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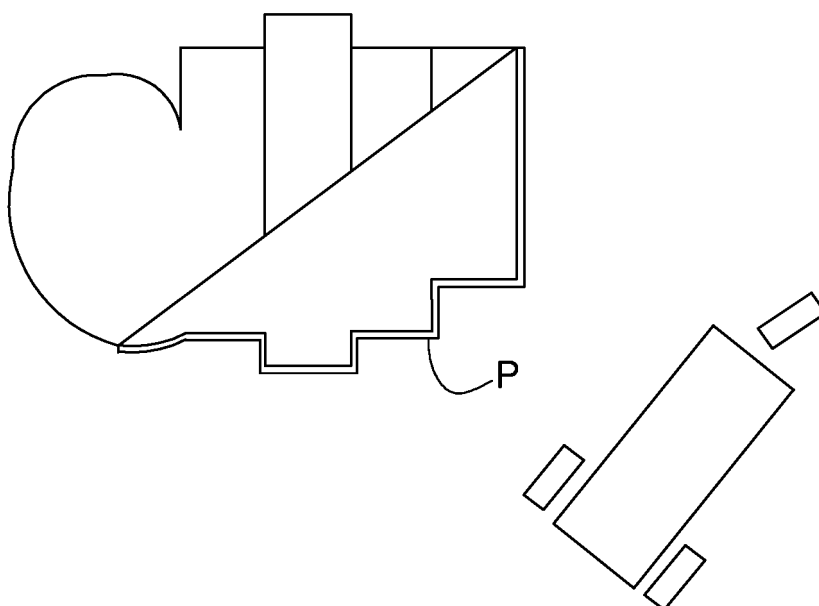
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(54) **METHOD FOR WRAPPING A LOAD WITH A FILM OF WRAPPING MATERIAL**

(57) The method for wrapping a load with a film of wrapping material provides for preparing an apparatus (2) for wrapping said load (1) with a film of wrapping material provided with at least one device for capturing three-dimensional images, in a workplace wherein at least one said load (1) to be wound is arranged. The

method provides for detecting, by means of said at least one device for capturing three-dimensional images, a cloud of points of a visible portion of said load (1) and for calculating, starting from said cloud of points, a local path that said apparatus (2) has to follow.

Fig.2



Description

Technical field

[0001] The present invention relates to an apparatus for wrapping a load with a film of wrapping material.

Prior art

[0002] In the technical sector of packaging loads including one or more products, the load is generally arranged on a support platform made up, for example, of a pallet.

[0003] Products are generally wrapped with a film of wrapping material, such as a stretchable material, to form a single, larger package. The packaging formed this way is easier to handle and transport.

[0004] The wrapping operation takes place using an apparatus, which is moved along the perimeter of the palletised products, and unroll the wrap film from a reel so as to make a packaging, following a specified number of turns made around the pallet.

[0005] A type of apparatus for wrapping products includes a guide carriage that supports a reel of wrap material rotated in order to unroll the material in the operational step. The carriage comprises handling means and a motor unit, capable of actuating the handling means to exert a propelling force on the carriage. A laterally projecting arm is associated with the carriage carrying at one end a contact roller, configured to engage the profile of the products to be wrapped, producing a reaction force that causes the motor unit to follow the perimeter of the products without further turning towards them.

[0006] A drawback complained of in relation to said type of apparatus is the presence of the feeler arm, which allows the profile of the palletised products to be followed but is a significant constraint for the apparatus. An aspect to consider is that this type of apparatus does not allow wrapping a load that has an irregular shape along a direction orthogonal to the bearing plane of the load, for example a load having one or more portions projecting outwards at a height different from the one on which the feeler arm works. In this case, in fact, the feeler arm is unable to detect the protruding portion and a collision of the apparatus with the load may occur.

[0007] To overcome the problem, a type of apparatus for wrapping products has been developed that does not require the use of the feeler arm.

[0008] An example of said type of apparatus is shown in the international patent application WO 2017/025870. The patent application describes an apparatus for wrapping a load, which includes a carriage, associated with guide means, and a column, mounted on the carriage, which carries a reel of plastic material. The apparatus comprises sensor means for detecting surfaces and/or edges of the load, along a direction substantially orthogonal to the plane of the load, the sensor means being able to send signals to a control unit which are analysed

to define a peripheral outline of maximum overall dimensions of the load and calculate, on the basis of the outline, a wrapping path of the apparatus around the load. The method implemented by the apparatus provides for activating the sensor means to detect a surface and/or an external edge closest to the apparatus and for carrying out a detection travel around the load, at a specified distance from the load, to detect and save the surfaces and/or the edges of the load. On the basis of the data acquired by the sensor means on the surfaces and/or edges of the load, the peripheral outline of maximum overall dimensions of the load and the wrapping path around the load is calculated. An algorithm used for processing the data acquired by the sensor means in order to extrapolate the peripheral outline of maximum dimension occupied by the load is the SLAM (Simultaneous Localization And Mapping) algorithm.

