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(54) **METHOD AND APPARATUS FOR COMPACTING WASTE AND VEHICLE COMPRISING SAID APPARATUS**

(57) The present invention discloses a method for compacting waste comprising the steps of: providing a receptacle having a loading area for receiving waste; loading waste on said loading area of said receptacle; providing a compression member for compacting the waste on said receptacle, said compression member being configured to execute a compacting cycle selected from a group of compacting cycles, in which said compression member is movable between a retracted position, an extended position and an intermediate position; sensing a volume of waste loaded in the receptacle with at least one sensor; determining a compacting cycle based on the sensed volume of waste; and executing said compacting cycle with the compression member.

The present invention also discloses an apparatus for compacting waste and a vehicle comprising said apparatus for compacting waste.

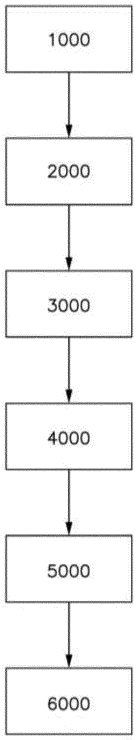


*Fig. 1*

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## Description

### Technical field

**[0001]** The present invention relates to the field of methods and apparatuses for compacting waste. The present invention also relates to a vehicle comprising an apparatus for compacting waste.

### State of the Art

**[0002]** Devices for compacting waste are known in the art as compacting waste to reduce its volume can be very advantageous for a number of reasons. For example, compacting waste reduces the space that is taken by it in containers, landfills, etc. and makes it easier to handle, as large volumes are more complex to handle than small ones.

**[0003]** Moreover, compacting waste also reduces the frequency in which containers, either being on streets or on vehicles, such as trucks, need to be emptied.

**[0004]** Although being advantageous, compacting waste also poses difficulties that causes disadvantages, as for example, it is typically high energy consuming. Therefore, it is advantageous to provide a device for compacting waste that is more efficient, i.e., that use less energy to operate.

**[0005]** US 2020/0276781 A1 discloses a compacting system comprising a container having an open end, the container having at least one sensor for detecting a level of waste within the container, and a compactor apparatus aligned with the open end of the container, the compactor apparatus having a loading area for the loading of waste, and a ram, the ram being movable between a retracted position in which the ram is positioned rearward the loading area, and a compacting position in which the ram extends through the open end of the container and into the container to move the waste from the loading area into the container. Said compacting system can further comprise a controller configured to receive information from the at least one sensor regarding a level of waste within the container, and to generate an alert or indication of the level of waste within the container. Said at least one sensor can be implemented by a pressure sensor or a camera. US 2020/0276781 A1 also discloses a method of compacting waste.

**[0006]** DE 9105772 U1 discloses a device for loading a bulk material collecting container, in particular a garbage truck collecting container, with a dumping chamber receiving the bulk material, a dumping device for dumping bulk material into the dumping chamber, in particular a tilting device for emptying containers such as refuse bins, a device for emptying the dumping chamber and for bringing the bulk material into the interior of the bulk material collecting container for example refuse bins, a device for clearing out the dumping chamber and for bringing the bulk material into the interior of the bulk material collecting container and with a control device for controlling the drive of said device for clearing out the dumping chamber, wherein the control device has a sensor unit which is mounted in the dumping chamber and measures the filling level of the bulk material, and activates the drive of the device for clearing out the dumping chamber only when the filling level of the bulk material measured by the sensor unit has exceeded a predetermined value.

**[0007]** EP 3483092 A1 discloses a garbage truck comprising a hopper for collecting refuse, a compactor for compacting refuse inside the hopper, machine vision means, and a control unit connected to the machine vision means and configured for monitoring an area of the interior of the hopper so as to determine a volume of refuse present inside the hopper for controlling the compactor depending on the volume of refuse present in the hopper. The garbage truck disclosed therein reduces its energy consumption compared to traditional garbage trucks known in the art as its compactor is only operated when needed, i.e., when the volume of refuse meets certain conditions, for example, when exceeds a certain threshold. EP 34883092 A1 also discloses a method for operating the aforementioned garbage truck.

**[0008]** The aforementioned devices from the prior art by the implementation of several embodiments and different strategies, can reduce the energy consumption of the device for compacting waste by operating their compression member for compacting waste only when there is a certain amount of waste to be compressed, thus avoiding performing compacting cycles with little amount of waste.

