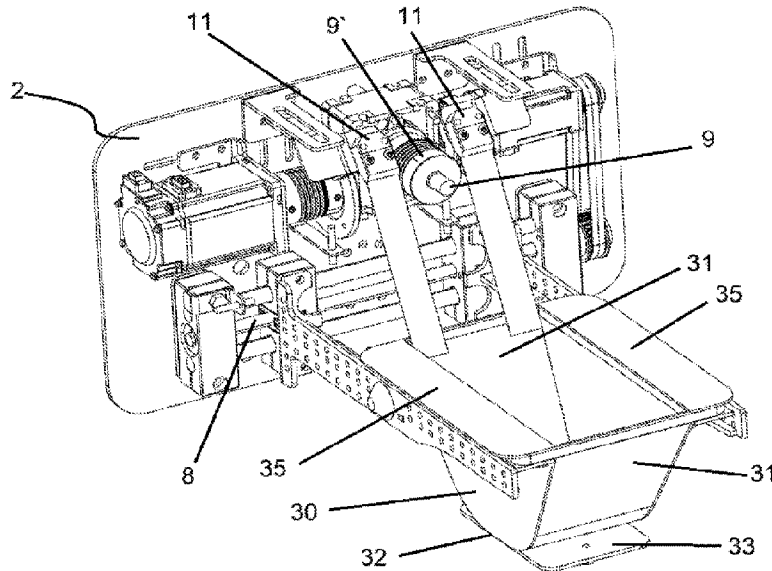




(86) **Date de dépôt PCT/PCT Filing Date:** 2020/08/28  
 (87) **Date publication PCT/PCT Publication Date:** 2021/04/08  
 (45) **Date de délivrance/Issue Date:** 2024/06/18  
 (85) **Entrée phase nationale/National Entry:** 2022/03/18  
 (86) **N° demande PCT/PCT Application No.:** LV 2020/050002  
 (87) **N° publication PCT/PCT Publication No.:** 2021/066637  
 (30) **Priorité/Priority:** 2019/10/03 (LV P-19-52)

(51) **Cl.Int./Int.Cl. B25J 11/00** (2006.01),  
**A23L 5/00** (2016.01), **A47J 44/00** (2006.01),  
**B25J 15/04** (2006.01), **B25J 19/02** (2006.01)  
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(54) **Titre : SYSTEME DE CUISSON ROBOTISE**  
 (54) **Title: A ROBOTIC COOKING SYSTEM**



(57) **Abrégé/Abstract:**

A robotic cooking system comprising a robotic arm, and end of arm tool with a gripper, and ingredient holding and dispensing assemblies; a cooking receptacle; dish storing device, and a tray designed to be releasably gripped by the gripper; the system having a dish and food transfer area, a cleaning system for cleaning the cooking receptacle and tray; the end of arm tool having a rotary drive adapted for engagement with the containers so that the dispenser can dispense the ingredient from the assembly; the rotary drive having a flexible coupling to compensate misalignment and/or ensure easy entering of the rotary drive to the containers; wherein the end of arm tool also has one or more air nozzles directed towards the tray to create air flow along the surface of the tray to facilitate discharging food ingredients from the tray.

## ABSTRACT

A robotic cooking system comprising a robotic arm, and end of arm tool with a gripper, and ingredient holding and dispensing assemblies; a cooking receptacle; dish storing device, and a tray designed to be releasably gripped by the gripper; the system having a dish and food transfer area, a cleaning system for cleaning the cooking receptacle and tray; the end of arm tool having a rotary drive adapted for engagement with the containers so that the dispenser can dispense the ingredient from the assembly; the rotary drive having a flexible coupling to compensate misalignment and/or ensure easy entering of the rotary drive to the containers; wherein the end of arm tool also has one or more air nozzles directed towards the tray to create air flow along the surface of the tray to facilitate discharging food ingredients from the tray.

## **A robotic cooking system**

### Technical Field

The invention relates to automatic cooking devices and systems, in particular,  
5 robotic systems for preparing meals.

### Background Art

Ready-made meal manufacturers, fast-food restaurants and catering services  
providers are facing tightening margins and increased demand for flexibility and  
10 food safety. Robotic cooking systems become a solution for such growing demands.

There is known a cooker (EP 0458977 B1), having a receptacle, the receptacle  
comprising a pot for holding ingredients, a heater for induction heating said pot and  
means for rotating the pot, said receptacle being supported by a main unit so that it  
15 can be inclined freely, wherein the cooker further comprises an angle control unit,  
which provides driving force for inclining said receptacle and a controller for  
controlling said angle control unit.

There is known an automatic cooking device (GB 2521999 A), comprising a housing,  
20 having an ingredients storage means, which has containers and a controllable  
dispensing means located in the base of each container; the dispensing means are  
designed to dispense ingredients into a mixing unit provided below the ingredients  
storage means. The mixing chamber has a controllable outlet in its base to dispense  
ingredients downwards into a cooking pot. A heater means cooks the ingredients in  
25 the cooking pot. The device further optionally comprises an automated cleaning  
means having multiple nozzles.

There is known a robotic cooking system (US 7174830 B1), comprising one or more  
robots having means to move food containers between multiple positions and  
30 means to stir food within a cooking pan, a food storage and selection area, a cooking  
area within a range of motion of the robot, at least one food container containing

food ingredients and a loading conveyor to move the food container to the cooking area; the robot is configured to move food ingredients from the loading conveyor into a cooking pan, held by the robot in a position over a cooking element in the cooking area. The robot uses the means to move food containers to unload food into  
5 a serving dish, which is moved by a conveyor to a serving area.

There is known a food preparation system (US 8276505 B2), comprising a housing comprising a wall; a control subsystem configured to control a plurality of food preparation processes capable of preparing a meal comprising a variety of foods  
10 based on user selection of the foods; plurality of ingredient storage containers comprising dry ingredient storage containers and liquid ingredient storage containers; a storage module configured to store the ingredient storage containers and a variety of ingredients contained within the ingredient storage containers for an extended period; an ingredient manipulator configured to access and remove a  
15 plurality of ingredients from the ingredient storage containers, as commanded by the control subsystem; a cooking receptacle disposed within the housing, the cooking receptacle being configured to cook ingredients placed therein by the ingredient manipulator; a dish and food transfer area; and a cleaning subsystem configured to clean the cooking receptacle and the surface of the wall of the housing.

