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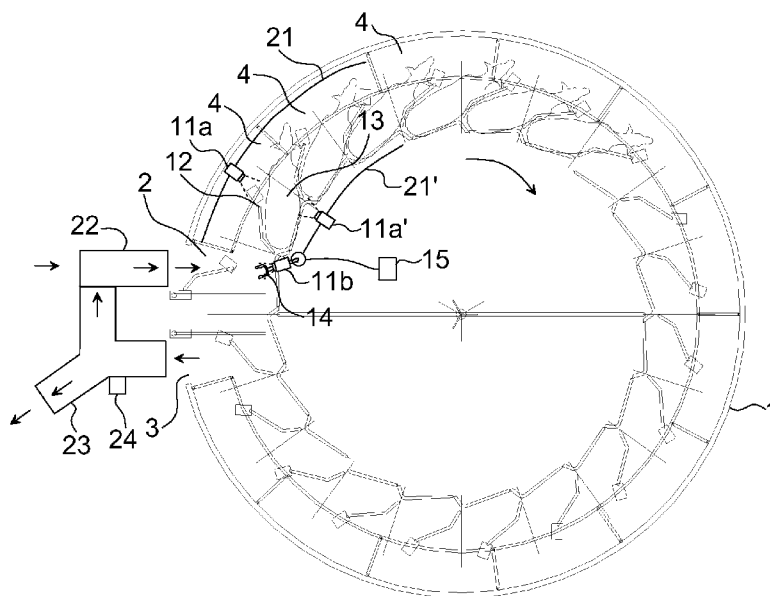


Fig. 1

(57) Abstract: An arrangement is provided in a rotary milking system comprising a rotating platform (1) which rotates during milking, an entry (2) thereto and an exit (3) from there. A selection gate arrangement (23) is provided at the exit of the rotating platform and is capable of selectively guide animals, which have been milked in the rotary milking system and leave the rotating platform through the exit, back to the entry of the rotating platform or to a waiting area (25). A control device (24) is provided for (i) determining whether an animal, which has been milked and leaves the rotating platform through the exit, has at least one udder compartment that was incompletely milked the last time the animal was milked, and (ii) controlling the selection gate arrangement to guide the animal back to the entry of the rotating platform or to the waiting area provided that the animal has at least one udder compartment that was incompletely milked the last time the animal was milked.

**ARRANGEMENT AND METHOD IN A MILKING SYSTEM, THE MILKING SYSTEM
ITSELF, AND A COMPUTER PROGRAM PRODUCT FOR CONTROLLING THE METHOD
TECHNICAL FIELD OF THE INVENTION**

5 The present invention relates generally to dairy farming and to
milking of dairy animals therein.

DESCRIPTION OF RELATED ART AND BACKGROUND OF THE INVENTION

10 A rotary milking system comprises a rotating platform which
animals enter and leave in a sequential order in order to be
milked. The rotating platform comprises a plurality of milking
stalls, each provided with milking equipment for milking of an
animal present in the milking stall. The rotating platform
rotates with the milking stalls and the animals which have
entered the rotating platform, slowly while the animals are
milked.

15 Sometimes the milking of an animal on the rotating platform is
not complete, that is, it may happen that a cow that has been
milked has an udder compartment that was incompletely milked.
The incomplete milking may have been caused by a teat cup kick
or fall off during milking. Incomplete milking may as well
20 depend on a damaged or infected teat.

In a semi-automated or fully automated rotary milking system,
teat cups of the milking equipments are automatically attached to
the teats of the animals to be milked by a robot arm provided
with a gripper. One single robot arm may serve all or at least
25 several milking stalls of the rotary milking system. Incomplete
milking in such rotary milking system may also be caused by a
failed teat cup attachment, e.g. caused by a dirty camera lens
or an unfavorable teat position.

30 FR 2 757 742 discloses a rotary milking system, wherein the
problem of incomplete milking is discussed. If the milk

quantity obtained is not proper, the animal is kept on the rotating platform for another revolution. When the animal passes the operator, he/she can verify that the milking claw is well in place. Should the milk quantity be too low also after a
5 second revolution, the animal is evacuated and an alarm is sent to get the operator's attention.

SUMMARY OF THE INVENTION

However, it shall be appreciated that in some rotary milking system designs, it is not possible to allow the animal to stay on
10 the rotating platform. Cleaning equipment or other equipment of the rotary milking system may occupy the space between the entry to and the exit from the rotating platform.