### Brief description of the invention

**[0009]** However, there is still a need to further increase the efficiency of the collection and compaction of waste. In order to further increase the energy efficiency of the waste compaction operation, according to a first aspect of the present invention it is disclosed a method for compacting waste comprising the steps of:

- providing a receptacle having a loading area for receiving waste;
- performing a first loading of waste through said loading area into said receptacle;
- providing a compression member for compacting the waste inside said receptacle, said compression member being configured to be able to execute a compacting cycle selected from a group of pre-defined compacting cycles stored in a computer unit having one or more processors, in which said compression member is movable between at least a retracted position, an extended position and an intermediate position;
- sensing a volume of waste loaded in the receptacle

after said first loading of waste with at least one sensor;

- determining by the computer unit a compacting cycle based on the sensed volume of waste; and
- executing said compacting cycle with the compression member.

**[0010]** By adapting a selected compacting cycle to the volume or amount of waste present in the receptacle having a loading area for receiving waste it is possible to further reduce the energy consumption of the method for compacting waste as the use of the compression member, typically a hydraulic press, is the most energy demanding element of an apparatus for compacting waste and, thereby, by optimizing the use of the compression member, the efficiency of the method for compacting waste is also greatly increased. In contrast, in the known prior art the compacting cycle is always the same and the improvements in the energy efficiency are provided by choosing not performing a compacting cycle if there is a little amount of waste, that is to say, in the known prior art, the compacting cycle does not adapt to the amount of waste present.

**[0011]** According to a first aspect of the present invention, the step of determining a compacting cycle to be executed may comprise at least the steps of:

- determining whether the sensed volume of waste exceeds a first predetermined threshold; and
- determining a first compacting cycle selected from a group of available compacting cycles if the sensed volume is equal or lower than said predetermined threshold or a second compacting cycle selected from the group of compacting cycles if the sensed volume of waste is greater than said predetermined threshold.

**[0012]** According to a first aspect of the present invention, said predetermined threshold may be between 30 and 60% of the volume of the receptacle having a loading area for receiving waste. Preferably, said predetermined threshold is between 35 and 50% of the volume of said receptacle. More preferably, said predetermined threshold is 40% of the volume of said receptacle.

**[0013]** According to a first aspect of the present invention, the step of determining the compacting cycle may further comprise the step of determining whether the sensed volume of waste exceeds a second predetermined threshold; and determining a third compacting cycle selected from the group of compacting cycles if the sensed volume of waste is greater, or equal or lower than said second predetermined threshold.

**[0014]** According to the first aspect of the present invention, the first compacting cycle may comprise the steps of:

a) moving the compression member from its retracted position to its extended position;

b) moving the compression member from its extended position to an intermediate position;

c) optionally repeating steps, a) and b); and

d) optionally returning the compression member to its retracted position.

**[0015]** According to the first aspect of the present invention, wherein the intermediate position of the compression member may correspond to 60 - 85% of the stroke, i.e., travel, of said compression member. Preferably, the intermediate position of the compression member corresponds to 65 to 80% of the stroke of the compression member. More preferably, said intermediate position of the compression members corresponds to 75% of the stroke, i.e., travel, of said compression member.

**[0016]** According to the first aspect of the present invention, the second compacting cycle comprises the steps of:

a) moving the compression member from its retracted position to an intermediate position;

b) moving the compression member from its intermediate position to its retracted position;

c) optionally repeating steps, a) and b);

d) moving the compression member to its extended position; and

e) optionally returning the compression member to its retracted position.

**[0017]** According to the first aspect of the present invention, the intermediate position of the compression member may correspond to 50 - 70 % of the stroke of said compression member. Preferably, the intermediate position of the compression member corresponds to 55 - 65% of the stroke of said compression member. More preferably, the intermediate position of the compression member corresponds to 60% of the stroke of said compression member.

**[0018]** According to the first aspect of the first aspect of the present invention, said predetermined threshold may depend on the type of waste, that is to say, the value of the predetermined threshold(s) may depend on whether the waste is organic waste, packaging waste, paper waste, glass waste, etc.

**[0019]** The method disclosed therefore comprises the definition and storage, for example in a memory of a computer unit or in a database accessible through the computer unit of several threshold values depending on the type of waste to be compacted.

**[0020]** According to a second aspect of the present invention it is also disclosed an apparatus for compacting waste comprising:

- a receptacle having a loading area for receiving waste;
- a loading unit for loading waste on said loading area;
- a compression member for compacting waste on said receptacle;
- at least one sensor configured to sense a volume of waste in the receptacle;
- a computer unit operatively connected to the at least one sensor and to the compression member, said computer unit being configured to execute a method for compacting waste according to the first aspect of the present invention.

**[0021]** According to the second aspect of the present invention, said at least one sensor may comprise at least one of: an ultrasound sensor, a video camera, a laser or a LIDAR. However, other suitable sensors can also be used. Preferably, said at least one sensor comprises two ultrasound sensors, each one arranged on opposite corners of the receptacle having a loading area for receiving waste.