20

There is known an automated meal production system (US 10154762 B2), comprising a plurality of ingredient holding and dispensing assemblies, each of the ingredient holding and dispensing assemblies comprising a container for holding a supply of an ingredient and a dispenser for dispensing an amount of the ingredient  
25 from a discharge of the ingredient holding and dispensing assembly and a plurality of heating and mixing assemblies which each comprise a heating pot configured for rotating the heating pot about its longitudinal rotational axis, each of the heating pots comprising an opening at an outer end of the heating pot through which the ingredients dispensed by one or more of the ingredient holding and dispensing  
30 assemblies are delivered into the heating pot; a side wall which extends

longitudinally from the closed base end and surrounds the longitudinal rotational axis; a heating cavity within the heating pot which is surrounded by the side wall, and an interior surface of the side wall which is within and which surrounds the heating cavity, each of the heating pots also comprising an internal mixing fin structure which runs longitudinally along and is formed on or attached to the interior surface of side wall so that the internal mixing fin structure projects from the interior surface of the side wall into the heating cavity, the mixing fin structure of each of the heating pots is carried by the side wall when the heating pot rotates about the longitudinal rotational axis so that the mixing fin structure revolves around the longitudinal rotational axis, and the heating pot of each of the heating and mixing assemblies also being configured for pivoting the heating pot about a secondary axis between an upward ingredient receiving orientation, a heating and mixing orientation which is pivoted downwardly from the upward ingredient receiving orientation to an angle which is not more than 90° from vertical; and a dispensing orientation which is pivoted downwardly from the heating and mixing orientation to an angle which is not more than 180° from vertical.

Although the prior art solutions partially solve the problem, their effectiveness is still relatively insufficient.

### Summary of Invention

The invention provides a robotic cooking system, comprising: a robotic arm with a controller and a motor drive unit, an end of arm tool comprising a gripper, a rotary drive; a plurality of ingredient holding and dispensing assemblies, each of the ingredient holding and dispensing assemblies comprising a container for holding a supply of an ingredient and dispenser for dispensing an amount of the ingredient from a discharge of the ingredient holding and dispensing assembly; a cooking receptacle, being configured to cook food ingredients placed therein; dishes storing device; a tray adapted to receive food ingredients from the dispenser and designed

to be releasably gripped by the gripper; a dish and food transfer area having at least one compartment, comprising an internal access door, an external access door and at least one surface adapted for placing a dish or food; a cleaning subsystem configured to clean the cooking receptacle and the tray; optionally, a trash  
5 compartment. The end of arm tool is further provided with a rotary drive adapted to be releasably engaged with the engagement means of a plurality of the containers for holding a supply of an ingredient designed so that at the engaged position the rotation of the rotary drive of the robotic arm causes the dispenser to dispense an amount of the ingredient. The proposed design of the robotic cooking system allows  
10 to avoid using number of motors in each container for holding a supply of an ingredient as a motor on the robotic arm, operably connected with the rotary drive of the robotic arm, after engagement with the engagement means on the containers causes the dispenser to dispense an amount of the ingredient. This, in turn, allows to simplify construction and makes less expensive the robotic cooking system.

15

According to another embodiment the subset of the plurality of ingredient holding and dispensing assemblies comprises a container with the dispenser and a screw conveyor, adapted to controllably move fluent solid ingredients in the container towards the dispenser, wherein the screw conveyor comprises two helically bladed  
20 screws: a central screw and a peripheral screw, the peripheral screw located around the central screw, both screws having the same rotational axis; wherein the helical blades of the screws have opposite directions. This solution prevents compaction and pressing of the ingredients in the container.

25 According to yet another embodiment the robotic arm is further provided with one or more air nozzles directed towards the inner part of the tray, so to create air flow along the surface of the tray towards a discharge edge of the tray to facilitate discharging food ingredients from the tray. Favorably, the tray is designed to have two parallel substantially vertical walls and two substantially inclined walls; where  
30 the two inclined walls, together with the tray's bottom form an arc, preferably a

parabolic arc. This advantageously allows to create air flow paths along the surface of the tray towards a discharge edge of the tray and thus, to facilitate discharging food ingredients from the tray.

#### 5 Brief Description of Drawings

Fig. 1 shows a perspective view of the robotic arm with end of arm tool;

Fig. 2 – is a frontal view of the plurality of ingredient holding and dispensing assemblies;

10 Fig. 3 – a perspective view of the cooking receptacle with part of the cleaning subsystem adapted to clean the cooking receptacle;

Fig. 4 – a perspective view of the dishes storing device;

Fig. 5 - a perspective view of one embodiment of the end of arm tool with gripper holding the tray;

15 Fig. 6 – a perspective view of the container adapted for holding a supply of solid ingredients;

Fig. 7 – a perspective view of part of the container adapted for holding a supply of solid ingredients, showing the screw conveyor;

Fig. 8 – a top view of the container adapted for holding a supply of solid ingredients;

20 Fig. 9 - a perspective view of the container adapted for holding a supply of liquid ingredients or viscous substance;

Fig. 10 – a perspective view of the dish and food transfer area;

Fig. 11 – a perspective view of the cleaning subsystem adapted to clean the tray.

#### Detailed Description of Invention

25

The proposed robotic cooking system, comprising: a robotic arm 1 (Fig. 1) with a controller and a motor drive unit, an end of arm tool 2; a plurality of ingredient holding and dispensing assemblies 20 (Fig. 2); a cooking receptacle 3, being configured to cook food ingredients placed therein (Fig. 3); dishes storing device 4

(Fig. 4); a tray 5 (Fig. 5). The robotic cooking system further comprises a cleaning subsystem 7' and 7'' configured to clean the cooking receptacle 3 and the tray 5.

