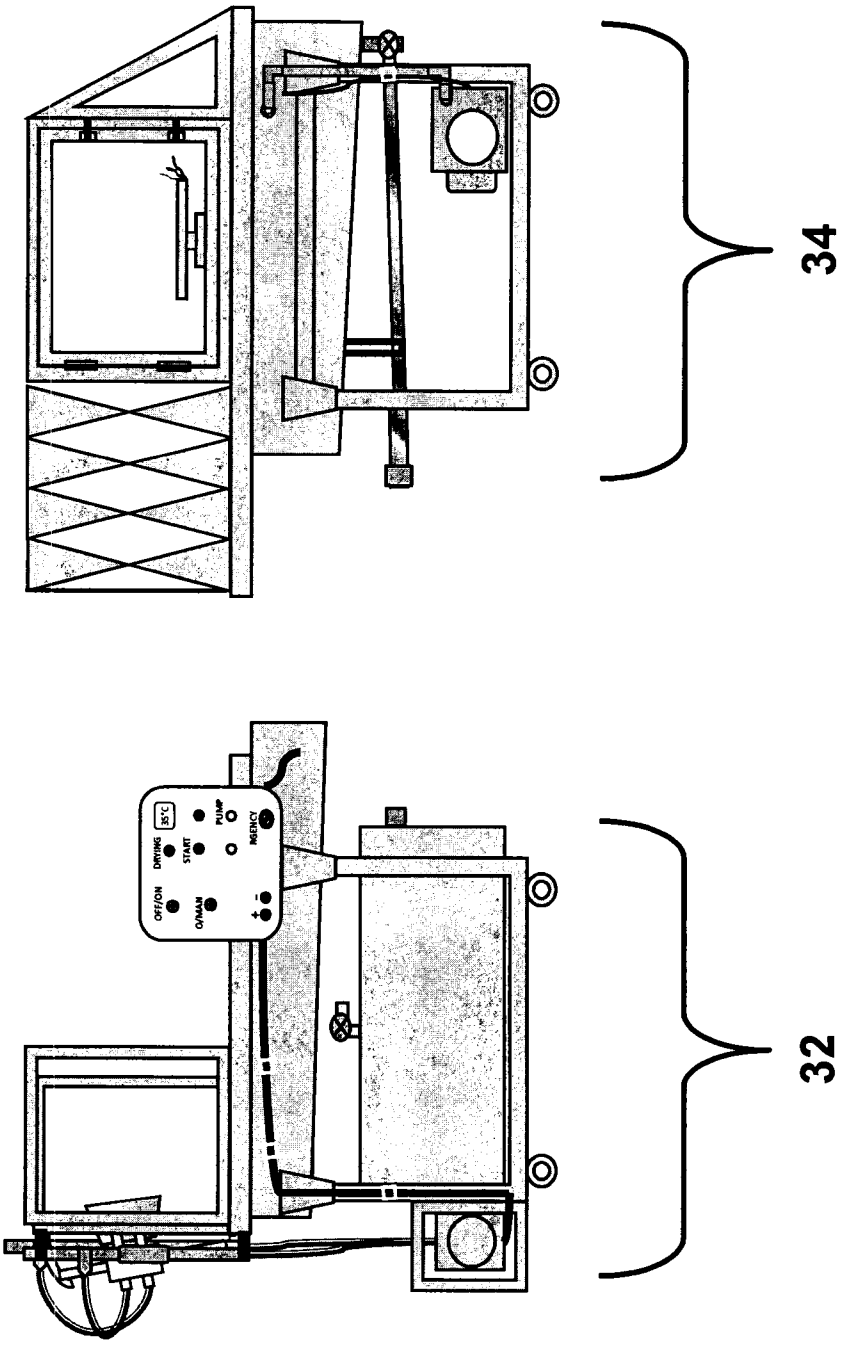


FIGURE 3

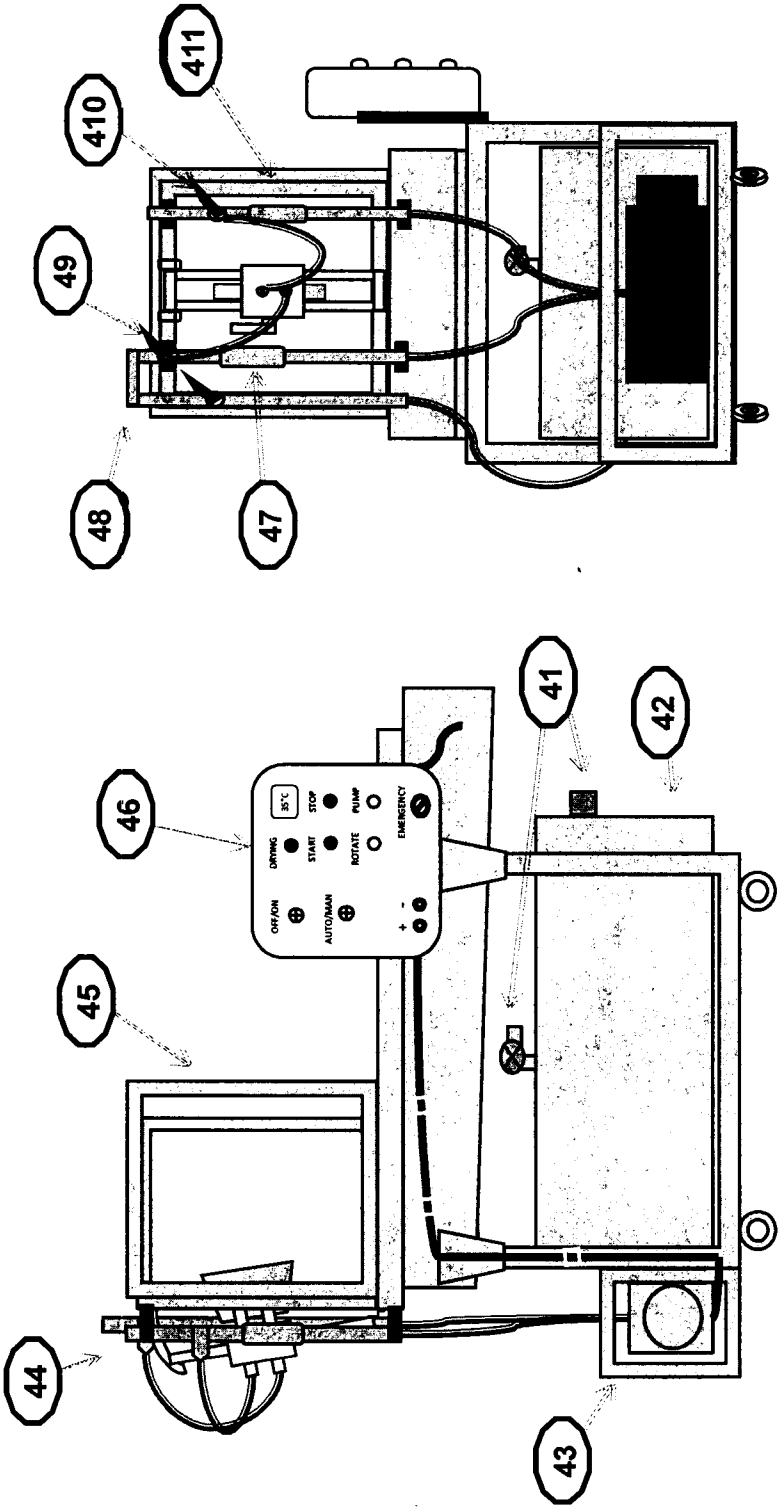

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FIGURE 4