Further, it may not be pleasant to the animals to stay on the rotating platform with the teat cups attached for longer periods
15 of time.

It is an object of the present invention to provide an arrangement and method in a rotary milking system, a rotary milking system including the arrangement, and a computer program product for controlling by which the above situation can be
20 handled appropriately and efficiently and by which the drawbacks of the prior art can be avoided.

It is a further object of the invention to provide such arrangement and method, which are automated, accurate, reliable, of low cost, and easy to install.

25 These objects, among others, are attained by arrangements and methods as defined in the appended patent claims.

According to a first aspect of the invention an arrangement is provided in a rotary milking system, which comprises a rotating platform which rotates during milking, an entry thereto and an
30 exit from there, and a plurality of milking equipments for milking animals thereon. The arrangement comprises a selection

gate arrangement and a control device operatively connected to the selection gate arrangement. The selection gate arrangement is arranged at the exit of the rotating platform and is capable of selectively guiding animals, which have been milked in the rotary milking system and leave the rotating platform through the exit, back to the entry of the rotating platform or to a waiting area. The control device is arranged to (i) determine whether an animal, which has been milked and leaves the rotating platform through the exit, has at least one udder compartment that was incompletely milked the last time the animal was milked, and (ii) control the selection gate arrangement to guide the animal back to the entry of the rotating platform or to the waiting area provided that the animal has at least one udder compartment that was incompletely milked the last time the animal was milked.

By means of the present invention the overall milk production is optimized since the milking of an animal that follows an incomplete milking of that animal can be made more efficient and in a manner suitable to an automated or semi-automated rotary milking system.

The determination as to whether an animal that presents itself at the milking system has an udder compartment that was incompletely milked the last time the animal was milked can be made based on milk yields and/or milking times measured during the last milking.

Alternatively or additionally, the determination as to whether an animal that presents itself at the milking system has an udder compartment that was incompletely milked the last time the animal was milked is made based on the measurement(s) by one or several sensors, e.g. a vacuum sensor and/or a camera, capable of detecting teat cup kick-off and/or incorrect or failed teat cup attachment.

In one embodiment the above arrangement is implemented in a rotary milking system comprising a teat cup attachment device and a control device for controlling the teat cup attachment device to attach teat cups to teats of animals prior to milking the animals. The rotary milking system is preferably arranged to milk the animal again provided that the animal has at least one udder compartment that was incompletely milked the last time the animal was milked and has been guided back to the entry of the rotating platform, either directly or via the waiting area.

This subsequent or second milking can be performed while improving animal care, increasing the utilization of the milking system, and increasing milk production.

In one version of the above embodiment the rotary milking system is arranged to milk the animal again in a milking procedure which is different from the one in which the animal was milked the last time the animal was milked with respect to the procedure for the attachment of teat cups to, and/or detachment of teat cups from, the teats of the animal.

Hereby, the animal care and treatment can be improved by means of reducing the wear of the teats. Concurrently, the subsequent milking can be made more efficient and adapted to the needs whereupon the utilization of the rotary milking system and thus the milk production can be increased.

This may be achieved in several different manners. For instance, the rotary milking system may be arranged to milk the animal again by means of attaching a teat cup to, and milk, only the teat of the at least one udder compartment that was determined to be incompletely milked the last time the animal was milked.

Alternatively, the rotary milking system may be arranged to milk the animal again by means of (i) attaching teat cups to,

and starting milking of, the teats of all the udder compartments of the animal; (ii) establishing during a short period of time in which of the teat cups a milk flow above a selected threshold is obtained; (iii) immediately after the expiry of the short period of time detaching the teat cups, in which a milk flow above the selected threshold is not obtained, from the teats, while keeping the other teat cups attached during the following milking.

According to a second aspect of the invention there is provided a method for controlling milking in a rotary milking system, which comprises a rotating platform which rotates during milking, an entry thereto and an exit from there, and a plurality of milking equipments for milking animals. According to the method it is determined whether an animal, which has been milked and leaves the rotating platform through the exit, has at least one udder compartment that was incompletely milked the last time the animal was milked. If the animal has at least one udder compartment that was incompletely milked the last time the animal was milked the animal is automatically guided back to the entry of the rotating platform or to a waiting area by means of an automated selection gate arrangement. The animal is then automatically allowed, enticed, or forced to enter the rotating platform again and is milked again.