Each of the ingredient holding and dispensing assemblies comprises a container 21  
5 for holding a supply of an ingredient and dispenser 22 (Fig. 6, Fig. 9) for dispensing  
an amount of the ingredient from a discharge 23 of the ingredient holding and  
dispensing assembly 20. The containers 21 for holding a supply of an ingredient  
comprise a plurality of containers adapted for holding a supply of liquid ingredients  
(such as water, milk, sauce) or viscous substance (such as oil, ketchup, mashed  
10 potato) - Fig. 9, and containers adapted for holding a supply of solid ingredients  
(such as pre-chopped meat, beans, rice, potato) - Fig. 6-8. The dispenser 22 is  
adapted to be actuated from a closed position to retain ingredients within the  
container, partly open position, and an open position such that ingredients are  
allowed to controllably fall through it or be controllably dispensed through it. The  
15 dispenser 22 can be controllable by a control means.

According to the preferred embodiment the end of arm tool 2 is further provided  
with one or more air nozzles 11 (Fig. 5) directed towards the inner part of the tray  
5, so to create air flow along the surface of the tray 5 towards a discharge edge of the  
20 tray 5 to facilitate discharging food ingredients from the tray 5 to e.g. cooking  
receptacle 3.

The tray 5 is designed to receive food ingredients from the dispenser 22 and  
designed to be releasably gripped by the gripper 8 located on the end of arm tool 2.  
25 According to one embodiment the tray 5 has two parallel substantially vertical walls  
30 (where the term "substantially" in the present description allows deviation to up  
to five degrees) and two inclined walls 31; where the two inclined walls 31, together  
with the tray's 5 bottom 32 form an arc, preferably a parabolic arc. The tray's 5  
bottom 32 is fixed to a balancing or holding means 33 adapted to ensure stable  
30 placement of the tray 5 on the required surface in the robotic cooking system. The

required surface can be flat and horizontal and can be inclined. The balancing or holding means 33 can be in the form of a plate, one or more strips, a magnet, or equivalent means.

5 The shape of the tray 5 allows to more effectively direct air flow paths from the air nozzles 11, along the surface of the tray 5 towards a discharge edge of the tray 5 to facilitate discharging food ingredients from the tray 5. Further, the tray 5 is provided with gripping area 34, adapted to be gripped by the gripper located on the end of arm tool 2. The gripping area 34 may be in the form of two horizontal bars 35  
10 fixed to the upper part of the parallel substantially vertical walls 30, where the horizontal bars 35 are provided with engagement means for engaging with the gripper 8. The horizontal bars 35 are designed to create a protective edge to shield the robotic arm 1 electronics from spilling of food ingredients from the tray 5 as well as liquid during washing of the tray 5 in the cleaning subsystem 7` and 7``.

15

The cooking receptacle 3 is configured to cook food ingredients placed therein (Fig. 3). The cooking receptacle 3 comprises a pot 12 designed for holding ingredients, one or more heaters 13 for induction heating the pot 12 and rotating means 15 for rotating the pot 12 about two or more rotational axis: for rotation of the pot 12  
20 during cooking of the ingredients about an axis inclined at about 10-50 degrees from the vertical, so that the ingredients remain in the pot 12, as well as for rotation of the pot 12 in the vertical plane for discharging the ingredients into a servicing dish. According to one embodiment the pot 12 has a substantially spherical bottom and an opening in the upper part, which is adapted to receive food ingredients from  
25 the discharge edge of the tray 5 and the dispenser 22 of a container 21``. The pot 12 preferably has a narrowing upper part designed to prevent spilling out of food ingredients from the tray 5 during rotation of the pot 12 in cooking position, when the pot 12 is inclined about 45-50 degrees from the verticality. The pot 12 further comprises one or two fins 14 adapted to be rotated inside the pot 12 in order to  
30 ensure uniform stirring of food ingredients in the pot 12, wherein the cooking

receptacle 3 is designed to controllably rotate the fins 14 in the direction, which is opposite to the direction of rotation of the pot 12.

5 The dishes storing device 4 comprises a frame and means for holding dishes (e.g. disposable dishes), as well as means for supplying dishes towards the opening of the dishes storing device 4 and separating the dishes, so that they can be picked by the gripper 8 (Fig. 4).

10 The dish and food transfer area 6 is designed to serve cooked meals to a customer (Fig. 10). The dish and food transfer area 6 has one or more compartments, comprising at least an internal access door and at least one surface adapted for placing a dish or food therein. The dish and food transfer area 6 may further comprise an external access door.

15 The robotic arm 1 comprises an arm base, an arm, an end of arm tool 2, a gripper 8 attached to the arm. The end of arm tool 2, is further provided with a rotary drive 9 adapted to be releasably engaged with engagement means 10 of a plurality of the containers 21 for holding a supply of an ingredient designed so that at the engaged position the rotation of the rotary drive 9 of the end of arm tool 2 causes the  
20 dispenser 22 of the ingredient holding and dispensing assembly 20 to dispense an amount of the ingredient from the discharge 23 of the ingredient holding and dispensing assembly 20. The rotary drive 9 is provided with a flexible coupling 9` adapted to compensate misalignment and ensure easy entering of the end of the engaging part of the rotary drive 9 to the engagement means 10 of a plurality of the  
25 containers 21. The flexible coupling 9` can be in the form of bellow coupling, beam coupling, jaw coupling, Oldham coupling and other type. The end of arm tool 2 further comprising one or more load cells, adapted to provide a representation (e.g. digital) of a load thereon, the gripper 8 being directly or indirectly associated with said plurality of load cells. The gripper 8 of the end of arm tool 2 are designed to be  
30 able to pick out and securely relocate a servicing dish. To be able to securely

relocate a servicing dish the gripper 8 has a cutout corresponding to a shape of the external part of the servicing dish.

The cleaning subsystem comprises a subsystem 7' adapted to clean the cooking receptacle 3 (Fig. 3) and a subsystem 7'' adapted to clean the tray 5 (Fig. 11). The subsystem 7'' is designed in the form of a closed bath 16, having openings adapted to receive the tray 5. The bath 16 comprises a washing nozzle 17 operably fixed to a pump and means for moving the washing nozzle 18 substantially perpendicularly towards the washable surface of the tray 5. The means for moving the washing nozzle 18 are designed to be driven by the rotary drive 9. Thus, the means for moving the washing nozzle 18 are also provided with the engagement means 10, which are the same as the engagement means 10 of a plurality of the containers 21.