[0009] A disadvantage of the developed wrapping method is the increase of the time required to carry out the wrapping, considering that it is necessary to perform a detection travel around the load in order to be able to detect the data relating to the surfaces and/or edges of the load and that the travel is generally carried out at a reduced speed compared to that used to wrap the load. Furthermore, the method involves storing data relating to the surfaces and/or edges of the load, as well as calculating a wrapping path, with a consequent need to store a significant amount of data in the control unit.

[0010] A further problem complained of is that the SLAM algorithm introduces an uncertainty in the reconstruction of the shape of the load and, therefore, the possibility that collisions of the apparatus with the load may occur during operation remains.

[0011] Finally, a further problem is related to the management of the variability of the load, which can occur both as a result of the wrapping operation and in the case of a dynamic loading of the pallet. In the first case, the application of the film of wrapping material causes a change in the shape of the load, especially in the case of load having a complex shape, for example with recesses that can be hidden by the applied film. In the second case, the addition of products during the wrapping step changes the shape of the load, which therefore has a variable shape over time.

[0012] Therefore, the need is felt to devise a method that allows more quick and safe wrapping of a load.

Disclosure

[0013] The aim of the present invention is solving the aforementioned problems, devising a method that allows a load to be wrapped with a film of wrapping material in a safe and reliable manner.

[0014] It is a further object of the present invention to provide a method for wrapping a load with a film of wrapping material that allows wrapping of a load having a shape that changes over time.

[0015] Still further object of the present invention is to

provide a method that allows wrapping of a load in an optimal way regardless of the shape of the load.

[0016] Another object of the invention is to provide a method for wrapping a load with a film of wrapping material, which is easy to carry out.

[0017] The aforementioned objects are achieved, according to the present invention, by the method for wrapping a load, comprising one or more products, with a film of wrapping material as in claim 1.

[0018] The method provides for preparing, in a working environment in which at least one load to be wrapped is arranged, an apparatus for wrapping said load equipped with at least one device for capturing three-dimensional images.

[0019] Then, a cloud of points of a portion of said load, visible in the visual field of said at least one device for capturing three-dimensional images is detected, by means of said at least one device for capturing three-dimensional images.

[0020] The method then provides for performing a projection of said cloud of points on a reference plane, substantially parallel to the plane of said load.

[0021] Preferably, said plane of lying of said load is substantially horizontal.

[0022] The method comprises the step of processing, on the basis of said cloud of points projected on said reference plane, a path around said visible portion of said load and of moving said apparatus around said visible portion of said load according to said path.

[0023] Simultaneously with the step of moving said apparatus, the method provides for wrapping said film of wrapping material around said load.

[0024] The method provides for repeating the aforementioned steps, moment by moment, for further portions of said load visible in said visual field of said at least one device for capturing three-dimensional images.

[0025] According to an aspect of the invention, the steps of detecting a cloud of points of the visible portion of said load, of carrying out a projection of the points on said reference plane, of calculating a path and of moving said apparatus along said path, wrapping the load, are repeated continuously until said load is completely wrapped.

[0026] Preferably, said load comprises one or more products, arranged on a support platform, for example on a pallet. It is possible to provide for further products to be loaded on the pallet during the step of wrapping the load.

[0027] In this case, said steps are preferably interrupted when the loading of further products is carried out and are performed again when the loading of said further products is completed.

[0028] Preferably, the interruption and resumption of said steps for wrapping said load are repeated for further cycles of loading products, until the complete wrapping of said load.

[0029] The method according to the present invention allows the calculation of a local path, that is a path that

the apparatus must follow in order to move safely around the portion of the load visible in the visual field of at least one device for capturing three-dimensional images at a predetermined instant. The method therefore allows the wrapping around the load in a safe and reliable way since the handling of the apparatus takes place based on the information on successive visible portions of the load, and this means that any variations in the shape of the load that can occur are considered.

[0030] Advantageously, said method does not provide for reconstructing edges and/or surfaces of said load on the basis of said cloud of points of a visible portion.

[0031] Preferably, said method does not comprise the step of calculating a three-dimensional model of said load.

[0032] Preferably, said local path calculated at a predetermined moment of time is overwritten with a local path calculated at a previous instant. Therefore, the method is easy to implement as it does not need to store data relating to a global path that the equipment must follow around the load.

