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(54) **CAPPING SYSTEM FOR BIOLOGICAL THERMAL REACTION AND METHOD OF USING THE SAME**

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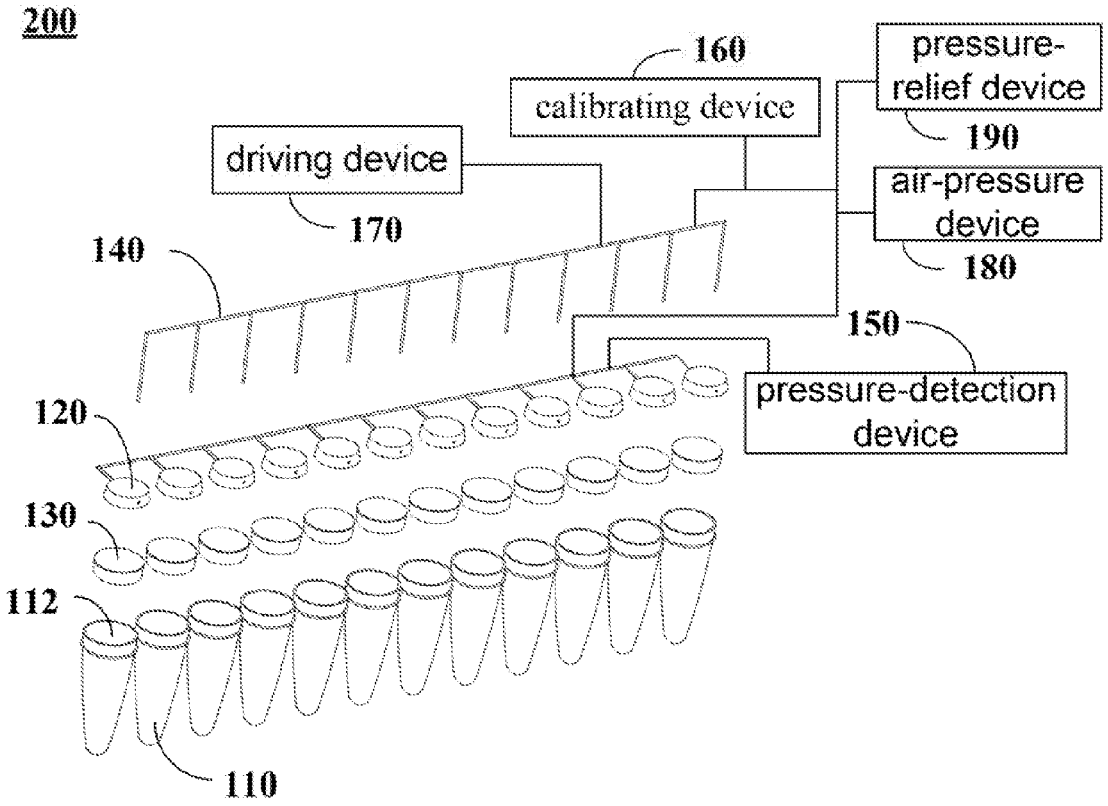
(57) **ABSTRACT**

The present invention provides a capping system for biological thermal reaction, which comprises at least one reaction tube, at least one suction unit, and at least one pushing rod. Each of the at least one reaction tube comprises an opening end. The at least one suction unit is used to suck at least one cap and move the at least one cap to the opening end of the at least one reaction tube. The at least one pushing rob is used to push the at least one cap into the opening end of the at least one reaction tube.