The subset of the plurality of ingredient holding and dispensing assemblies 20 comprises a container 21' with the dispenser 22 and a screw conveyor 24, adapted to controllably move fluent solid ingredients in the container 21' towards the dispenser 22. The screw conveyor 24 comprises two helically bladed screws: a central screw 25 and a peripheral screw 26, located around the central screw 25, both screws having the same rotational axis (Fig. 7-8). The helical blades of the screws 25 and 26 have opposite directions (left and right), so that as a result of rotation of a rotational shaft of the screws 25 and 26, the screws 25 and 26 force the contents of the container 21' to move in opposite directions: one towards the dispenser 22 and the other – in opposite direction. This solution prevents compaction and pressing of the ingredients in the container 21' (as it is in the case of the prior art screw conveyors, especially the ones, where the cross-section of the dispenser outlet is smaller than the size of the cross-section of the container comprising the screw). According to one embodiment the helical blades of the screws 25 and 26 are in the shape of a helical coil. A rotational shaft of both screws 25 and 26 is provided with engagement means 10 designed to be releasably

engaged with the rotary drive 9 of the end of arm tool 2. The container 21` preferably has a U-shape crosssection (Fig. 7).

The subset of the plurality of ingredient holding and dispensing assemblies 20  
5 comprises a container 21`` and a peristaltic pump 27, which drive is designed to be releasably engaged with the rotary drive 9 of the end of arm tool 2. Each container 21`` is designed to allow the gripper 8 to grip and releasably fix the container 21``, as well as to remove it from its storage location, bring it towards the cooking receptacle 3 and back to the storage location. According to the preferred  
10 embodiment, the container 21`` is designed to accommodate a replaceable sealed receptacle operably connected with the peristaltic pump 27 and the dispenser 22 by means of flexible pipe.

The robotic cooking system may further comprise a ventilation, humidity and  
15 temperature controlling system adapted to ensure the pre-set level of humidity and temperature in the robotic cooking system.

## Claims

1. A robotic cooking system, comprising: a robotic arm with a controller and a  
5 motor drive unit, an end of arm tool with a gripper; a plurality of ingredient  
holding and dispensing assemblies, each of the ingredient holding and  
dispensing assemblies comprising a container for holding a supply of an  
ingredient and dispenser for dispensing an amount of the ingredient from a  
10 discharge of the ingredient holding and dispensing assembly; a cooking  
receptacle, being configured to cook food ingredients placed therein; dishes  
storing device; a tray adapted to receive food ingredients from the dispenser  
and designed to be releasably gripped by the gripper; a dish and food transfer  
area having at least one compartment; a cleaning subsystem configured to  
15 clean the cooking receptacle and the tray; wherein the end of arm tool is  
further provided with a rotary drive adapted to be releasably engaged with the  
engagement means of a plurality of the containers for holding a supply of an  
ingredient designed so that at the engaged position the rotation of the rotary  
drive of the end of arm tool causes the dispenser of the ingredient holding and  
20 dispensing assembly to dispense an amount of the ingredient from the  
discharge of the ingredient holding and dispensing assembly; wherein the  
rotary drive is provided with a flexible coupling adapted to compensate  
misalignment and/or ensure easy entering of the end of the engaging part of  
the rotary drive to the engagement means of a plurality of the containers,  
wherein the end of arm tool is further provided with one or more air nozzles  
25 directed towards the inner part of the tray, so to create air flow along the  
surface of the tray towards a discharge edge of the tray to facilitate discharging  
food ingredients from the tray.
2. The robotic cooking system according to claim 1, wherein a subset of the  
30 plurality of ingredient holding and dispensing assemblies comprises a

- container with the dispenser and a screw conveyor, adapted to controllably move fluent solid ingredients in the container towards the dispenser, wherein the screw conveyor comprises two helically bladed screws: a central screw and a peripheral screw, the peripheral screw located around the central screw, both screws having the same rotational axis; wherein the helical blades of the screws have opposite directions; a rotational shaft of both screws is provided with engagement means designed to be releasably engaged with the rotary drive of the end of arm tool.
- 5
- 10 3. The robotic cooking system according to any one of claims 1-2, wherein a subset of the plurality of ingredient holding and dispensing assemblies comprises a container and a peristaltic pump, which drive is designed to be releasably engaged with the rotary drive of the end of arm tool; wherein each container is designed to allow the gripper to grip and releasably fix the container, as well as to remove it from its storage location and return it back to the storage location.
- 15
- 20 4. The robotic cooking system according to any one of claims 1-3, wherein the container is designed to accommodate a replaceable sealed receptacle operably connected with the peristaltic pump and the dispenser by means of flexible pipe.
- 25 5. The robotic cooking system according to any one of claims 1-4, wherein the cooking receptacle comprises a pot for holding ingredients, one or more heaters for induction heating the pot and rotating means for rotating the pot about two or more rotational axis, wherein the pot is further provided with one or two fins adapted to be rotated inside the pot in order to ensure uniform stirring of food ingredients in the pot, wherein the cooking receptacle is

designed to controllably rotate the fins in the direction, which is opposite to the direction of rotation of the pot.

- 5 6. The robotic cooking system according to any one of claims 1-5, wherein the tray is designed to have two parallel substantially vertical walls and two substantially inclined walls; where the two inclined walls, together with the tray's bottom form an arc, preferably a parabolic arc.
- 10 7. The robotic cooking system according to any one of claims 1-6, wherein the cleaning subsystem is adapted to clean the cooking receptacle and a subsystem is adapted to clean the tray, wherein the subsystem is designed in the form of a closed bath, having openings adapted to receive the tray, the bath comprising a washing nozzle operably fixed to a pump and means for moving the washing nozzle, wherein the means for moving the washing nozzle are provided with  
15 the engagement means, which are the same as the engagement means of a plurality of the containers, where the means for moving the washing nozzle are designed to be driven by the rotary drive.
- 20 8. The robotic cooking system according to any one of claims 1-7, wherein the tray is further provided with gripping area, adapted to be gripped by the gripper, where the gripping area is in the form of two horizontal bars fixed to the upper part of the parallel substantially vertical walls, where the horizontal bars are provided with engagement means for engaging with the gripper.
- 25 9. The robotic cooking system according to any one of claims 1-8, wherein the end of arm tool further comprising one or more load cells, adapted to provide a representation of a load on the gripper, the gripper being directly or indirectly associated with said plurality of load cells.