**[0022]** According to a third aspect of the present invention, it is also disclosed a vehicle comprising an apparatus according to the second aspect of the present invention.

**[0023]** According to the third aspect of the present invention, said vehicle may be a truck.

**[0024]** As used herein, waste includes any kind of garbage, trash, litter, rubbish, etc. and any matter to be discarded or recycled, like glass, paper, cardboard, plastic, containers, etc.

**[0025]** It will be understood that references to geometric position, such as parallel, perpendicular, tangent, etc. allow deviations up to $\pm$ 5° from the theoretical position defined by this nomenclature.

**[0026]** It will also be understood that any range of values given may not be optimal in extreme values and may require adaptations of the invention to these extreme values are applicable, such adaptations being within reach of a skilled person.

**[0027]** Other features of the invention appear from the following detailed description of an embodiment.

## Brief description of the Figures

**[0028]** The foregoing and other advantages and features will be fully understood from the following detailed description of an embodiment with reference to the accompanying drawings, to be taken in an illustrative and non-limitative manner, in which:

FIG. 1 shows a flow diagram of an exemplary embodiment of the main steps of a method for compacting waste according to the present invention.

FIG. 2 shows schematically a first compacting cycle of the method for compacting waste shown in FIG. 1.

FIG. 3 shows schematically a second compacting cycle of the method for compacting waste shown in FIG. 1.

FIG. 4 shows a perspective view of an exemplary embodiment of a vehicle according to the present invention.

FIG. 5 shows a detail view of the vehicle shown in FIG. 4.

## Detailed description of an embodiment

**[0029]** The foregoing and other advantages and features will be fully understood from the following detailed description of an embodiment with reference to the accompanying drawings, to be taken in an illustrative and not limitative way.

**[0030]** FIG. 1 shows a flow diagram of an exemplary embodiment of a method for compacting waste according to the present invention. In a first step 1000 it is provided a receptacle 10 having a loading area 11 for receiving waste (see FIGS. 2 to 5).

**[0031]** The second step 2000 comprises the operation of performing at least a first loading of waste through said loading area 11 into the receptacle 10. Waste can be loaded on said loading area 11 by using a loading unit 20 or manually by operators or users. Said loading unit 20 can be a crane, a robotic arm or any other suitable mechanism for loading and unloading waste containers.

**[0032]** In a third step 3000 a compression member 30 for compacting waste on said receptacle 10 it is provided. Said compression member 30 is configured to execute, following the instructions of a computer unit, a compacting cycle selected from a group of pre-defined compacting cycles, i.e., two or more compacting cycles, in which said compression member 30 is movable between a retracted position, an extended position and an intermediate position. Compression members known in the art are typically movable only between a retracted position and a fully extended position. Compacting cycles according to the present invention wherein the compression member 30 does not travel the full stroke or travel reduce the energy consumption compared to cycles known in the art wherein the compression member only moves from a fully retracted to a fully extended position, and vice versa.

**[0033]** In a fourth step 4000 the volume of waste in the receptacle 11 is sensed with at least one sensor 40. In certain embodiments, besides the amount of volume of waste in the receptacle 11, also the distribution of said

volume can also be sensed, as often the distribution of the waste in the receptacle 10 is not uniform and this could influence which is the optimal compacting cycle to be performed.

**[0034]** In the fifth step 5000 a most suitable compacting cycle is determined, generally by calculation or selection by means of a processor of a computer unit, based on the sensed volume of waste in the previous step 4000.

**[0035]** The sixth step 6000 comprises executing the previously determined compacting cycle with the compression member 30.

**[0036]** The aforementioned order of the steps can change in other embodiments. The use of terms first, second, third, etc., steps should not be understood in a limitative way. For example, the step of providing a compression member 30 can be done before loading waste on the loading area 11 of the receptacle. However, the step 2000 of loading waste on the loading area 11 must be done before the step 4000 of sensing the volume of waste on said loading area 11, as otherwise there is no waste to be sensed. Similarly, before the step 6000 of executing a compacting cycle with the compression member 30, the step 5000 of determining a compacting cycle from a group of available compacting cycles needs to be performed.

**[0037]** In the exemplary embodiment shown, the step 5000 of determining the optimal compacting cycle based on the sensed volume of wate can comprise the step of determining whether the sensed volume of waste exceeds a predetermined threshold; and determining a first compacting cycle selected from the group of compacting cycles if the sensed volume is equal or lower than said predetermined threshold or a second compacting cycle selected from the group of compacting cycles if the sensed volume of waste is greater than said predetermined threshold. In the exemplary embodiment shown, said threshold is 40% of the volume or capacity of the receptacle 10. However, in other embodiments said threshold may range, for example, between 30 to 60% of the volume of the receptacle 10.