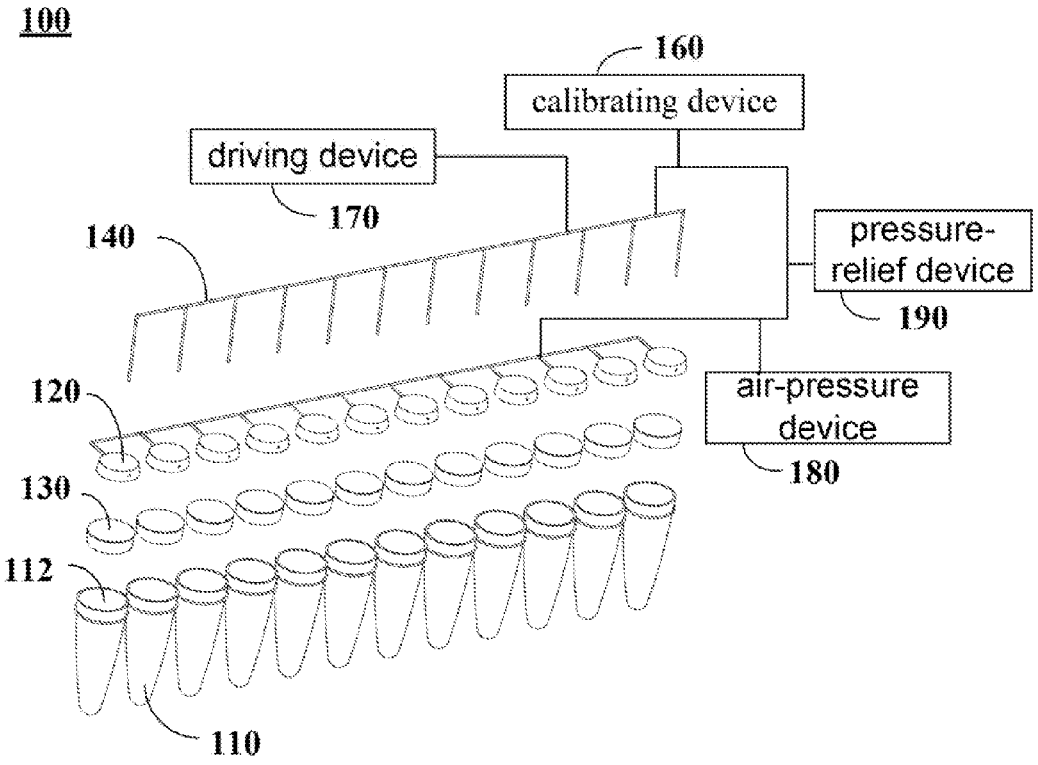

100
160
calibrating device
driving device
170
140
pressure-relief device
190
120
air-pressure device
180
130
112
110