Further characteristics of the invention and advantages thereof, will be evident from the detailed description of preferred embodiments of the present invention given hereinafter and the accompanying Figs. 1-2, which are given by way of illustration only and are thus not limitative of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates schematically a rotary milking system in accordance with an embodiment of the invention.

Fig. 2 illustrates schematically a rotary milking system in accordance with a further embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

Fig. 1 illustrates a schematically outlined semi-automated or automated rotary milking system provided for semi-automated or automated milking of animals. The rotary milking system comprises a rotating platform 1 which animals 13 enter and leave in a sequential order in order to be milked and which rotates during milking, an entry 2 to the rotating platform 1 for entry of animals to the rotating platform 1, and an exit 3 from the rotary milking system for allowing animals to leave the rotating platform 1 after milking. The rotating platform 1 is provided with a plurality of milking stalls 4, each being provided with respective milking equipment (not illustrated) for milking animals on the rotating platform 1 and each being provided to house a single animal 13 during milking. In front of the entry 2 there may be provided an entry box or an entry passageway 22 provided with an animal identification device, which is arranged to identify each of the animals that enter the rotary milking system, and optionally an automatic gate device.

While Fig. 1 shows a rotary milking system in herringbone configuration, the invention is applicable to other kind of configurations such as parallel and tandem configurations.

Further, the rotary milking system comprises an automatic teat cup attachment device or robot 14 and a control device 15 for controlling the teat cup attachment device to attach teat cups to teats of animals prior to milking the animals with aid from a camera arrangement including e.g. three camera systems 11a, 11a', and 11b.

Two camera systems 11a, 11a' of the three-dimensional camera arrangement can be arranged to be movable along a respective path in the form of a rail 21, 21' or similar mounted e.g. in a

ceiling of a building housing the rotary milking system. The movement of two camera systems 11a, 11a' can be locked to the movement, i.e. rotation, of the rotating platform 1 such that the two camera systems 11a, 11a' are stationary with respect to the rotating platform 1 when recording images of the teats of the animal 13 on the rotating platform 1. Alternatively, the two camera systems 11a, 11a' are stationary with respect to the rotating platform 1 during all times.

One camera system 11b is mounted on an arm of the teat cup attachment device 14.

The rotating platform 1 may, for each of the animals, be kept still while the teat cup attachment device 14 automatically attaches teat cups to the teats of the animal, and is rotated there in between, but preferably the rotating platform 1 is rotated continuously during the attachment of the teat cups and the milking of the animals.

When the teat cups have been attached to the teats of an animal on the rotating platform 1 the two camera systems 11a, 11a' are moved in an opposite direction with respect to the direction of movement of the rotating platform 1 such that the two camera systems 11a, 11a' will be aligned for use in a next one of the milking stalls, when again the two camera systems 11a, 11a' are locked to the rotating platform.

It shall be appreciated that the rotary milking system may be provided with other kinds of visual teat sensing devices. For instance, the two camera systems 11a, 11a' may be dispensed with and a sole visual teat sensing device, mounted on the arm of the teat cup attachment device or elsewhere, is used to locate the teats of the animal during the teat attachment procedure. Further, the rotary milking system may be provided with more than one teat cup attachment device such that teat cups can be attached to the teats of several animals simultaneously.

The rotary milking system comprises a central control and process apparatus (not illustrated) for controlling various parts of the rotary milking system 1 such as the movement of the rotating platform 1 and the operation of the milking equipment of the milking stalls 4, and for gathering information such as milk yields and milking times for each of the milking animals 13.

Sometimes the milking is not complete, that is, milking is terminated and the animal is allowed to leave the milking system despite that an udder compartment is not completely emptied. This may happen after a teat cup kick or fall off. Conditions for when re-attachment of a teat cup to, and re-starting the milking of, a teat, in case of a teat cup kick or fall off, are disclosed in WO2004/100650, the contents of which being hereby incorporated by reference. If such conditions are not met the udder compartment is left incompletely milked as the animal is allowed leave the milking system after milking.