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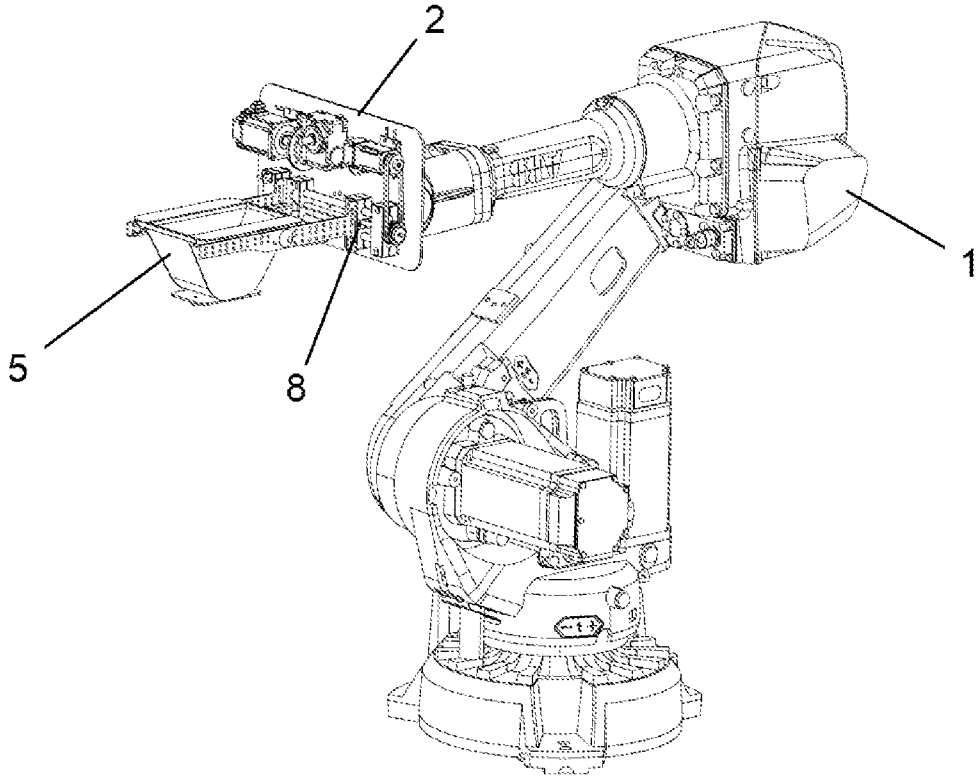


Fig. 1

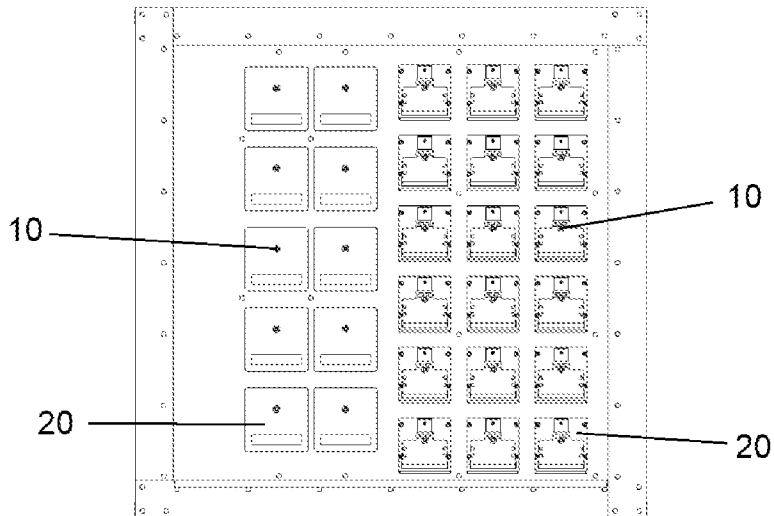


Fig. 2

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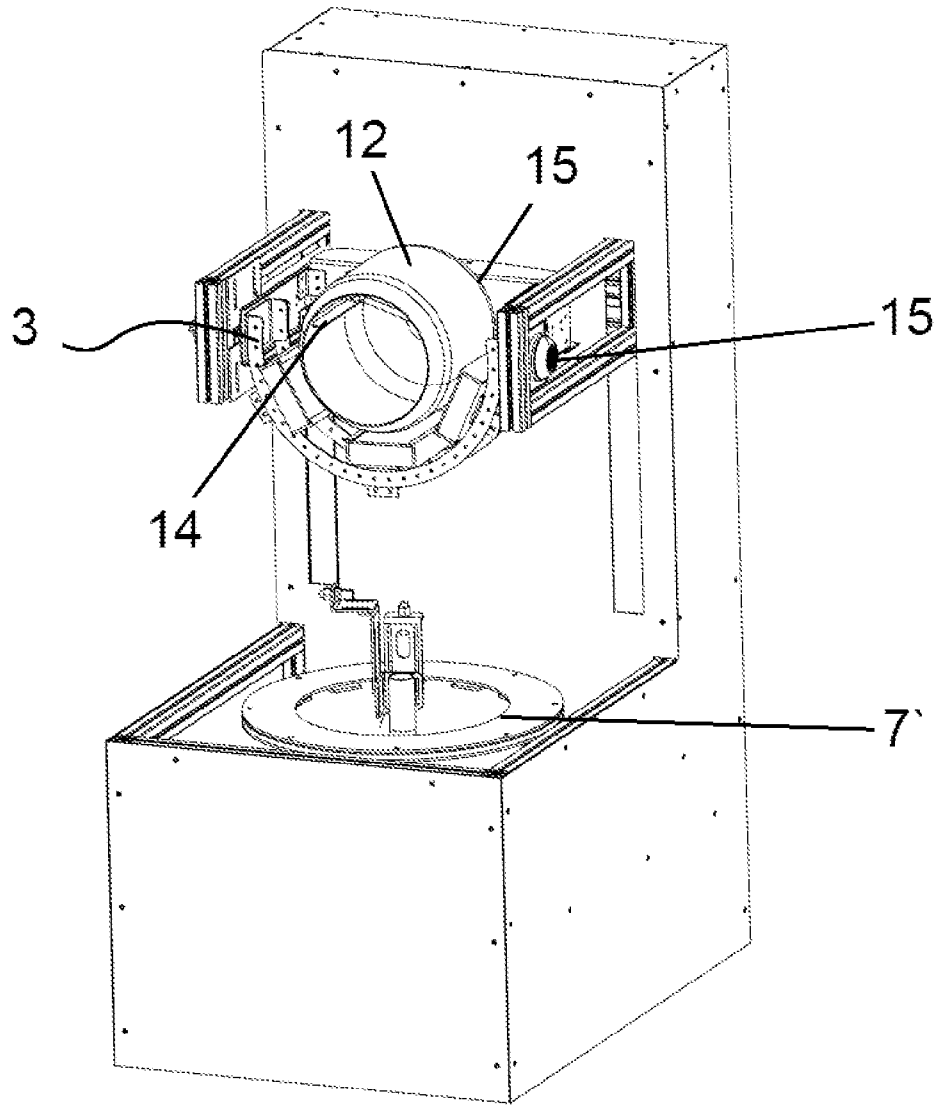