FIG.1

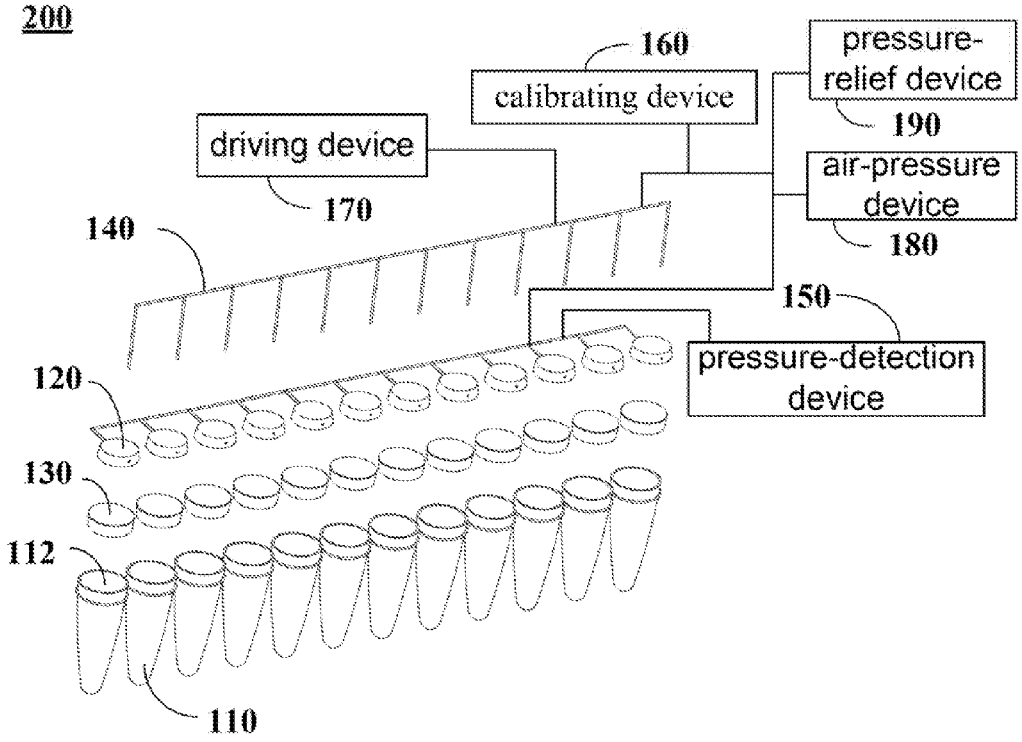

200
160
calibrating device
pressure-relief device
190
driving device
170
air-pressure device
180
140
150
pressure-detection device
120
130
112
110

FIG.2

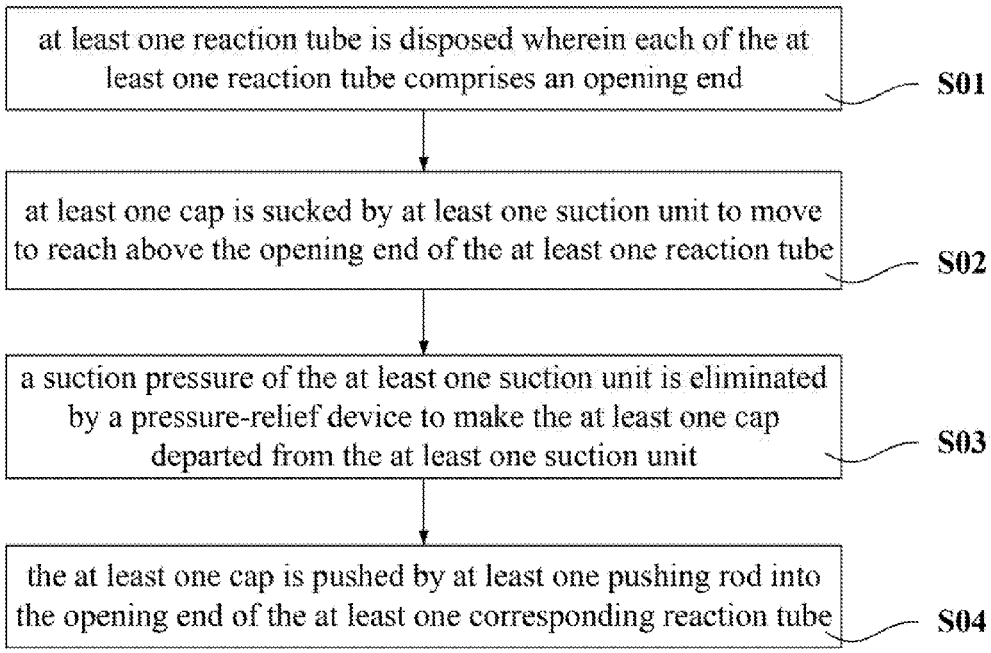

at least one reaction tube is disposed wherein each of the at least one reaction tube comprises an opening end
S01
at least one cap is sucked by at least one suction unit to move to reach above the opening end of the at least one reaction tube
S02
a suction pressure of the at least one suction unit is eliminated by a pressure-relief device to make the at least one cap departed from the at least one suction unit
S03
the at least one cap is pushed by at least one pushing rod into the opening end of the at least one corresponding reaction tube
S04