[0033] Preferably, said step of calculating, on the basis of said cloud of points, projected on said reference plane, a path to be followed around said visible portion of said load comprises the step of calculating a polygonal line that delimits a region comprising said cloud of points projected onto said reference plane, positioning said polygonal line at a predetermined distance from said visible portion of said load and calculating a curved peripheral outline which delimits a region comprising said polygonal line.

[0034] Preferably, said path is calculated starting from said curved peripheral outline. Basically, the method allows wrapping a load of any shape, regular or irregular, as it does not need to reconstruct the edges and/or surfaces or a three-dimensional model, but is based on the construction of a local path, moment by moment, based on the curved peripheral outline obtained from the detected cloud of points.

[0035] Preferably, said predetermined distance is a safety distance to be maintained between said apparatus and said load to be wrapped.

[0036] Preferably, said curved peripheral outline has at least one point in common with said polygonal line.

[0037] Preferably, each point of said curved peripheral outline is spaced from said relative visible portion of said load by a value equal to at least the value of said predetermined distance.

[0038] According to an aspect of the invention, the method provides, at the beginning of each wrapping cycle, before said step of detecting, by means of said at least one device for capturing three-dimensional images, a cloud of points of a portion of said load visible in the visual field of said at least one device for capturing three-dimensional images, the step of attaching said film of wrapping material to said load, in automatic manner.

[0039] Preferably, said step of automatically attaching said film of wrapping material to said load comprises, first

of all, the step of detecting said load to be wrapped in the visual field of said at least one device for capturing three-dimensional images.

[0040] Preferably, following said step of detecting said load, the method provides for calculating an optimal initial position for coupling said film of wrapping material to said load and for moving said apparatus up to said initial position so as to automatically attach said film to said load.

[0041] Preferably, said step of automatically attaching said film to said load is carried out by means of a coupling device.

[0042] Preferably, at the end of said step of automatically attaching said film of wrapping material to said load, said coupling device is taken to be used for wrapping a further load 1.

[0043] According to an aspect of the invention, said method comprises the step of automatically identifying the loads to be wrapped in a work environment.

[0044] More specifically, the method involves preparing said apparatus equipped with at least one device for capturing three-dimensional images in a work environment and activating said at least one device for capturing three-dimensional images.

[0045] The method then includes the step of checking whether at least one load is present in the visual field of said at least one capturing for acquiring three-dimensional images.

[0046] In the event that no load is detected in the visual field of said at least one device for capturing three-dimensional images, the method provides for carrying out checks in the working environment surrounding said apparatus, in particular in the regions still not checked up by said device for capturing three-dimensional images.

[0047] Preferably, said step of carrying out checks in the working environment surrounding said apparatus provides for performing a rotation of said at least one device for capturing three-dimensional images around a relative axis of rotation or of said apparatus around a relative axis of rotation.

[0048] Preferably, said apparatus is rotated around said preferably longitudinal axis of rotation, through a predetermined angle.

[0049] Preferably said angle is less than or equal to 360 °.

[0050] Preferably said angle is substantially equal to 360 °.

[0051] In the event that, following a first check in the visual field of said at least one device or, following said further check in the working environment surrounding the apparatus that has not yet been checked up by the device, a series of loads, the load placed closest to said apparatus and/or the most easily reachable load is selected.

[0052] Preferably, the method provides for moving said apparatus to a position next to said selected load.

[0053] Preferably, at said optimal position, at least a portion of said load is visible from said device for capturing three-dimensional images.

[0054] Advantageously, the method comprises the step of reading an identifying device associated with said load.

5 **[0055]** Preferably, then, the checking is carried out that said identified load is present in a predefined list of activities to be performed.

10 **[0056]** Preferably, the method provides, finally, for detecting said identified load to be wrapped in the visual field of said at least one device for capturing three-dimensional images and for carrying out said steps for wrapping said load.

Description of drawings

15 **[0057]** The details of the invention will become more evident from the detailed description of a preferred embodiment of the method for wrapping a load with a film of wrapping material, shown for illustrative purposes in the accompanying drawings, wherein:

Figures 1 - 4 show consecutive steps of the method object of the invention;

Figures 1a - 4a show the same steps illustrated in the corresponding Figures 1-4 in successive instants.

Best mode

30 **[0058]** Figures 1-4 schematically show a sequence of steps of the method object of the present invention while Figures 1a-4a show the same sequence of steps at a next instant.