Fig. 3

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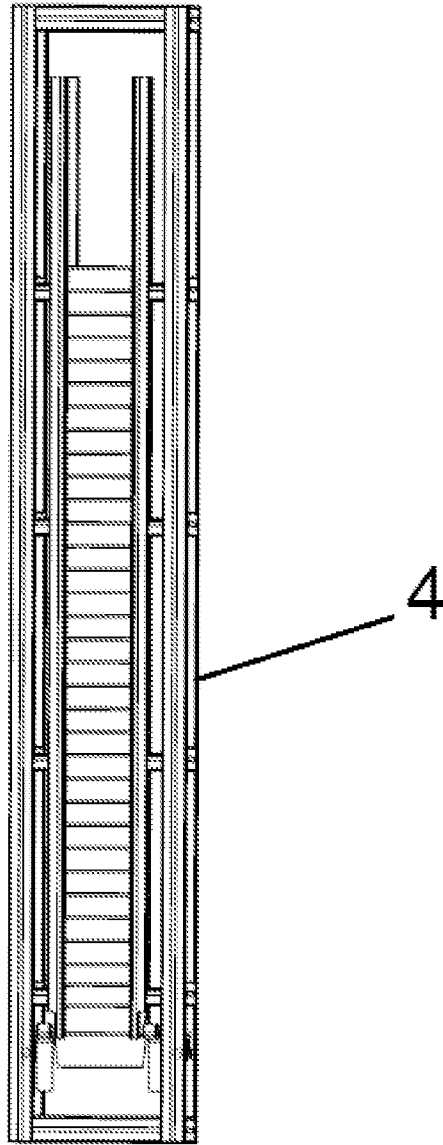


Fig. 4

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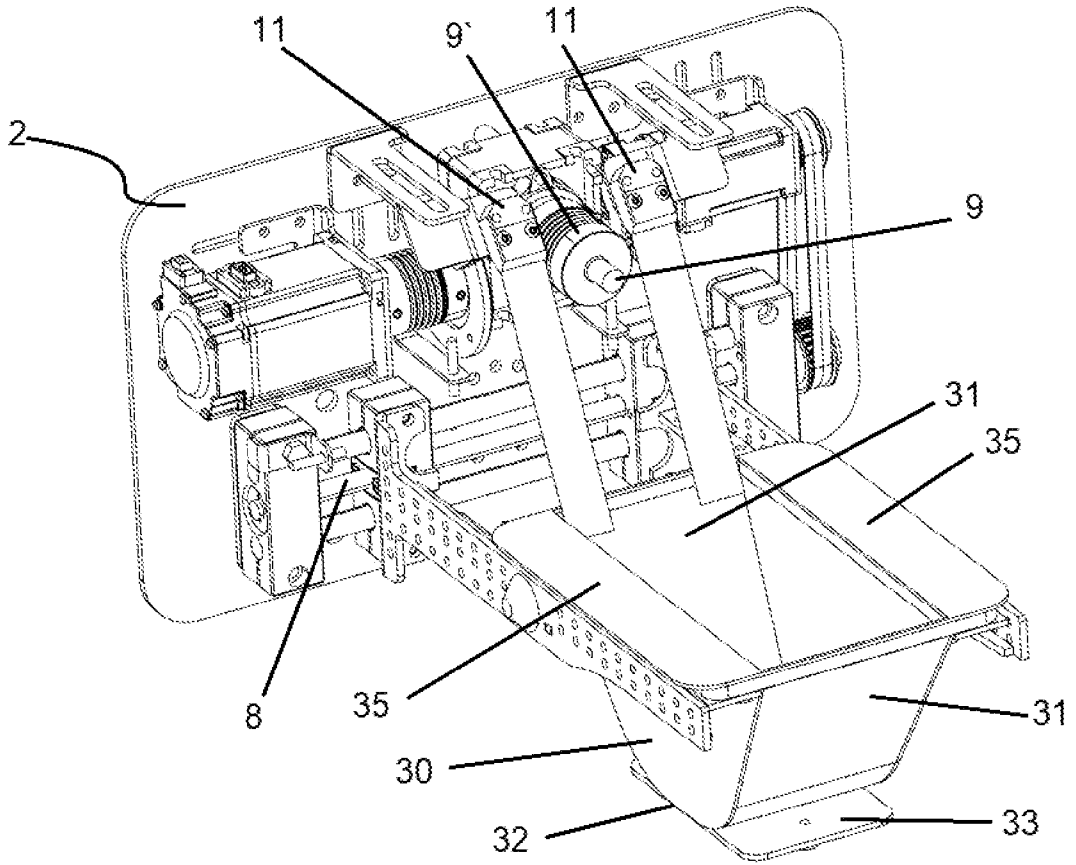