FIG.3

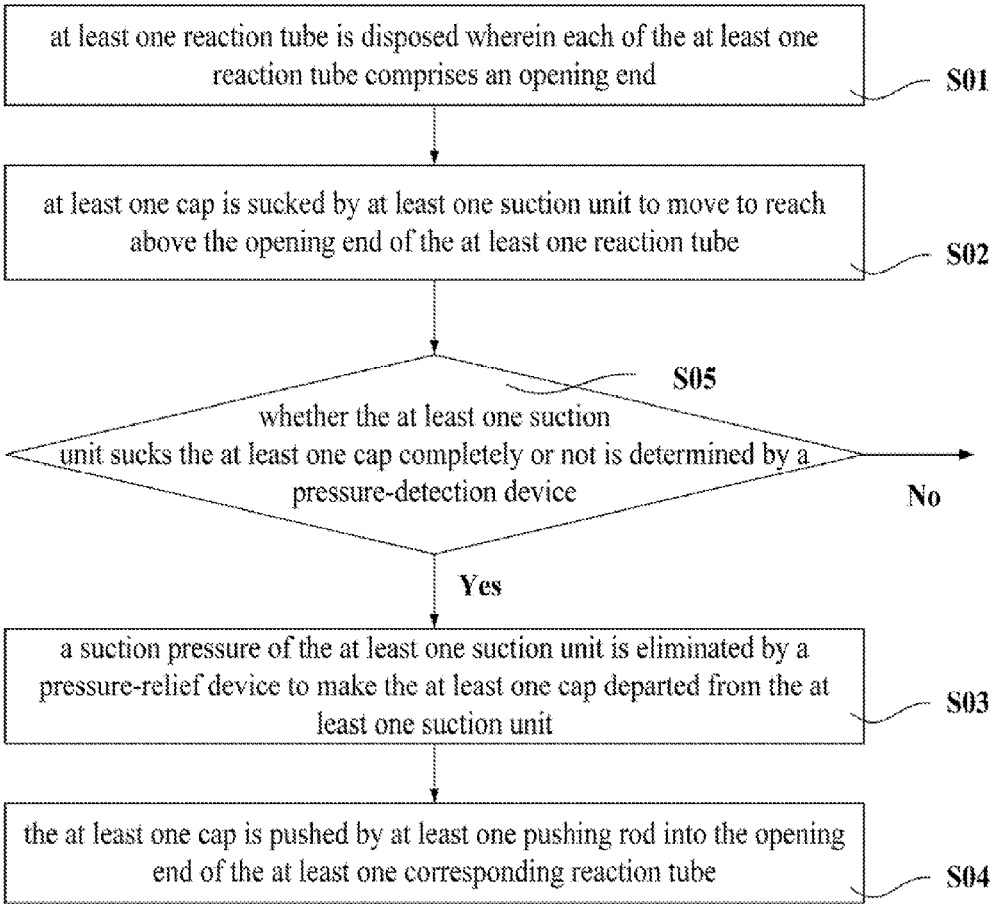

at least one reaction tube is disposed wherein each of the at least one reaction tube comprises an opening end
S01
at least one cap is sucked by at least one suction unit to move to reach above the opening end of the at least one reaction tube
S02
S05
whether the at least one suction unit sucks the at least one cap completely or not is determined by a pressure-detection device
No
Yes
a suction pressure of the at least one suction unit is eliminated by a pressure-relief device to make the at least one cap departed from the at least one suction unit
S03
the at least one cap is pushed by at least one pushing rod into the opening end of the at least one corresponding reaction tube
S04

FIG.4

CAPPING SYSTEM FOR BIOLOGICAL THERMAL REACTION AND METHOD OF USING THE SAME

FIELD OF THE INVENTION

[0001] The present invention relates to a capping system for biological thermal reaction and a method of using the same, and in particular, is related to the biomedical industry, for applying on automated equipments.

BACKGROUND OF THE INVENTION

[0002] In the biomedical laboratory, usually, reactants are usually put into a plastic reaction tube for generating biochemical reaction. It is common to seal the reaction tube for avoiding an influence from the external environment and keeping the consistency of the reaction condition. For bio-heat reactions, such as Polymerase Chain Reaction (PCR) needs to be processed over 90 Celsius degrees for several hours, whereby air-sealability is very important.