**[0038]** In other embodiments, there may be more than two thresholds and therefore more than three compacting cycles to choose from. In particular, there can be n+1 compacting cycles to choose from, where n is the number of thresholds. A greater number of thresholds allows to finely tune the compacting cycles to a greater number of loads and situations of the container 10.

**[0039]** The values of the one or more predetermined threshold may vary depending on the kind of waste to be compacted. The kind of waste may be sensed by the at least one sensor 40 or may be input by an operator of the apparatus 1 for compacting waste.

**[0040]** Fig. 2 schematically shows a first compacting cycle of the method for compacting waste shown in FIG. 1.

**[0041]** In the uppermost part of FIG. 2 it is depicted step 4000 of the method for compacting waste of FIG. 1 wherein the volume of waste in the receptacle 10 is sensed by the at least one sensor 40. In the case shown, the volume of waste is equal or lower than a predetermined threshold, and therefore, the first compacting cycle is determined.

**[0042]** The exemplary embodiment of the first compacting cycle depicted in FIG. 2 comprises the step 6100 of moving the compression member 30 to its extended position. Typically, in the step 6100 the compression member 30 moves to its extended position from its idle state, which usually corresponds to the retracted position.

**[0043]** After moving the compression member 30 to its extended position and, therefore, performing a first compaction of the waste, in the next step 6200 the compression member 30 is moved from its extended position to an intermediate position. In this exemplary embodiment, said intermediate position corresponds to 75% of the stroke of the compression member 30, wherein 0% corresponds to the compression member 30 fully retracted and 100% corresponds to the compression member 30 being fully extended. In other embodiments of the first compacting cycle, said intermediate position can range, for example, between 60 to 85% of the stroke of the compression member 30.

**[0044]** The depicted step 6300 illustrates the optional step of repeating one or more times the steps 6100 and 6200 until the desired compaction of the waste is achieved. In the last step 6400, which is also optional, the compression member 30 is returned to its retracted position, waiting to begin a new compacting cycle, which may be the same or a different one, depending on the volume of waste sensed by the at least one sensor 40 in the step 4000.

**[0045]** Fig.3 schematically shows a second compacting cycle of the method for compacting waste shown in FIG. 1.

**[0046]** Similarly, to FIG. 2, in the uppermost part of FIG. 3 it is depicted the step 4000 of the method for compacting waste shown in FIG. 1 wherein the volume of waste is sensed using at least one sensor 40. In this case, the volume of waste exceeds the predetermined threshold and therefore it is determined in step 5000 that the second compacting cycle of the group of available compacting cycles is to be performed.

**[0047]** Once the step 6000 of executing the determined or selected compacting cycle begins, the first step 6110 of the second compacting cycle comprises moving the compression member 30 to an intermediate position. After the first step 6110, in the next step 6210 the compression member 30 is returned to its retracted position. Optionally, in step 6310 (not depicted) the steps 6110 and 6210 are repeated one or more times until the desired preliminary compaction is achieved. The intermediate cycles of steps 6110 and 6210 perform a preliminary compression of the waste, so that later on, in step 6410, wherein the compression member 30 is moved to its extended position, the large volume of waste originally present in the receptacle 10 can be properly compressed.

**[0048]** After the step 6410 wherein the waste has been fully compacted by moving the compression member 30 to its extended position, the optional step 6510 can be performed, in which said compression member 30 is returned to its retracted position.

**[0049]** In the second compacting cycle depicted in FIG. 3, said intermediate position corresponds to 60% of the stroke of the compression member 30. In other embodiments, said intermediate position of the second compacting cycle can range, for example, between 50 to 70% of the stroke of the compression member 30.

**[0050]** It should be noted, that as described hereinabove, the intermediate position in different compacting cycles may not be the same. For example, in the exemplary embodiments shown, in the first compacting cycle the intermediate position corresponds to 75% of the stroke of the compression member 30, whereas in the second compacting cycle the intermediate position corresponds to 60% of the stroke of the compression member 30.

**[0051]** FIG. 4 shows an enlarged perspective view of an exemplary embodiment of a vehicle according to the present invention. FIG. 5 shows a detail view of the vehicle shown in FIG. 4. The vehicle 100 comprises an apparatus 1 according to the present invention. In this exemplary embodiment, the apparatus 1 comprises a receptacle 10 having a loading area 11 for receiving waste, a loading unit 20 for loading waste on said loading area 11, a compression member 30 (not shown, see for example, FIGS. 2 and 3) for compacting waste on said receptacle 10, at least one sensor 40 for sensing a volume of waste in the receptacle 10 and a computer unit (not shown) operatively connected to the at least one sensor 40 and to the compression member 30, said computer unit being configured to execute a method for compacting waste according to the present invention.