35 **[0059]** The method for wrapping a load with a film of wrapping material provides for preparing, in a working environment wherein at least one load 1 to be wrapped is arranged, an apparatus 2 for wrapping the load 1 with a film of wrapping material provided with at least one device for capturing three-dimensional images, not shown in the figures.

40 **[0060]** The load 1 may comprise a single product or a group of products, preferably arranged on a pallet or on a series of stacked pallets.

[0061] The wrapping material may be a stretchable material, for example a plastic material.

45 **[0062]** The device for capturing three-dimensional images includes a time-of-flight camera, a stereo camera or a stereo camera with projector. Alternatively, said device may comprise a series of sound wave emitting sensors and corresponding receiving sensors or it may be based on the technology called Lidar (Laser Imaging Detection and Ranging).

[0063] Alternatively, the device for capturing three-dimensional images can include a "smart camera" or a "mono camera".

55 **[0064]** It is possible to provide that the apparatus is equipped with one or more devices for capturing three-dimensional images.

[0065] The apparatus 2 is set up in the working envi-

ronment where the load 1 is positioned so that the latter is visible, at least for a portion, from the device for capturing three-dimensional images.

[0066] The method provides for detecting, using at least one device for capturing three-dimensional images, a cloud of points of a portion of the load 1 visible in the visual field V of the device for capturing three-dimensional images.

[0067] After, a projection of the cloud of points is carried out on a reference plane, parallel to a plane of lying of the load 1, which is substantially horizontal.

[0068] On the basis of the cloud of points projected on the reference plane, a path to follow around the visible portion of the load 1 is calculated. In practice, a path that the apparatus 2 must follow around the visible portion of the load 1 is calculated, avoiding collisions from occurring.

[0069] The calculated path is local or is related to the portion of the load 1 visible in the visual field V of the device for capturing three-dimensional images.

[0070] The path calculated at a predetermined instant t is overwritten to the path calculated at a previous instant t-1 in order to guide, instant by instant, the apparatus around load 1.

[0071] The method does not reconstruct surfaces and/or edges of the load 1, starting from the detected cloud of points, but the detected data relating to the visible portion of the load 1 are used to estimate a local path.

[0072] More specifically, the step of elaborating a path involves calculating a polygonal line P which delimits a region comprising the cloud of points projected on the reference plane (see Figure 2 and Figure 2a) and of positioning the polygonal line P at a predetermined distance d_0 from the visible portion of the load 1 (see Figure 3 and Figure 3a). This distance d_0 is the safety distance to be established between the apparatus 2 and the load 1 to be wrapped.

[0073] Finally, a curved peripheral outline C is calculated, which delimits a region comprising the polygonal line P (see Figure 4 and Figure 4a).

[0074] Preferably, the curved peripheral contour C comprises at least one point in common with the polygonal line P and each point of the curved peripheral outline is spaced from the relative visible portion of the load 1 by a value at least equal to the value of the predetermined distance d_0 .

[0075] The local path is therefore established considering the curved peripheral outline C obtained in such a way as to ensure safe movement of the apparatus around the corresponding portion of the load 1.

[0076] The method provides, following the elaboration of the path, for moving the apparatus 2 around the visible portion of the load 1 following the elaborated path.

[0077] At the same time, the film of wrapping material is wrapped around the load 1.

[0078] The method provides for repeating, moment by moment, the previously described steps of detecting a cloud of points of the visible portion of the load 1, of carrying out a projection of the points on the reference plane,

of calculating a path and of moving the apparatus 2 according to the path and of wrapping the load 1 with the film of wrapping material.

[0079] According to an embodiment, the aforementioned steps are repeated, instant by instant, continuously until the load 1 is completely wound.

[0080] Alternatively, the aforementioned steps are interrupted to allow one or more additional products to be loaded on the pallet on which the load 1 is arranged and are resumed once the product loading is complete.

[0081] It is possible to provide that the interruption of the aforementioned phases and the execution of the phases are repeated for further product loading cycles, until the load 1 is completely wrapped.

[0082] In this way, it is possible to carry out the wrapping of the load 1 in a discontinuous way, stopping, if necessary, the steps of detecting a cloud of points of the visible portion of the load 1, of carrying out a projection of the points on the reference plane, of calculating a path and of moving the apparatus 2 according to the path, wrapping the load. These steps are carried out again every time a cycle of loading the products onto the pallet has ended.

[0083] The method also provides, during the wrapping of the film around the load 1, for detecting obstacles that are unrelated to the load 1. Obstacles may be men or objects.

[0084] Following the obstacle detection, an error signal is sent to a control unit of the apparatus 2 and, if necessary, the apparatus 2 is stopped in order to avoid collisions.