[0003] The conventional automated equipments applied for PCR use two kinds of methods for sealing the reaction tubes. 1. The reaction tubes are sealed by manual operation; and 2. The special-specification plastic tube and tools are used.

[0004] In the first method, during the operation of the automated equipments, the reaction tubes are token out to be sealed by manual operation. However, the manual operation might cause some reaction tubes sealed un-completely and time wasted.

[0005] In the second method, e.g. a Roch's COBAS Ampliprep is designed with the reaction tubes and caps having threads. It is found that although a sealability of the reaction tubes are ensured, a rotatable mechanism is needed for use, and furthermore, one cap is sealed for one operation; if multiple reaction tubes are simultaneously sealed, it is needed to use quite a few mechanisms, so that the manufacturing cost is raised. Meanwhile, the reaction tubes and caps with thread also means higher manufacturing cost (a common reaction tubes have no thread).

[0006] Furthermore, comparative with the first method, the second method is for a completely automated equipment. However, there are still several issues. 1. It is unable to know whether the cap is moved to the position of the reaction tube; 2. The cap might be slid down from the reaction tube when rotating; and 3. The rotatable mechanism is easily out of order.

[0007] Hence, it is essential to provide a capping system for biological thermal reaction and a method of using the same, so as to solve the above technical issues.

[0008] However, the conventional art provides solutions to the above-mentioned technical problems, but there is no effective way to solve the above-mentioned technical problems at the same time.

SUMMARY OF THE INVENTION

[0009] In order to solve the aforementioned technical problems of the conventional art, an objective of the present invention is to provide suction units and pushing rods. When the suction units suck a cap, it is determined whether the cap is sucked according to a pressure-detection device, and the cap can be correctly reached to above the reaction tube. The respective pushing rods are aligned to each of caps, with performing a single direction movement, so as to accurately push each cap into each of the reaction tubes.

[0010] In order to achieve the objective, the present invention provides a capping system for biological thermal reaction, which comprises at least one reaction tube, at least one suction unit and at least one pushing rod.

[0011] Each of the at least one reaction tube comprises an opening end. The at least one suction unit is used for sucking at least one cap and moving the at least one cap to reach above the opening end of the at least one reaction tube. The at least one pushing rod is used for pushing the at least one cap into the opening end of the at least one corresponding reaction tube.

[0012] In a preferred embodiment, the capping system further comprises a pressure-detection device for determining whether the at least one suction unit sucks the at least one cap completely or not.

[0013] In a preferred embodiment, the capping system further comprises a calibrating device for aligning the at least one suction unit with the at least one cap for a sucking process, for moving the at least one cap in alignment with the at least one reaction tube for performing a moving process, and for aligning the at least one rod with the at least one cap for performing a pushing process which pushes the at least one cap into the opening end of the at least one corresponding reaction tube.

[0014] In a preferred embodiment, the capping system further comprises a driving device for actuating the at least one rod to perform a pushing process which pushes the at least one cap into the opening end of the at least one corresponding reaction tube.

[0015] In a preferred embodiment, the capping system further comprises an air-pressure device for providing an enough suction pressure for the at least one suction unit.

[0016] In a preferred embodiment, the capping system further comprises a pressure-relief device for eliminating a suction pressure of the at least one suction unit, so as to make the at least one cap departed from the at least one suction unit.

[0017] In a preferred embodiment, the capping system is used for bio-heat reaction over 90 Celsius degrees.

[0018] In order to achieve the object, the present invention provides a capping method for biological thermal reaction, which comprises steps of: at least one reaction tube being disposed wherein each of the at least one reaction tube comprises an opening end; next, at least one cap being sucked by at least one suction unit to move to reach above the opening end of the at least one reaction tube; and the at least one cap being pushed by at least one pushing rod into the opening end of the at least one reaction tube.