In accordance with an aspect of the present invention there is provided a selection gate arrangement 23 at the exit 3 of the rotating platform which is capable of selectively guiding animals, which have been milked in the rotary milking system and leave the rotating platform 1 through the exit 3, back to the entry 2 of the rotating platform via the entry box or entry passageway 22, or elsewhere such as to a pasture or loose house environment. The selection gate arrangement 23 comprises two automatic exit gate devices and optionally an automatic entry gate device.

Further, a control device 24 is operatively connected to the selection gate arrangement 23 and is provided for (i) determining whether an animal, which has been milked and leaves the rotating platform 1 through the exit 3, has at least one udder compartment that was incompletely milked the last time the animal was milked, and (ii) controlling the selection gate arrangement 23 to guide the animal back to the entry 2 of the

rotating platform 1 via the entry box or entry passageway 22 provided that the animal has at least one udder compartment that was incompletely milked the last time the animal was milked. If not, the control device 24 controls the selection
5 gate arrangement 23 to guide the animal elsewhere.

The control device 24 is provided for determining that the animal has an udder compartment that was incompletely milked the last time the animal was milked if the milk yield from that animal or that udder compartment (if this was measured
10 individually) was below a first threshold value the last time the animal was milked and/or if the milking time for that animal or that udder compartment (if this was measured individually) was below a second threshold value the last time the animal was milked.

Alternatively or additionally, one or several sensors, e.g. a vacuum sensor and/or a camera (not illustrated), is/are arranged to detect e.g. teat cup kick-off and/or incorrect or failed teat cup attachment and to provide the control device 24 with such information, by aid of which the control device 24
15 determines whether an animal that presents itself at the milking system has an udder compartment that was incompletely milked the last time the animal was milked.
20

The first and second threshold values may be values independent of the animal or values dependent on the animal, preferably
25 percentage values of an expected milk yield for the animal or for the udder compartment of the animal.

Each animal that is guided back to the entry 2 of the rotating platform 1 is allowed or guided onto the rotating platform 1 and is milked again. Preferably, for each of the animals, this
30 subsequent milking is performed in a milking procedure which is different from the one in which the animal was milked the last time the animal was milked with respect to the procedure for the attachment of teat cups to, and/or detachment of teat cups

from, the teats of the animal in order to reduce the wear of the teats of the animal.

For instance, the subsequent milking may be performed, for each of the animals, by means of attaching a teat cup to, and milking, only the teat of the at least one udder compartment that was determined to be incompletely milked the last time the animal was milked.

Hereby, the milking procedure including the automatic teat cup attachment is performed faster and the wear on the teats of the animal is reduced.

Alternatively, the subsequent milking may be performed, for each of the animals, by means of (i) attaching teat cups to, and starting milking of, the teats of all the udder compartments of the animal; (ii) establishing during a short period of time, e.g. less than about 30 seconds, preferably less than about 15 or 20 seconds, in which of the teat cups a milk flow above a selected threshold is obtained; and (iii) immediately after the expiry of the short period of time detaching the teat cups, in which a milk flow above the selected threshold is not obtained, from the teats, while keeping the other teat cups attached during the following milking.

Also in this version, the milking procedure including the automatic teat cup attachment is performed faster and the wear on the teats of the animal is reduced since teat cups will not be detached after such a short time in a regular milking procedure. This embodiment is particularly suitable when it is not generally known which of the udder compartments that was/were incompletely milked the last time the animal was milked.

Fig. 2 illustrates schematically a rotary milking system in accordance with a further embodiment of the invention. This

embodiment differs from the embodiment of Fig. 1 in that the selection gate arrangement 23 leads to a waiting area 25 and elsewhere, and in that there is provided a further selection gate arrangement 26 capable of directing animals in the waiting area 25 to the entry 2 of the rotating platform via the entry box or entry passageway 22 or elsewhere such as to a pasture or loose house environment or to a treatment station. The further selection gate arrangement 26 comprises two automatic exit gate devices and optionally an automatic entry gate device.

The control device 24 of Fig. 2 is arranged to (i) determine whether an animal, which has been milked and leaves the rotating platform 1 through the exit 3, has at least one udder compartment that was incompletely milked the last time the animal was milked, and (ii) control the selection gate arrangement 23 of Fig. 2 to guide the animal to waiting area 25 provided that the animal has at least one udder compartment that was incompletely milked the last time the animal was milked. If not, the control device 24 controls the selection gate arrangement 23 to guide the animal elsewhere.