[0085] According to an embodiment, the method provides, at the beginning of each wrapping cycle, before the step of detecting a cloud of points of a portion of the load 1 visible in the visual field V of the device for capturing three-dimensional images, for the step of attaching a film of wrapping material to the load 1 automatically.

[0086] More in detail, the method involves detecting a load 1 to be wrapped in the visual field V of the device for capturing three-dimensional images and calculating an optimal initial position for attaching the film of wrapping material to the load 1.

[0087] The apparatus 2 is then moved to reach the calculated optimal position and, finally, the film of wrapping material is automatically attached to the load 1 by means of a coupling device, not shown in the figures.

[0088] The aforementioned steps of detecting a cloud of points of the visible portion of the load 1, of carrying out a projection of the points on the reference plane, of calculating a path and moving the apparatus 2 according to the path, wrapping the load 1 the film of wrapping material, are then performed.

[0089] At the end of the wrapping of the load 1, the method also provides for removing the coupling device to use it for wrapping an additional load 1.

[0090] According to a further embodiment, the method provides for automatically detecting the loads to be

wrapped 1 in a working environment.

[0091] Initially, an apparatus 2 for wrapping, equipped with at least one device for capturing three-dimensional images is prepared in a working environment.

[0092] The method provides for activating the device for capturing three-dimensional images and checking if, in the visual field V of at least one device for acquiring three-dimensional images, there is at least one load 1 is.

[0093] In the event that no loads 1 are detected in the visual field V, a rotation of at least one device for capturing three-dimensional images or of the apparatus 2 is carried out to explore the surrounding environment. For example, the apparatus is rotated around an axis of rotation by an angle less than or equal to 360 °.

[0094] Preferably the rotation angle is substantially equal to 360 °.

[0095] Preferably the rotation axis is a longitudinal axis.

[0096] In the event that a series of loads 1 is detected in the working area, the load 1 to be wrapped closest to the apparatus 2 and/or more easily accessible is selected and the apparatus 2 is moved towards the selected load 1.

[0097] More specifically, the apparatus 2 is moved to a position near the selected load 1, where at least a portion of the load 1 is visible from the device.

[0098] Subsequently, the method provides for reading an identifying device associated with the load 1, for example an identification code, to identify the load 1.

[0099] Preferably, the method also provides for checking that the identified load 1 is present in a list of predetermined activities to be performed.

[0100] The method then provides for detecting the load 1 to be wrapped in the visual field V of the device for capturing three-dimensional images and performing the previously described steps for wrapping the load.

[0101] Once the wrapping of the selected load 1 has been completed, the steps of detecting a further load 1 to be wrapped in the working environment are repeated, of moving the apparatus 2 to reach the additional selected load 1 and positioning thereof so that it is displayed from the device for capturing three-dimensional images at least a part of the load 1 and of performing the wrapping steps.

[0102] These steps are repeated for all loads 1 identified in the list of activities to be carried out.

[0103] In the practical embodiment of the invention, the materials used, as well as the shape and dimensions may be modified according to the needs.

[0104] Should the technical features mentioned in any claim be followed by reference signs, such reference signs were included strictly with the aim of enhancing the understanding of the claims and hence they shall not be deemed restrictive in any manner whatsoever on the scope of each element identified for exemplifying purposes by such reference signs.

Claims

1. A method for wrapping a load, comprising one or more products, with a film of wrapping material, said method comprising the following steps:

- a. preparing an apparatus (2) for wrapping said load (1) with a film of wrapping material provided with at least one device for capturing three-dimensional images, in a workplace wherein at least one said load (1) to be wound is arranged;
- b. detecting, by means of said at least one device for capturing three-dimensional images, a cloud of points of a portion of said load (1), visible in the visual field (V) of said at least one device for capturing three-dimensional images;
- c. making a projection of said cloud of points on a reference plane, substantially parallel to a lying plane of said load (1);
- d. calculating a path, based on said cloud of points projected onto said reference plane, around said visible portion of said load (1);
- e. moving said apparatus (2) around said visible portion of said load (1) according to said path and simultaneously,
- f. wrapping said film of wrapping material around said load (1);
- g. repeating, instant by instant, said steps (b.-f.) for successive portions of said load (1) visible in said visual field (V) of said at least one device for capturing three-dimensional images.

2. A method as in claim 1, **characterised in that** said step (d.) of calculating a path based on said cloud of points projected onto said reference plane, around said visible portion of said load (1) includes further steps of:

- d1. calculating a polygonal line (P) which delimits a region comprising said cloud of points projected on said reference plane;
- d2. positioning said polygonal line (P) at a specific distance (d_0) from said visible portion of said load (1);
- d3. calculating a curved peripheral outline (C) which delimits a region comprising said polygonal line, said path being calculated starting from said curved peripheral outline (C).