[0019] In a preferred embodiment, the capping method further comprises a step of: whether the at least one suction unit sucks the at least one cap completely or not being determined by a pressure-detection device

[0020] In a preferred embodiment, the capping method further comprises a calibrating device for aligning the at least one suction unit with the at least one cap for performing a sucking process, for moving the at least one cap in alignment with the at least one reaction tube for performing a moving process, and for aligning the at least one rod with the at least one cap for performing a pushing process which pushes the at least one cap into the opening end of the at least one corresponding reaction tube.

[0021] In a preferred embodiment, the capping method further comprises a step of using a driving device for actuating the at least one rod to perform a pushing process which pushes the at least one cap into the opening end of the at least one corresponding reaction tube.

[0022] In a preferred embodiment, the capping method further comprises a step of using an air-pressure device for providing an enough suction pressure for the at least one suction unit.

[0023] In a preferred embodiment, the capping method further comprises a step of: using a pressure-relief device to eliminate a suction pressure of the at least one suction unit, to make the at least one cap departed from the at least one suction unit.

[0024] In a preferred embodiment, the capping method is used for bio-heat reaction over 90 Celsius degrees.

[0025] Compared with the conventional art, the present invention provides suction units and pushing rods. When the suction units suck a cap, whether the cap is sucked is determined according to a pressure-detection device. The respective pushing rods are aligned with each of caps and perform a single direction movement, so as to accurately push each cap into each of reaction tubes.

DESCRIPTION OF THE DIAGRAMS

[0026] The technical solution and the beneficial effects of the present invention are best understood from the following detailed description with reference to the accompanying figures and embodiments.

[0027] FIG. **1** is a disassembled schematic diagram of a capping system of a first preferred embodiment according to the present invention;

[0028] FIG. **2** is a disassembled schematic diagram of a capping system of a second preferred embodiment according to the present invention;

[0029] FIG. **3** is a flow diagram of a capping method of a first preferred embodiment according to the present invention; and

[0030] FIG. **4** is a flow diagram of a capping method of a second preferred embodiment according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] The following description of the embodiments is given by way of illustration with reference to the specific embodiments in which the invention may be practiced. The terms such as "up", "down", "front", "back", "left", "right", "inside", "outside", "side", etc., The direction of the diagram. Accordingly, the use of a directional term is used to describe and to understand the present invention and is not intended to limit the invention.

[0032] FIG. **1** is a disassembled schematic diagram of a capping system **100** of a first preferred embodiment according to the present invention. The capping system **100** comprises at least one reaction tube **110**, at least one suction unit **120**, at least one pushing rod **140**, a calibrating device **160**, a driving device **170**, an air-pressure device **180** and a pressure-relief device **190**.

[0033] Each of the at least one reaction tube **110** comprises an opening end **112**. In detail, the opening end **112** is used to store materials for bio-heat reaction. The bio-heat reaction is performed over 90 Celsius degrees. The at least one suction unit **120** is used for sucking at least one cap **130** and moving the at least one cap **130** to reach above the opening end **112** of the at least one reaction tube **110**. The pressure-relief device **190** is used for eliminating a suction pressure of the at least one suction unit **120** to make the at least one cap **130** departed from the at least one suction unit **120**. Before the suction pressure of the at least one suction unit **120** is eliminated, the at least one cap **130** is unable to be departed from the at least one suction unit **120**. The at least one cap **130** and/or the at least one suction unit **120** might be damaged to cause its air sealability decreased if an external forces is applied to depart the at least one suction unit **120** from the at least one cap **130**. With the pressure-relief device **190**, a pressure generated between the at least one suction unit **120** and the at least one cap **130** can recover as same as the ambient pressure so that the at least one cap **130** can be departed from the at least one suction unit **120**, automatically. In detail, once the at least one cap **130** is accurately pushed into the at least one reaction tube **110**, the air-sealability of the at least one reaction tube **110** can be ensured. The at least one pushing rod **140** is used for pushing the at least one cap **130** into the opening end **112** of the at least one corresponding reaction tube **110**. Alternatively, with different mechanical design, it is possible to push the cap(s) into one (or multiple) reaction tubes **110**.