The waiting area 25 may be arranged to hold animals for a time period, after which the animals in the waiting area 25 may, one at a time, be allowed to enter the further selection gate arrangement 26. Preferably, each of the animals in the waiting area 25 is guided, one at a time, to enter the rotary milking system so as to be milked in accordance with the description with reference to Fig. 1. However, some of the animals in the waiting area 25 may be guided elsewhere such as to a pasture or loose house environment or to a treatment station.

Preferably, the embodiment of Fig. 2 is implemented in a rotary milking system wherein animals are milked batch wise. In such instance, the animals in the waiting area 25 are milked after the batch of animals has been milked in the rotary milking system. Alternatively, the rotary milking system is provided to

allow or guide the animals to enter the rotating platform 1 in an order of the expected milking time, such that e.g. the animal having longest expected milking time is allowed or guided to enter the rotating platform first, the animal having
5 second longest expected milking time is allowed or guided to enter the rotating platform as second animal, etc., wherein the rotational speed is increasing continuously or stepwise to adapt to a shorter and shorter milking time. In such milking system the animals having at least one udder compartment that
10 was incompletely milked the last time the animals were milked are allowed or guided to enter the milking platform 1 after the animal having shortest expected milking time is allowed or guided to enter the rotating platform 1.

The arrows at and to the left of the entry 2 to and exit 3 from
15 the rotating platform 1 in Figs. 1 and 2 indicate the traffic pattern of animals. The arrows within the rotating platforms indicate the rotation directions of the rotating platforms.

While the present invention has been described in a variety of embodiments it is obvious that they can be modified in a
20 variety of more versions without departing from the scope of the present invention.

CLAIMS

1. An arrangement in a rotary milking system, which comprises a rotating platform (1) which rotates during milking, an entry (2) thereto and an exit (3) from there, and a plurality of milking equipments for milking animals (13) on said rotating platform, characterized in

- a selection gate arrangement (23) provided at the exit of the rotating platform and being capable of selectively guiding animals, which have been milked in the rotary milking system and leave the rotating platform through the exit, back to the entry of said rotating platform or to a waiting area (25); and

- control means (24) operatively connected to the selection gate arrangement and provided for (i) determining whether an animal, which has been milked and leaves the rotating platform through the exit, has at least one udder compartment that was incompletely milked the last time the animal was milked, and (ii) controlling the selection gate arrangement to guide the animal back to the entry of said rotating platform or to said waiting area provided that the animal has at least one udder compartment that was incompletely milked the last time the animal was milked.

2. The arrangement of claim 1 comprising one or several sensors, e.g. a vacuum sensor and/or a camera, capable of sensing a parameter related to the milking of the animal, particularly a teat cup kick-off and/or an incorrect or failed teat cup attachment, and operatively connected to said control means, wherein said control means is provided for determining whether said animal, which has been milked and leaves the rotating platform through the exit, has at least one udder compartment that was incompletely milked the last time the animal was milked based on the sensing of said one or several sensors.

3. The arrangement of claim 1 wherein said control means is provided for determining that said animal has an udder compartment that was incompletely milked the last time the animal was milked if the milk yield from that animal or that udder compartment was below a first threshold value the last time the animal was milked and/or if the milking time for that animal or that udder compartment was below a second threshold value the last time the animal was milked.

4. The arrangement of claim 3 wherein the first threshold value is a value dependent on said animal, preferably a percentage value of an expected milk yield for the animal or for the udder compartment of the animal.

5. The arrangement of claim 3 or 4 wherein the second threshold value is a value dependent on said animal, preferably a percentage value of an expected milking time for the animal or for the udder compartment of the animal.

6. A rotary milking system (3) comprising the arrangement of any of claims 1-5.

7. The rotary milking system of claim 6 comprising a teat cup attachment device (14), and a control device (15) for controlling the teat cup attachment device to attach teat cups to teats of animals prior to milkings the animals.

8. The rotary milking system of claim 6 or 7 provided for milking the animal again provided that the animal has at least one udder compartment that was incompletely milked the last time the animal was milked and is guided back to the entry of said rotating platform, either directly or via said waiting area.

9. The rotary milking system of claim 8 provided for milking the animal again in a milking procedure which is different from the one in which the animal was milked the last time the animal

was milked with respect to the procedure for the attachment of teat cups to, and/or detachment of teat cups from, the teats of the animal.