Fig. 5

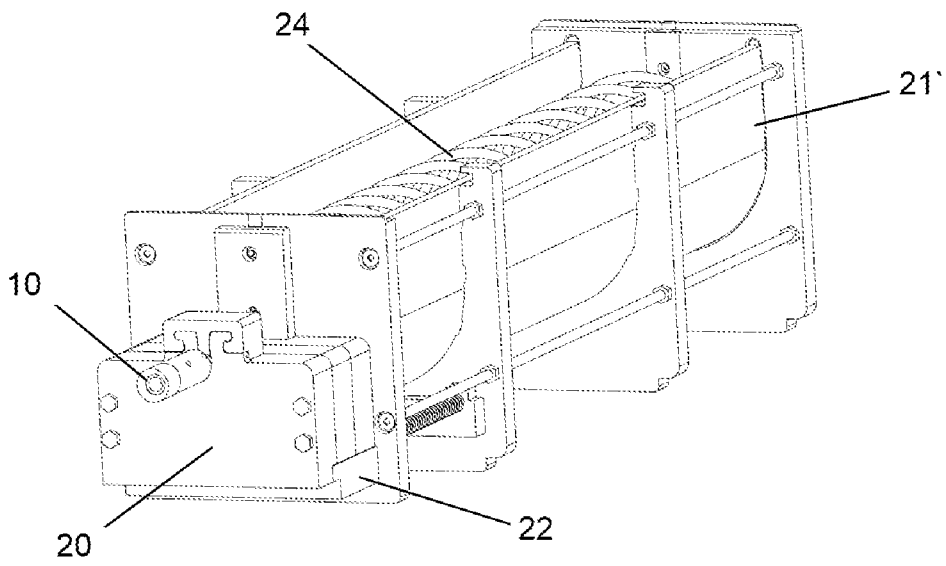


Fig. 6

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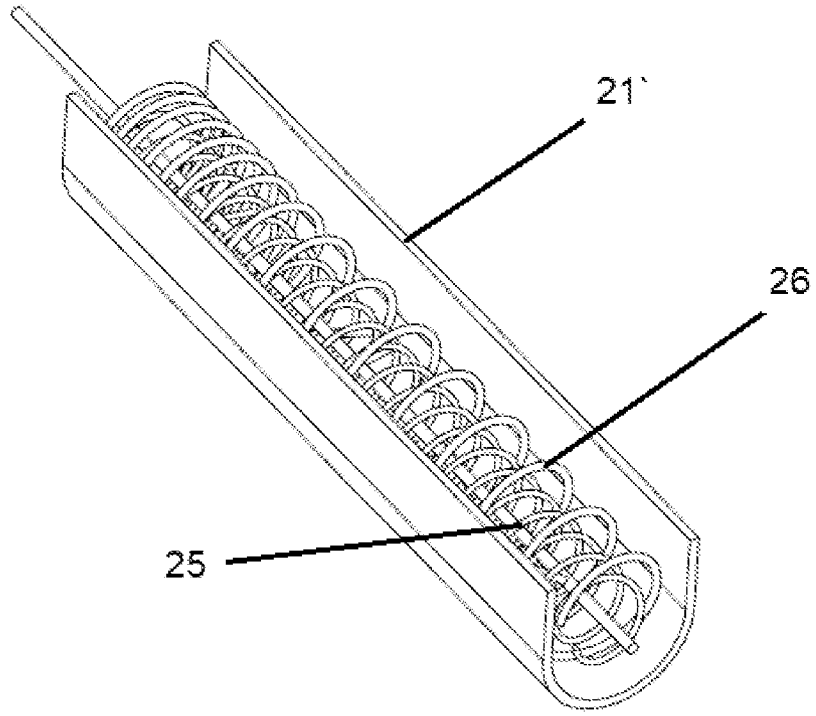