[0034] The calibrating device **160** is used for aligning the at least one suction unit **120** with the at least one cap **130** for performing a sucking process, for moving the at least one cap **130** in alignment with the at least one reaction tube **110** for performing a moving process, and for aligning the at least one rod **140** with the at least one cap **130** for performing a pushing process, to make the at least one cap **130** into the opening end **112** of the at least one corresponding reaction tube **110**.

[0035] In detail, the calibrating device can align the position with laser. The driving device **170** is used for actuating the at least one rod **140** to perform a pushing process, so as to make the at least one cap **130** into the opening end **112** of the at least one corresponding reaction tube **110**. In detail, the driving device **170** can be one or a combination of air-actuation device and oil-actuation device. The air-pressure device **180** is used for providing an enough suction pressure for the at least one suction unit **120**. In detail, the air-pressure device **180** can be vacuum pump or a device for extracting air.

[0036] Preferably, the driving device **170** can be incorporated into the air-pressure device **180**, the pushing rods **140** performs the pushing process with the force provided by the air-pressure device, so as to push the at least one cap **130** into the opening end **112** of the at least one corresponding reaction tube **110**.

[0037] In actual operation, first, the reactants are disposed inside the at least one reaction tube **110**; then, the calibrating device **160** aligns the position of the at least one reaction tube **110**; next, the at least one suction unit **120** sucks the at least one cap **130** and moves the at least one cap **130** to reach above the opening end **112** of the at least one reaction tube **110** (which just relies thereon but is not sealed yet by the cap); next, the pressure-relief device **190** eliminates the suction pressure of the at least one suction unit **120** to make the at least one cap **130** departed from the at least one suction unit **120**; next, the at least one pushing rod **140** simultaneously pushes the at least one cap **130** into the opening end **112** of the at least one corresponding reaction tube **110**, to

form an air-tight sealing. Next, the reaction tube **110** can be used for bio-chemistry experiments. In the above operation process, with a linear operation (down-press movement) of the at least one pushing rod **140**, the automatic bio-heat reaction equipment can accomplish a complete automation and raise its sealing speed. Generally speaking, a bio-heat reaction over 90 Celsius degrees requires a very high level of air-sealability, the capping system of the present invention can be structured in air-tight sealing to ensure the safety of the high temperature bio-heat reaction (over 90 Celsius degrees).

[0038] FIG. **2** is a disassembled schematic diagram of a capping system **200** of a second preferred embodiment according to the present invention. A difference of the second preferred embodiment from the first preferred embodiment is adding of one pressure-detection device **150**. In the first preferred embodiment, the at least one cap **130** is sucked by the air-pressure device **180**, so that it is possible that some of the caps may be not sucked. The pressure-detection device **180** is used to determine whether the at least one suction unit **120** sucks the at least one cap **130** completely or not. In detail, when the at least one suction unit **120** completely sucks the at least one cap **130**, the pressure-detection device **180** will detect a specific vacuum degree; on the contrary, when the at least one suction unit **120** does not suck the at least one cap **130**, the pressure-detection device **180** will detect atmospheric pressure, the operator can notice the error and correct it.

[0039] FIG. **3** is a flow diagram of a capping method of a first preferred embodiment according to the present invention (wherein the numerals of the elements are referred to FIG. **1**). First, by performing a step S**01**, at least one reaction tube **110** is disposed wherein each of the at least one reaction tube **110** comprises an opening end **112**; next, by performing a step S**02** at least one cap **130** is sucked by at least one suction unit **120** to move to reach above the opening end **112** of the at least one reaction tube **110**; next, by performing a step S**03**, a suction pressure of the at least one suction unit **120** is eliminated by a pressure-relief device **190** to make the at least one cap **130** departed from the at least one suction unit **120**; and finally, by performing a step S**04**, the at least one cap **130** is pushed by at least one pushing rod **140** into the opening end **112** of the at least one corresponding reaction tube **110**.