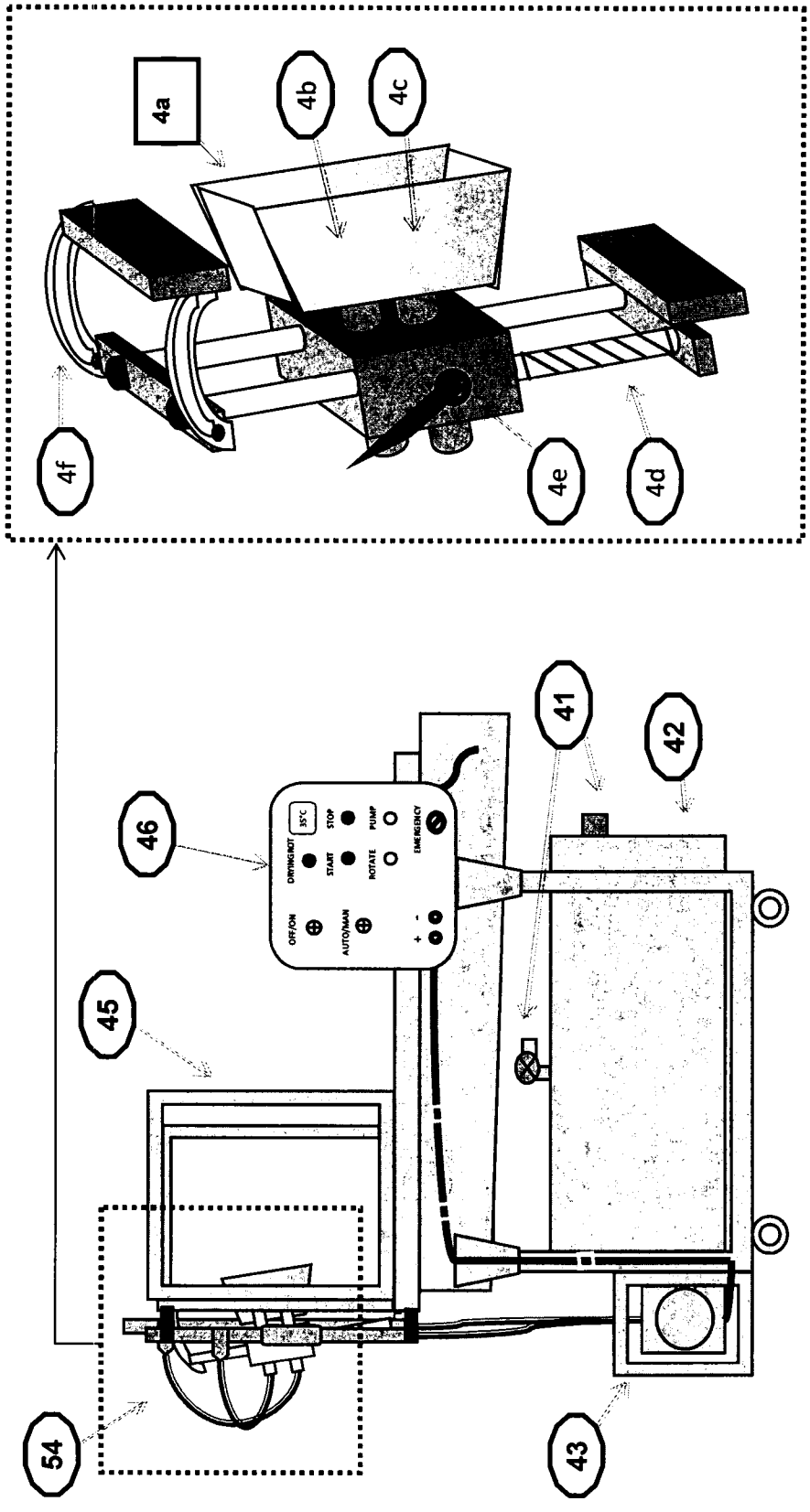

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FIGURE 5

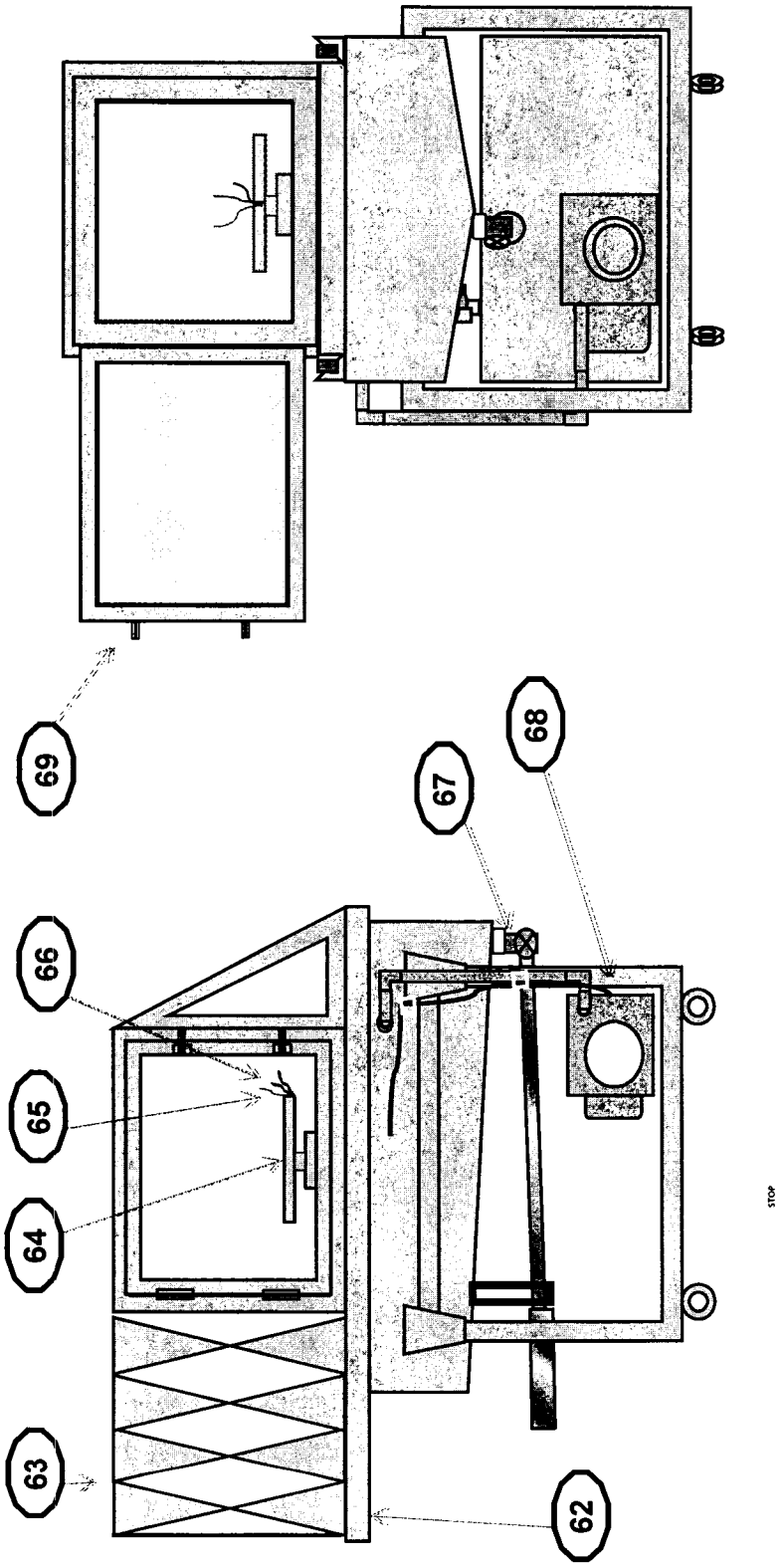


FIGURE 6