5 10. The rotary milking system of claim 8 or 9 provided for milking the animal again by means of attaching a teat cup to, and milking, only the teat of the at least one udder compartment that was determined to be incompletely milked the last time the animal was milked.

10 11. A method for controlling milking in a rotary milking system comprising a rotating platform (1) which rotates during milking, an entry (2) thereto and an exit (3) from there, and a plurality of milking equipments for milking animals (13) on said rotating platform, characterized by the steps of:

15 - determining whether an animal, which has been milked and leaves the rotating platform through the exit, has at least one udder compartment that was incompletely milked the last time the animal was milked;

20 - guiding the animal back to the entry of said rotating platform or to a waiting area (25) by means of an automated selection gate arrangement (23) provided that the animal has at least one udder compartment that was incompletely milked the last time the animal was milked; and

25 - milking the animal again provided that the animal has at least one udder compartment that was incompletely milked the last time the animal was milked and is guided back to the entry of said rotating platform, either directly or via said waiting area.

30 12. The method of claim 11 wherein each milking of the animal is preceded by automatically attaching teat cups to the teats of the animal by means of a milking robot (14).

13. The method of claim 11 or 12 wherein the animal is milked again in a milking procedure which is different from the one in which the animal was milked the last time the animal was milked with respect to the procedure for the attachment of teat cups to, and/or detachment of teat cups from, the teats of the animal.

14. The method of any of claims 11-13 wherein the animal is milked again by attaching a teat cup to, and milking, only the teat of the at least one udder compartment that was determined to be incompletely milked the last time the animal was milked.

15. The method of any of claims 11-13 wherein the animal is milked again by means of (i) attaching teat cups to, and starting milking of, the teats of all the udder compartments of the animal; (ii) establishing during a short period of time in which of the teat cups a milk flow above a selected threshold is obtained; (iii) immediately after the expiry of the short period of time detaching the teat cups, in which a milk flow above the selected threshold is not obtained, from the teats, while keeping the other teat cups attached during the following milking.

16. A computer program product loadable into the internal memory of a computer of a milking system, comprising software code portions for controlling the method as claimed in any of claims 12-15 when said product is run on said computer.

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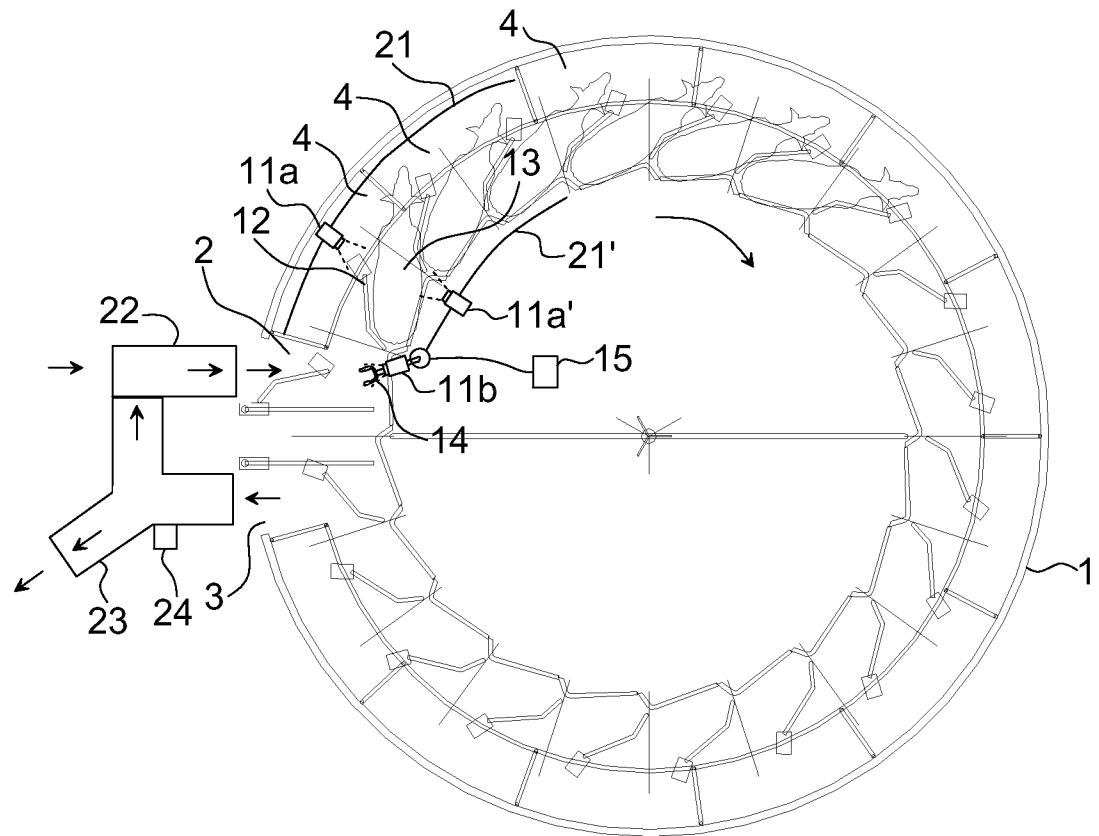