3. A method according to claim 2, **characterised in that** said curved peripheral outline (C) has at least one common point with said polygonal line (P), each point of said curved peripheral outline (C) being spaced from said relative visible portion of said load (1) of a value equal to at least the value of said specific distance (d_0).

4. A method as in claim 1, 2 or 3, **characterised in that**

said path calculated to move said apparatus (2) around said visible portion of said load (1) at an instant (t) is overwritten to a path calculated at a previous instant (t-1) relating to a portion of said load (1) visible in the visual field (V) of said device for capturing three-dimensional images at said previous instant (t-1). 5

5. A method as in one of the preceding claims, **characterised in that** it provides, at the beginning of each wrapping cycle, before said step (b.) of detecting, by means of said at least one device for capturing three-dimensional images, a cloud of points of a portion of said load (1) visible in the visual field (V) of said at least one device for capturing three-dimensional images, the step (a0.) of automatically attaching said film of wrapping material to said load (1). 10 15

6. A method according to claim 5, **characterised in that** said step (a0.) of automatically attaching said film of wrapping material to said load (1) includes the following steps: 20

- a1. detecting said load (1) to be wound in the visual field (V) of said at least one device for capturing three-dimensional images; 25
- a2. calculating an initial optimal position for attaching said film of wrapping material to said load (1);
- a3. moving said apparatus (2) up to said initial position and automatically attaching said film of wrapping material to said load (1). 30

7. A method as in any one of the preceding claims, **characterised in that** said step (g.) of repeating, instant by instant, said steps (b.-f.) for successive portions of said load (1) visible in said visual field (V) of said at least one device for capturing three-dimensional images is carried out continuously until said wrapping of said film of wrapping material around said load (1) is completed. 35 40

8. A method as in any one of claims 1-6, **characterised in that** said step (g.) of repeating, instant by instant, said steps (b.-f.) for successive portions of said load (1) visible in said visual field (V) of said at least one device for capturing three-dimensional images is interrupted when the loading of further products is performed and is performed again when the loading of said further products is finished. 45 50

9. A method as in the claim 8, **characterised in that** said steps of interrupting of carrying out said step (g.) in order to load further products and of resuming carrying out said step (g.), once the loading of said further products is finished, are repeated for successive cycles of loading of products, until the wrapping of said load (1) is completed. 55

Fig.1a

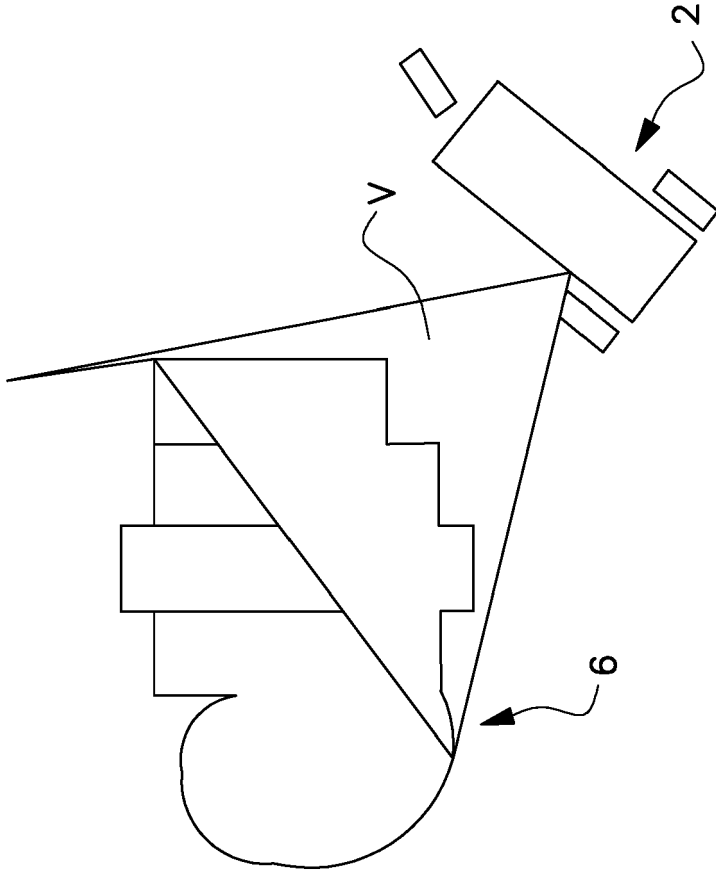
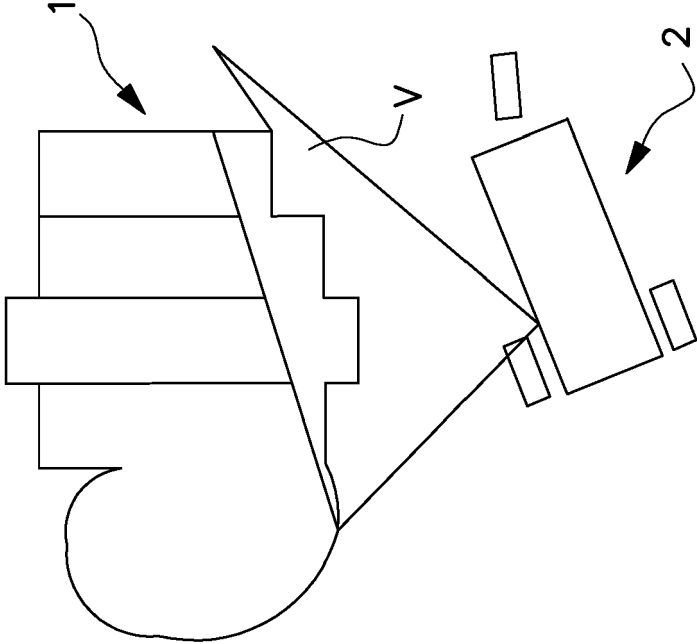