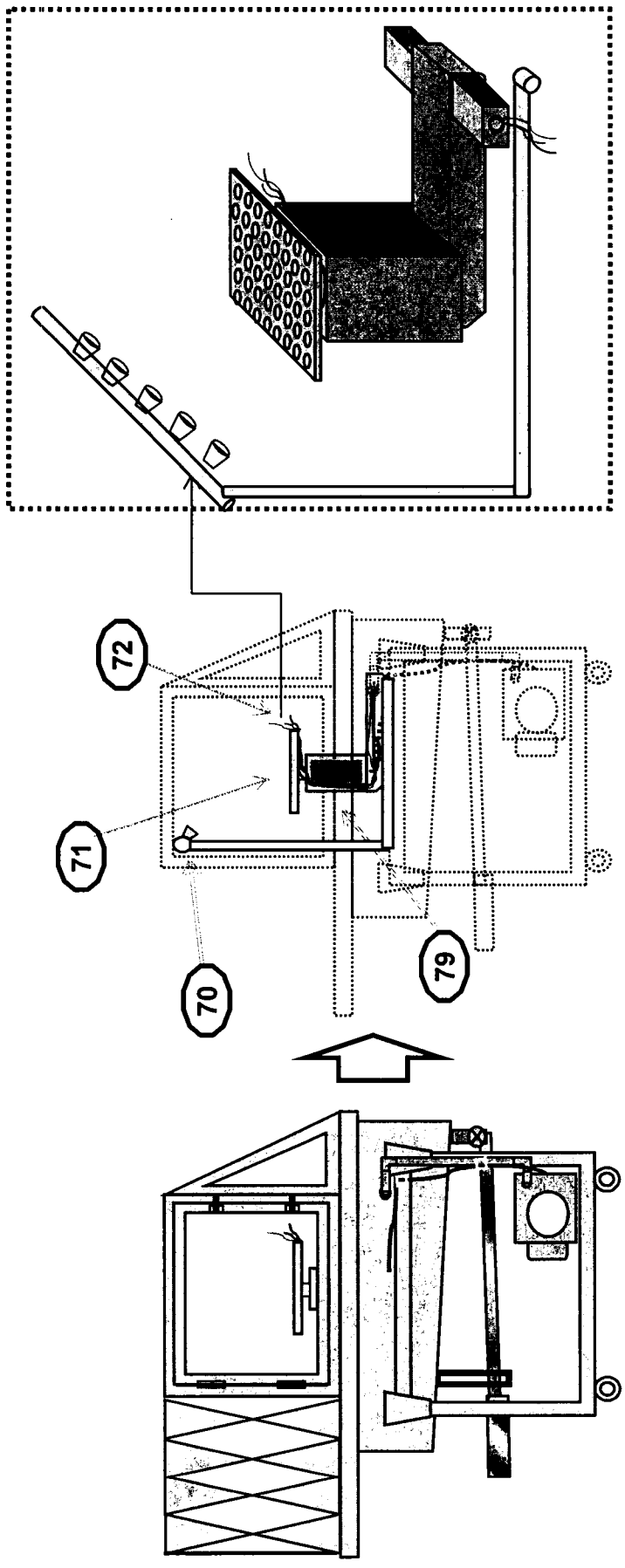


FIGURE 7

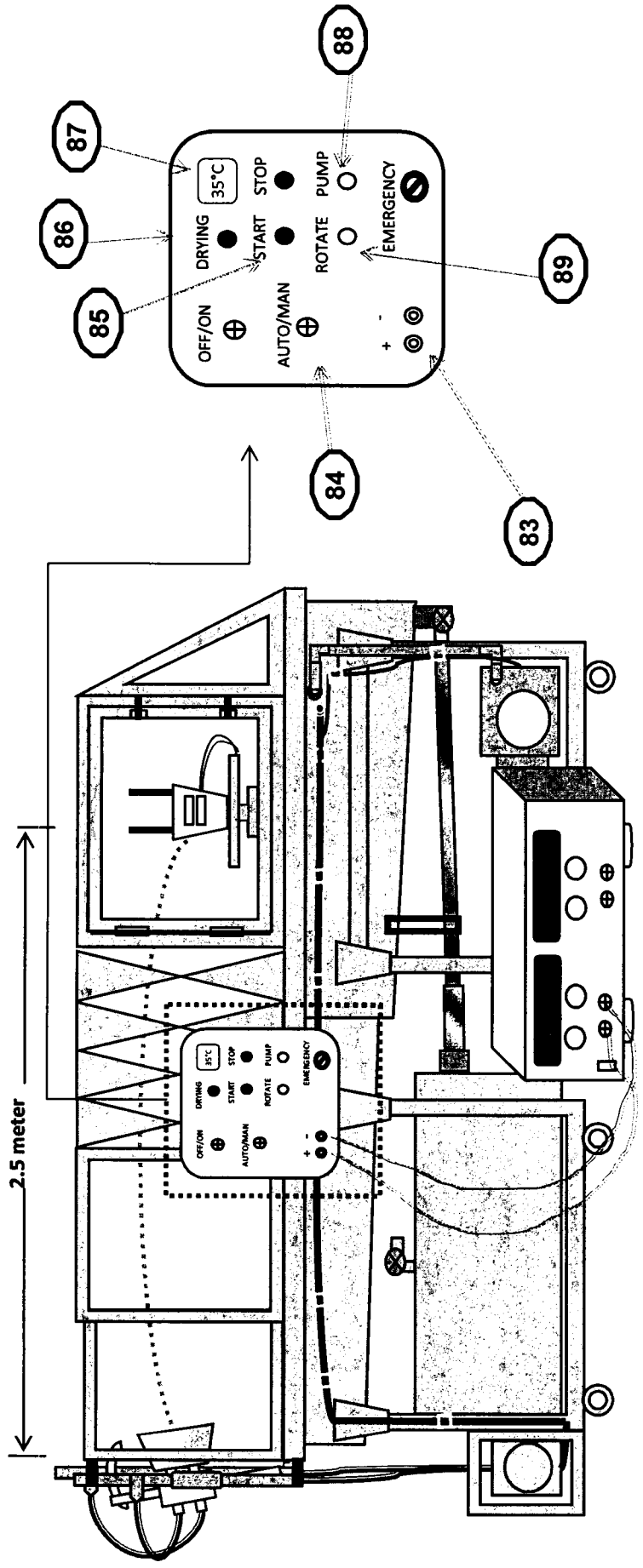

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2.5 meter