[0040] FIG. **4** is a flow diagram of a capping method of a second preferred embodiment according to the present invention (the numerals of the elements are referred to FIG. **1**). A difference of the second preferred embodiment from the first preferred embodiment, further comprises a step S**05** between the step S**02** and the step S**03**. In the step S**05**, whether the at least one suction unit **120** sucks the at least one cap **130** completely or not is determined by a pressure-detection device **150**. In detail, when the pressure-detection device **180** detects a specific vacuum degree, then the step S**03** is performed; on the contrary, when the at least one suction unit **120** does not suck the at least one cap **130**, the pressure-detection device **180** will detect atmospheric pressure, the operator can notice the error and correct it, rather than performing the step S**03** to cause the equipment damaged.

[0041] As described above, although the present invention has been described with the preferred embodiments thereof, those skilled in the art will appreciate that various modifications, additions, and substitutions are possible without departing from the scope and the spirit of the invention. Accordingly, the scope of the present invention is intended to be defined only by reference to the claims.

What is claimed is:

1. A capping system for biological thermal reaction, comprising:
- at least one reaction tube wherein each of the at least one reaction tube comprises an opening end;
- at least one suction unit for sucking at least one cap and moving the at least one cap to reach above the opening end of the at least one reaction tube; and
- at least one pushing rod for pushing the at least one cap into the opening end of the at least one corresponding reaction tube.

2. The capping system according to claim **1**, further comprising a pressure-detection device for determining whether the at least one suction unit sucks the at least one cap completely or not.

3. The capping system according to claim **1**, further comprising a calibrating device for aligning the at least one suction unit with the at least one cap for performing a sucking process, for moving the at least one cap in alignment with the at least one reaction tube for performing a moving process, and for aligning the at least one rod with the at least one cap for performing a pushing process which pushes the at least one cap into the opening end of the at least one corresponding reaction tube.

4. The capping system according to claim **1**, further comprising a driving device for actuating the at least one rod to perform a pushing process which pushes the at least one cap into the opening end of the at least one corresponding reaction tube.

5. The capping system according to claim **1**, further comprising an air-pressure device for providing an enough suction pressure for the at least one suction unit.

6. The capping system according to claim **1**, further comprising a pressure-relief device for eliminating a suction pressure of the at least one suction unit, to make the at least one cap departed from the at least one suction unit.

7. The capping system according to claim **1**, wherein the capping system is used for biological thermal reaction over 90 Celsius degrees.

8. A capping method for biological thermal reaction, comprising steps of:
- disposing at least one reaction tube wherein each of the at least one reaction tube comprises an opening end;
- using at least one suction unit to suck at least one cap and move the at least one cap to reach above the opening end of the at least one reaction tube; and
- pushing the at least one cap by at least one pushing rod into the opening end of the at least one corresponding reaction tube.

9. The capping method according to claim **8**, further comprising a step of:
- using a pressure-detection device to determine whether the at least one suction unit sucks the at least one cap completely or not.

10. The capping method according to claim **8**, further comprising a step of using a calibrating device for aligning the at least one suction unit with the at least one cap for performing a sucking process, for moving the at least one cap in alignment with the at least one reaction tube for performing a moving process, and for aligning the at least one rod with the at least one cap for performing a pushing

process which pushes the at least one cap into the opening end of the at least one corresponding reaction tube.

11. The capping method according to claim **8**, further comprising a step of using a driving device for actuating the at least one rod to perform a pushing process which pushes the at least one cap into the opening end of the at least one corresponding reaction tube.

12. The capping method according to claim **8**, further comprising a step of using an air-pressure device for providing an enough suction pressure for the at least one suction unit.

13. The capping method according to claim **8**, further comprising a step of:

eliminating a suction pressure of the at least one suction unit by a pressure-relief device, to make the at least one cap departed from the at least one suction unit.

14. The capping method according to claim **8**, wherein the capping method is used for biological thermal reaction over 90 Celsius degrees.

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