Fig.1

Fig.2a

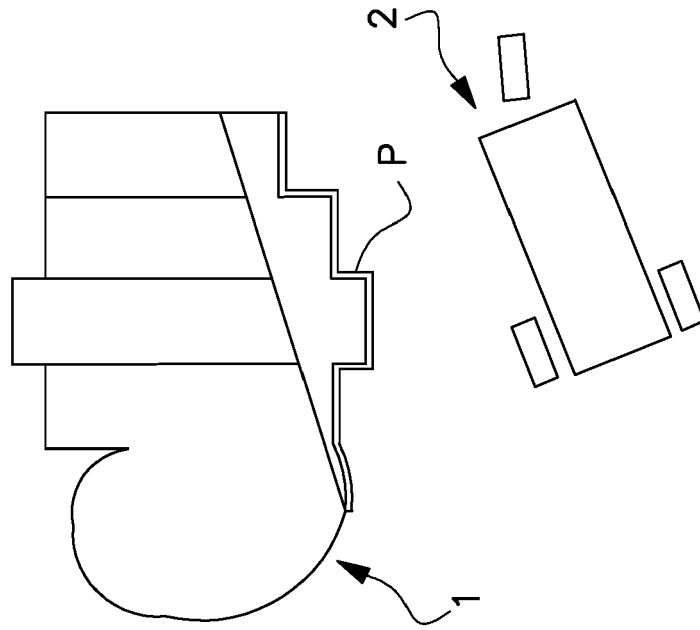


Fig.2

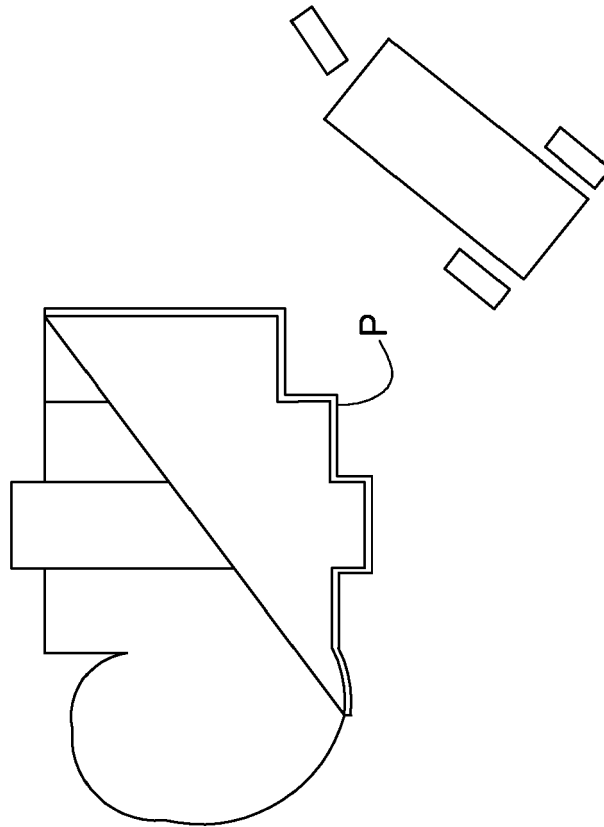


Fig.3a