FIGURE 8

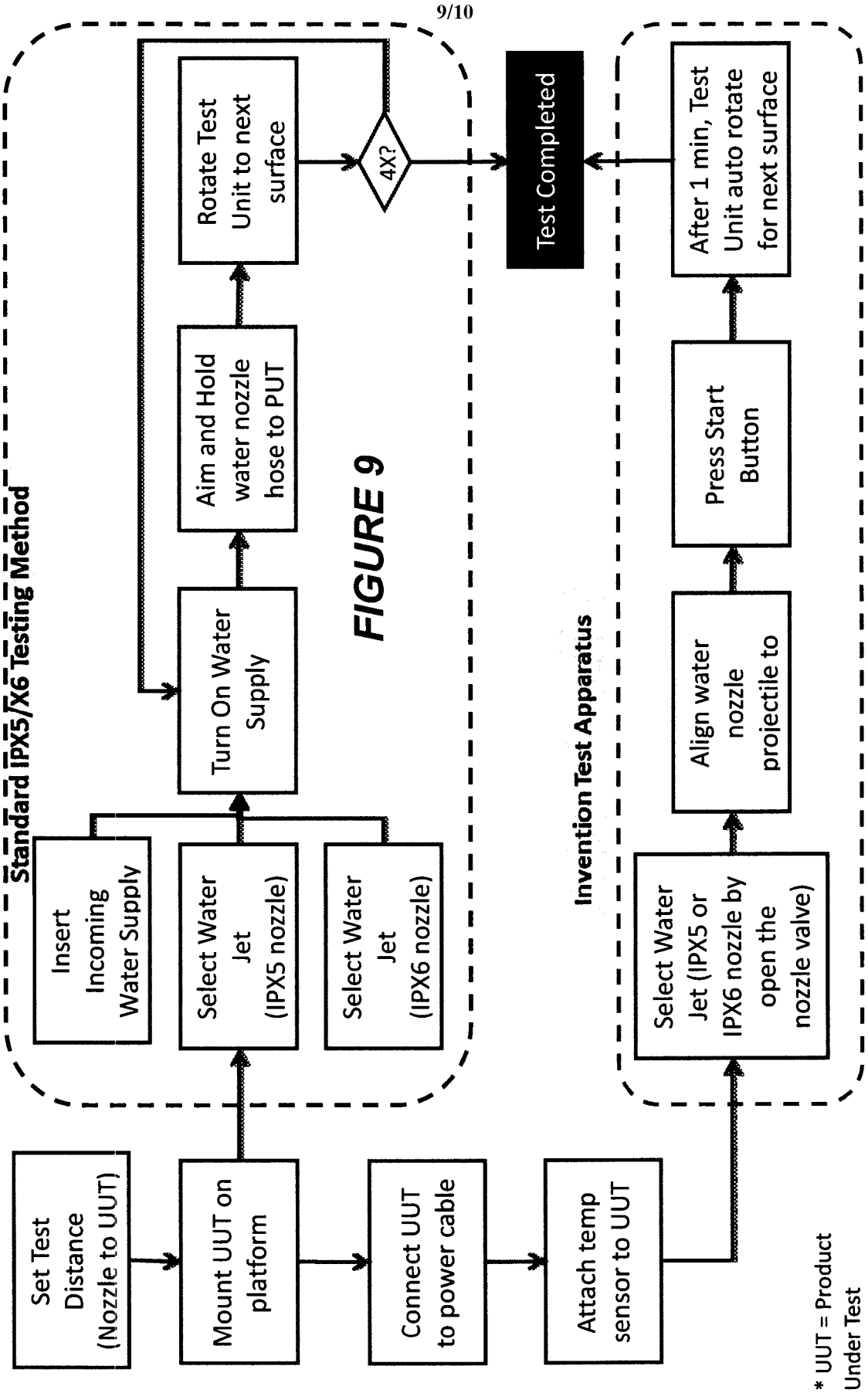

Standard IPX5/X6 Testing Method
Set Test Distance (Nozzle to UUT)
Mount UUT on platform
Connect UUT to power cable
Attach temp sensor to UUT
Insert Incoming Water Supply
Select Water Jet (IPX5 nozzle)
Select Water Jet (IPX6 nozzle)
Turn On Water Supply
Aim and Hold water nozzle hose to PUT
Rotate Test Unit to next surface
4X?
Test Completed
Invention Test Apparatus
Select Water Jet (IPX5 or IPX6 nozzle by open the nozzle valve)
Align water nozzle projectile to
Press Start Button
After 1 min, Test Unit auto rotate for next surface
* UUT = Product Under Test