**[0052]** As can be seen, in the exemplary embodiment shown the loading unit 20 comprises a crane for handling waste containers. However, in other embodiments the loading unit 20 can be a side loading unit or a back loading unit, for example.

**[0053]** In the exemplary embodiment shown, the compression member 30 is a horizontal hydraulic press. However, in other embodiments said compression member 30 can be for example, a vertical or a diagonal press.

**[0054]** The exemplary embodiment shown comprises one ultrasound sensor 40 centred on the receptacle 10 and oriented to the loading area 11. Other embodiments, for example, can comprise two ultrasound sensors 40 arranged on opposite corners of the receptacle 10 in order to ensure that the whole volume of the receptacle 10, and in particular, of the loading area 11, can be monitored.

**[0055]** It is also possible that other embodiments of the present invention comprise other kind of sensors 40, as for example a video camera, a LIDAR, a laser sensor, etc. More than one kind of sensors 40 can also be use even combined operationally in a single embodiment.

**[0056]** Although the use of a truck as a vehicle 100 comprising an apparatus 1 is preferred, said vehicle can also be, for example, a train or a boat.

**[0057]** It will be understood that various parts of one embodiment of the invention can be freely combined with parts described in other embodiments, even being said combination not explicitly described, provided that such combination is within the scope of the claims and that there is no harm in such combination.

## Claims

1. Method for compacting waste comprising the steps of:

   - providing (1000) a receptacle (10) having a loading area (11) for receiving waste;
   - performing (2000) at least a first loading of waste through said loading area (11) into said receptacle (10);
   - providing (3000) a compression member (30) for compacting the waste inside said receptacle (10), said compression member (30) being configured to execute a compacting cycle selected from a group of pre-defined available compacting cycles, in which said compression member (30) is movable between a retracted position, an extended position and an intermediate position;
   - sensing (4000) a volume of waste loaded in the receptacle after said at least first loading of waste, with at least one sensor (40);
   - determining (5000) by a computer unit a compacting cycle from said group of pre-defined available compacting cycles based on the sensed volume of waste; and
   - executing (6000) said compacting cycle with the compression member (30).

2. Method, according to claim 1, wherein the step of determining (5000) the compacting cycle comprises at least the steps of:

   - determining whether the sensed volume of waste exceeds a predetermined threshold; and
   - determining a first compacting cycle selected from said group of pre-defined available compacting cycles if the sensed volume is equal or lower than said predetermined threshold or a second compacting cycle selected from the group of pre-defined available compacting cycles if the sensed volume of waste is greater than said predetermined threshold.

3. Method, according to claim 2, wherein said predetermined threshold is between 30 and 60% of the volume of said receptacle (10) having a loading area (11) for receiving waste.

4. Method, according to claim 3, wherein said predetermined threshold is between 35 and 50% of the volume of said receptacle (10).

5. Method, according to claim 4, wherein said predetermined threshold is 40% of the volume of said receptacle (10).

6. Method, according to any one of claims 2 to 5, wherein the first compacting cycle comprises the steps of:

a) moving (6100) the compression member (30) to its extended position;
b) moving (6200) the compression member (30) from its extended position to an intermediate position;
c) optionally repeating (6300) steps a) and b); and
d) optionally returning (6400) the compression member (30) to its retracted position.

7. Method, according to claim 6, wherein the intermediate position of the compression member (30) corresponds to 60 - 85% of the stroke of said compression member.

8. Method, according to claim 7, wherein the intermediate position of the compression member (30) corresponds to 75% of the stroke of said compression member.

9. Method, according to any one of claims 2 to 8, wherein the second compacting cycle comprises the steps of:

a) moving (6110) the compression member (30) to an intermediate position;
b) moving (6210) the compression member from its intermediate position to its retracted position;
c) optionally repeating (6310) steps a) and b);
d) moving (6410) the compression member to its extended position; and
e) optionally returning (6510) the compression member to its retracted position.

10. Method, according to claim 9, wherein the intermediate position of the compression member (30) corresponds to 50 - 70 % of the stroke of said compression member.

11. Method, according to claim 10, wherein the intermediate position of the compression member (30) corresponds to 60% of the stroke of said compression member.

12. Method, according to any one of claims 2 to 11, wherein said predetermined threshold depends on the type of waste and wherein the values of the type of waste and corresponding thresholds are stored in a memory of the computer unit

13. Apparatus (1) for compacting waste comprising:

- a receptacle (10) having a loading area (11) for receiving waste;
- a loading unit (20) for loading waste through said loading area (11) into said receptacle (10);
- a compression member (30) for compacting waste on said receptacle (10);
- at least one sensor (40) configured to sense a volume of waste in the receptacle (10);
- a computer unit operatively connected to the at least one sensor (40) and to the compression member (30), said computer unit being configured to execute a method for compacting waste according to any one of claims 1 to 12.