Fig. 7

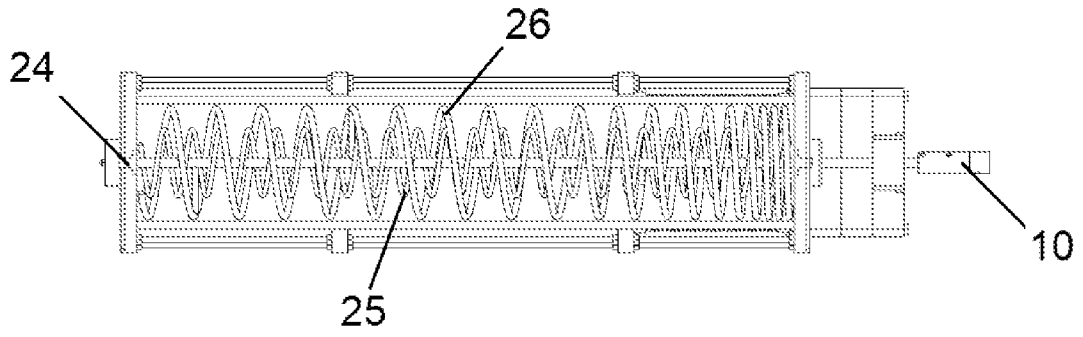


Fig. 8

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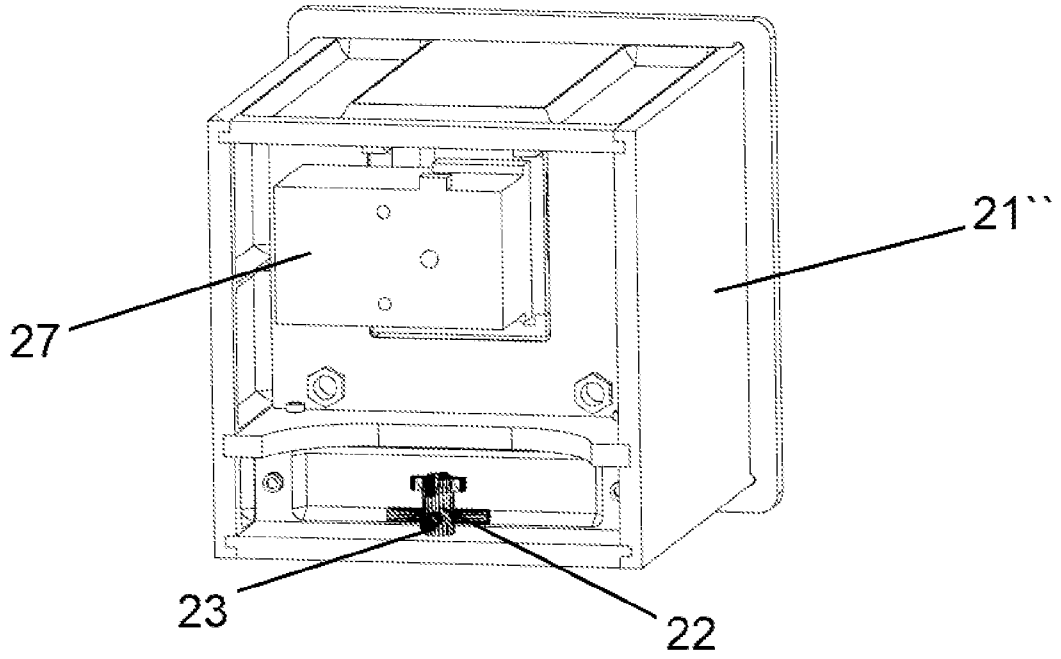


Fig. 9

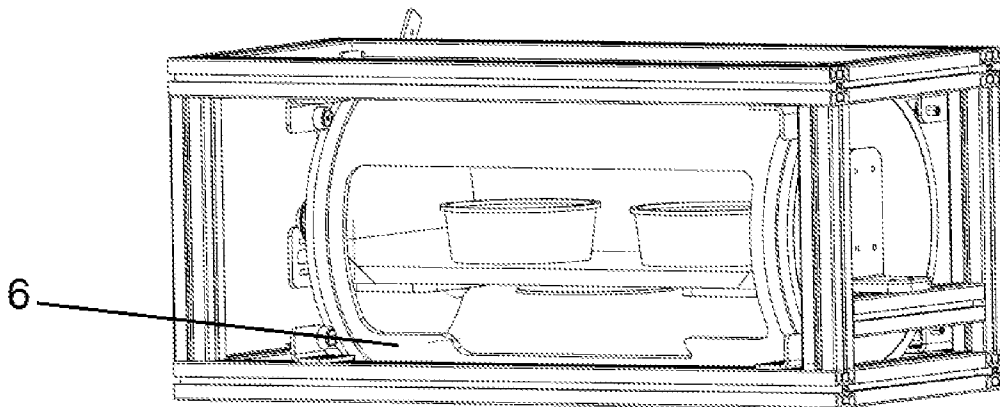


Fig. 10

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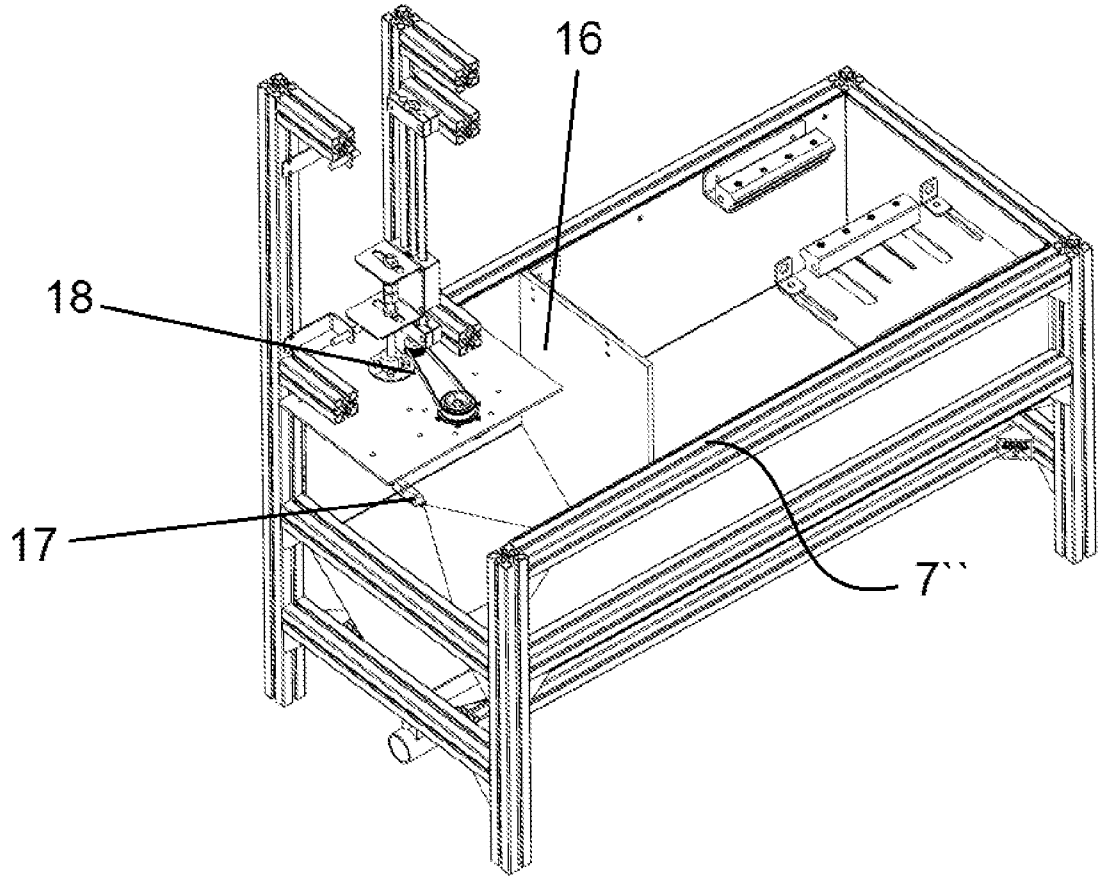


Fig. 11