FIGURE 9

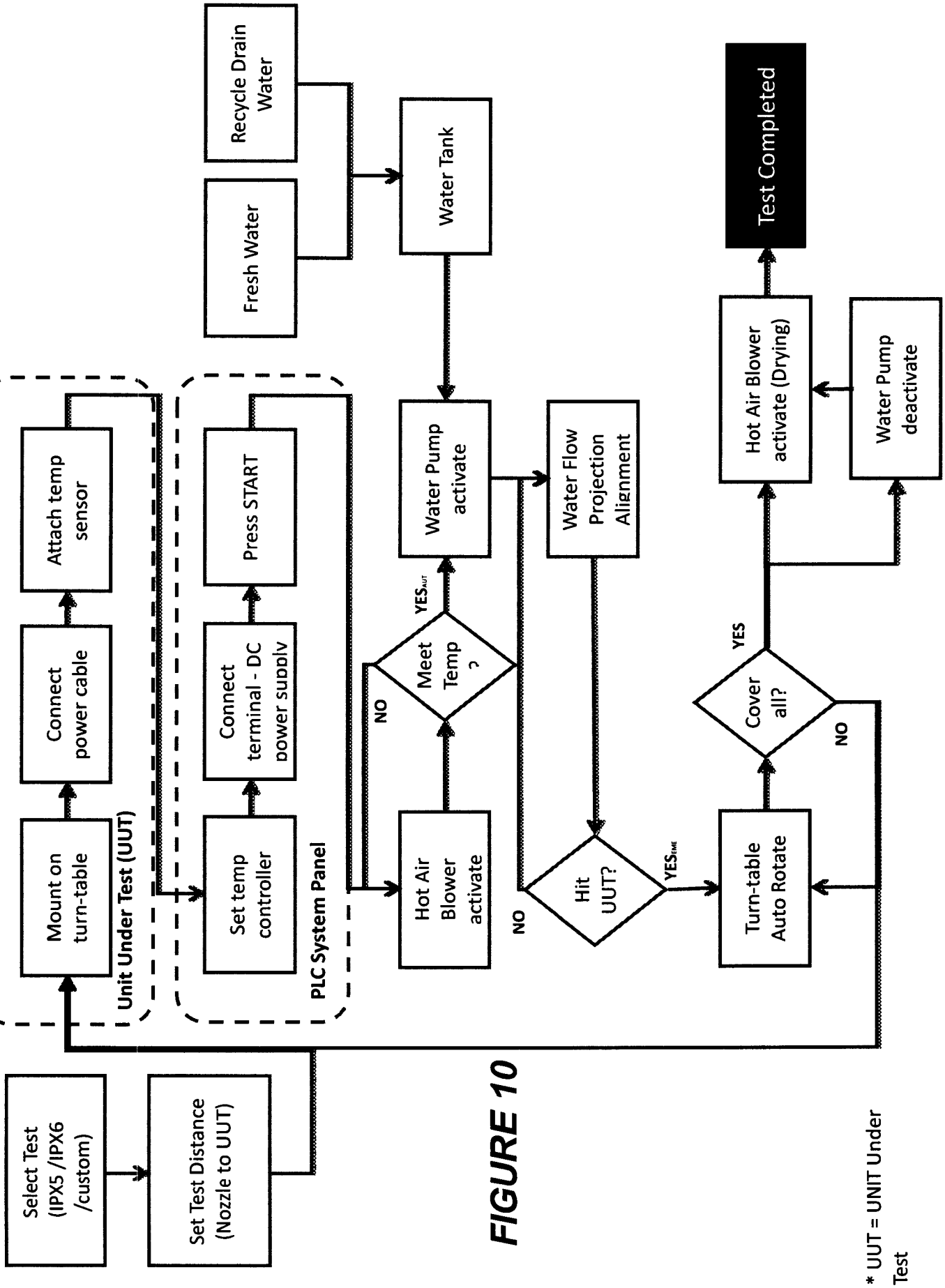


FIGURE 10

* UUT = UNIT Under Test

INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2014/000078

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01M3/04 G01M99/00
ADD.

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)
G01M G01N

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 354 139 Bl (MENOVICK GEORGE P [US] ET AL) 12 March 2002 (2002-03-12) the whole document -----	1-10
X	JP S60 131440 A (HONDA HIDEYUKI) 13 July 1985 (1985-07-13) abstract figures 1,3,4 -----	1,4,9 , 10
A	US 6 113 262 A (PUR0LA DAVID [US] ET AL) 5 September 2000 (2000-09-05) abstract column 1, paragraph 42 - paragraph 57 column 3, paragraph 59 - column 4, paragraph 6 -----	9

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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