14. Apparatus (1), according to claim 13, wherein said at least one sensor (40) comprises at least one of: an ultrasound sensor, a video camera, a laser or a LIDAR.

15. Vehicle (100) comprising an apparatus (1) according to claim 13 or 14.

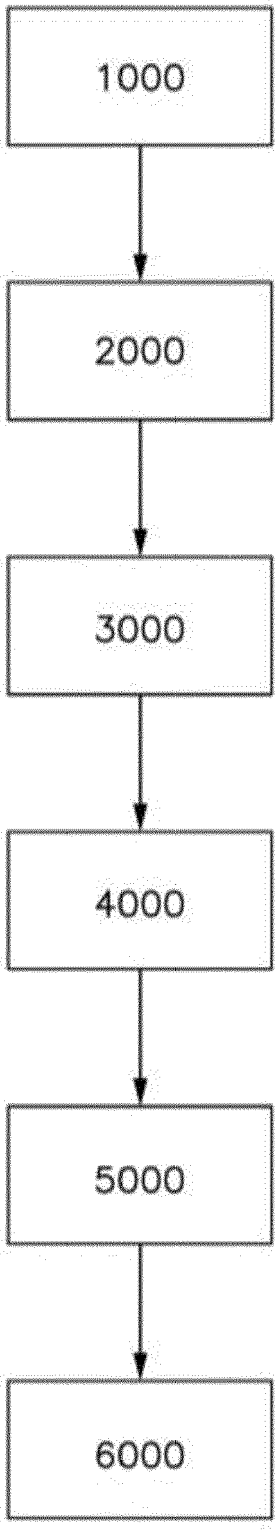


Fig. 1

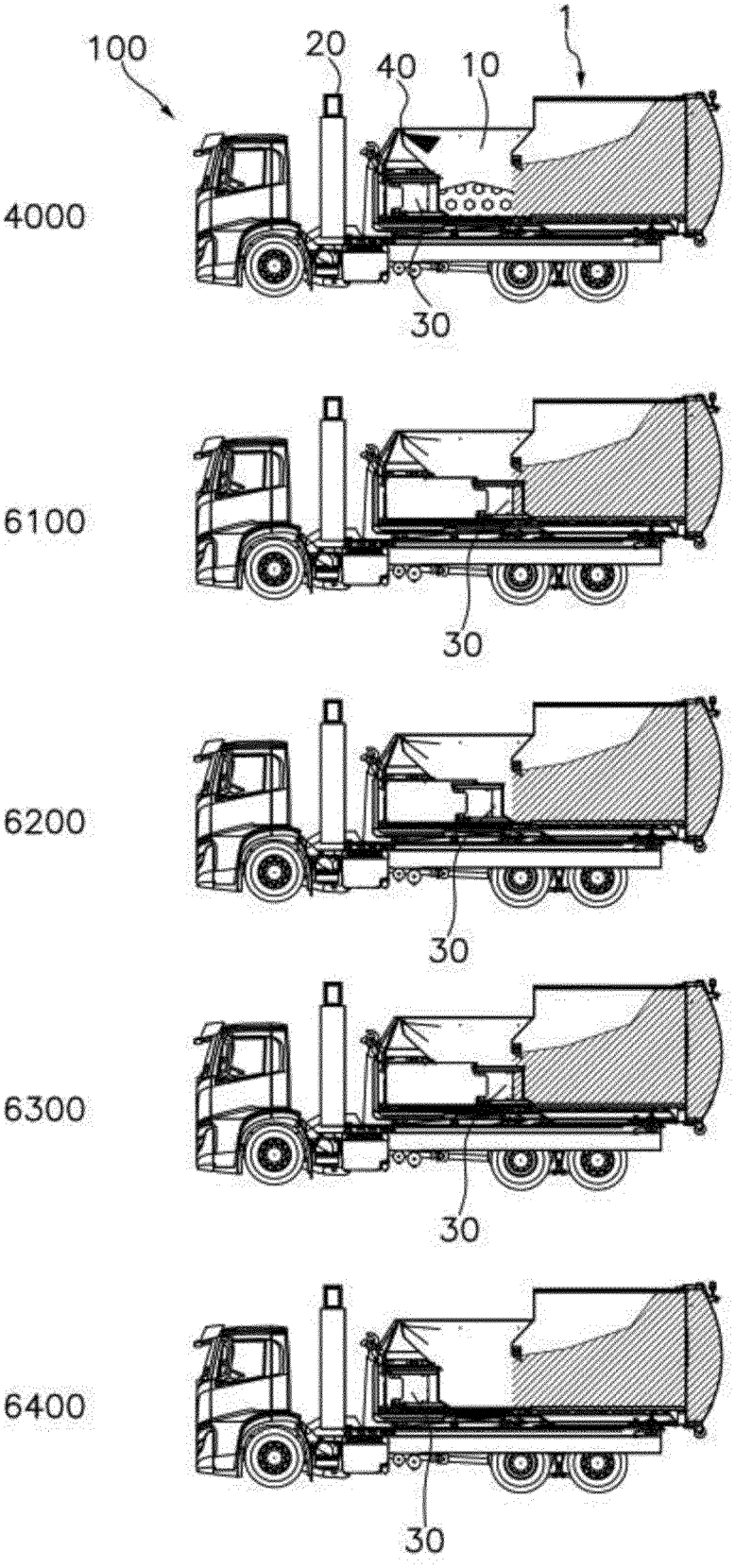


Fig.2

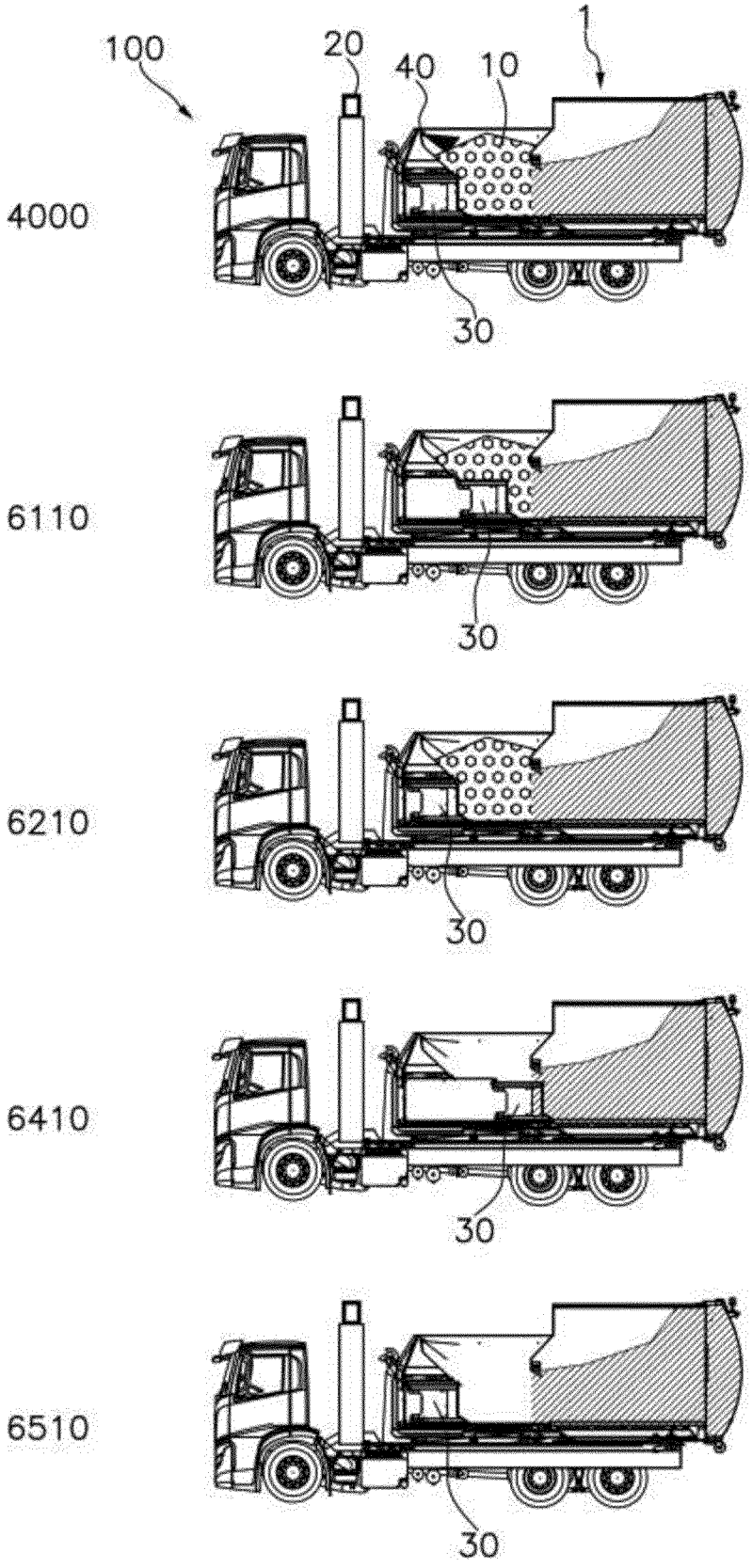


Fig.3

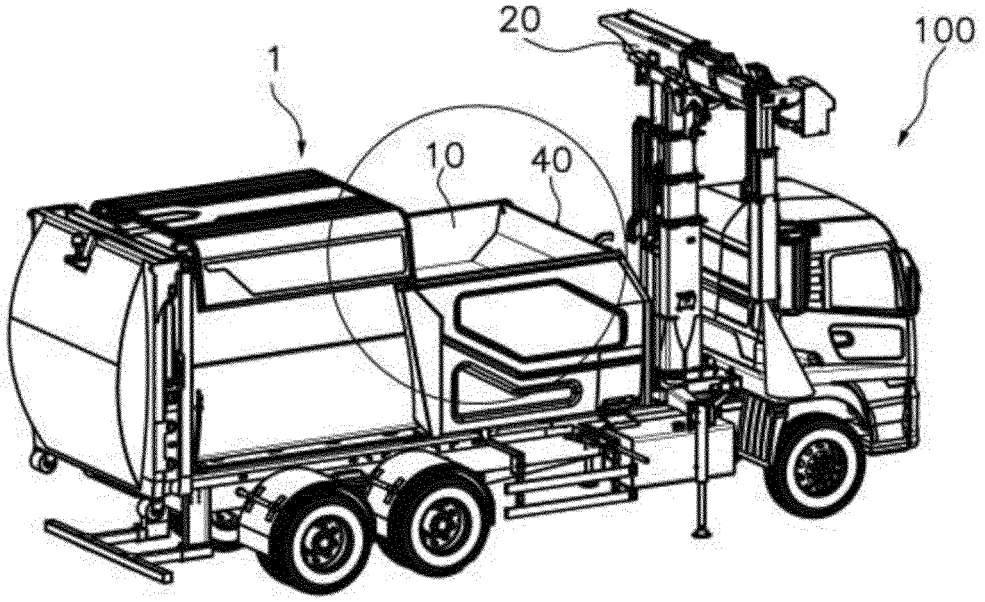


Fig.4

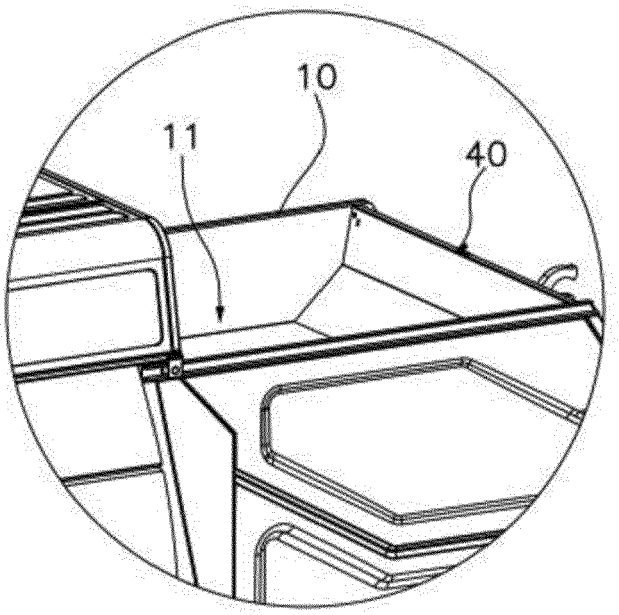


Fig.5