Fig. 1

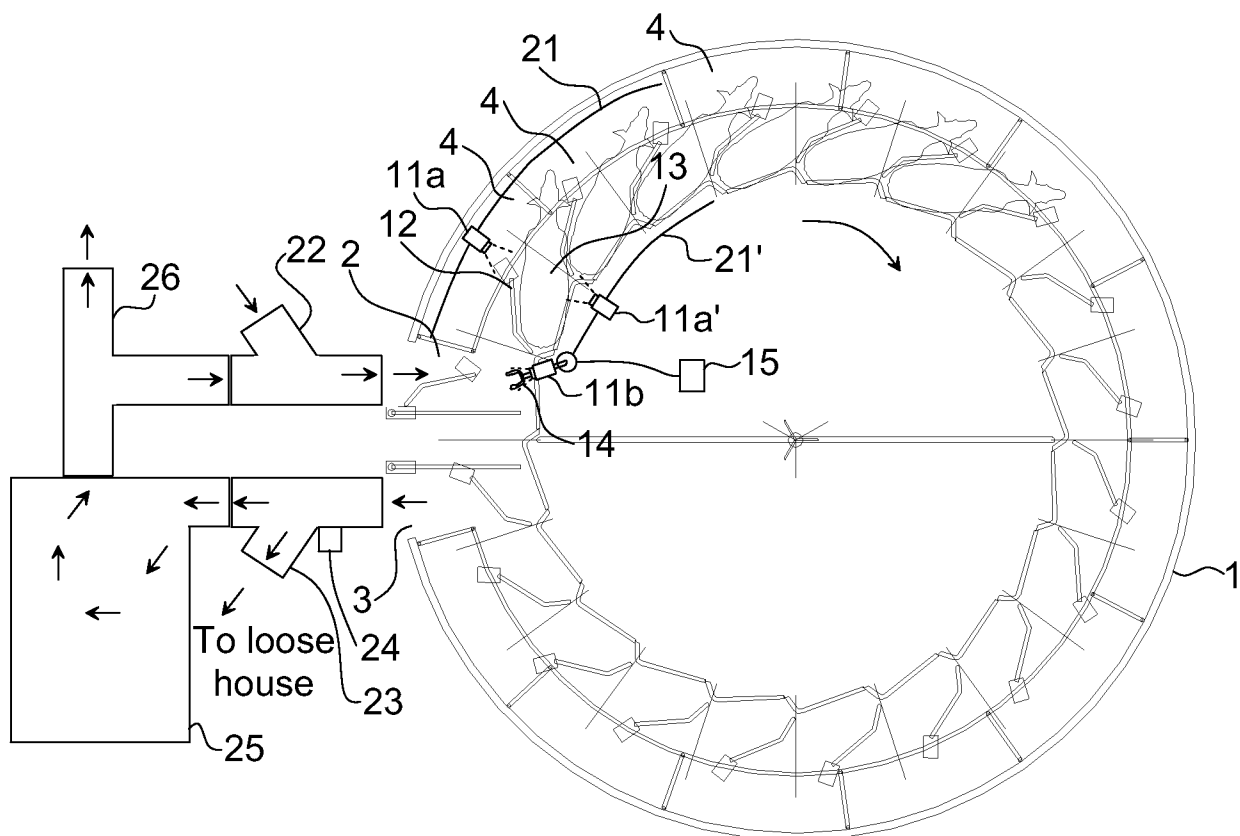


Fig. 2