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# EUROPEAN SEARCH REPORT

Application Number
EP 22 38 2213

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | EP 3 483 092 A1 (DENNIS EAGLE LTD [GB]) 15 May 2019 (2019-05-15) * paragraphs [0001], [0007], [0008], [0012], [0014], [0018], [0019], [0024] - [0030], [0031], [0032], [0037] - [0038]; figures 1-8 * | 1-15 | INV. B30B9/30 B65F3/00 B65F3/20 B65F3/14 |
| X | WO 02/062565 A1 (PMDS L L C [US]) 15 August 2002 (2002-08-15) * page 20 - page 25; figures 1-21 * | 1,13 | |
| A | WO 2021/176137 A1 (KAPASITY OY [FI]) 10 September 2021 (2021-09-10) * abstract; figures * | 1-15 | |
| A | EP 1 148 991 A1 (COMPACT WASTE SYSTEMS INC [CA]) 31 October 2001 (2001-10-31) * abstract; figures * | 1-15 | |
| A | US 2019/019167 A1 (CANDEL EDY [IL] ET AL) 17 January 2019 (2019-01-17) * abstract; figures * | 1-15 | TECHNICAL FIELDS SEARCHED (IPC) B30B B65F |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 19 August 2022 | Labre, Arnaud |

CATEGORY OF CITED DOCUMENTS

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