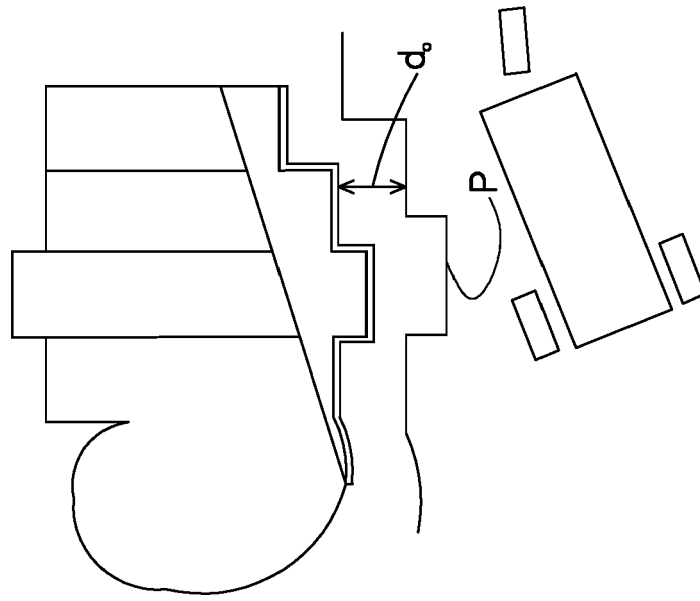


Fig.3

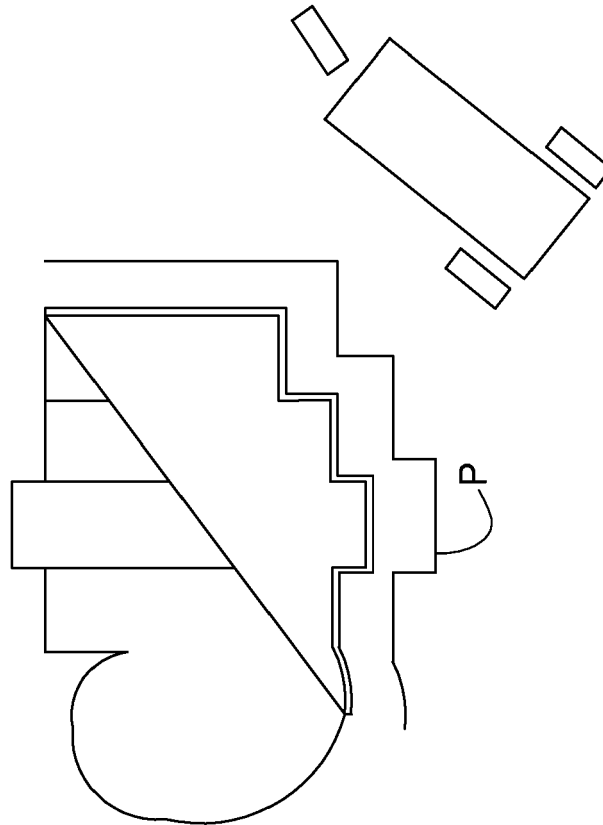


Fig.4a

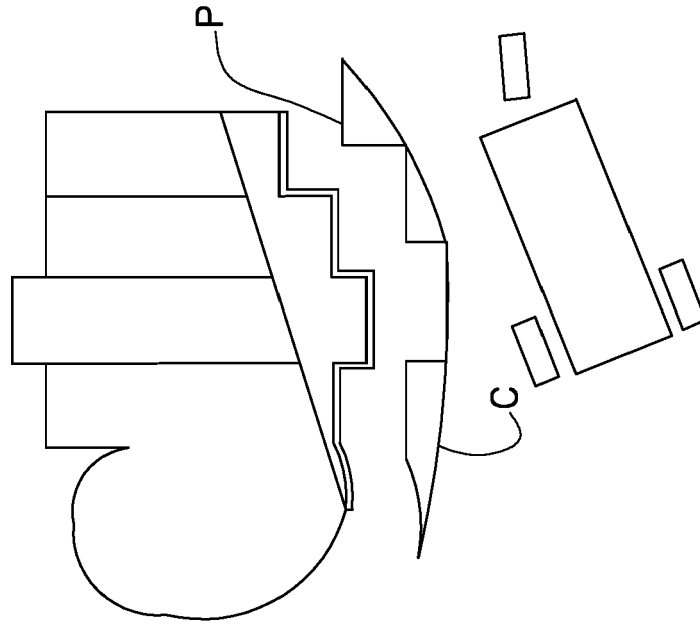
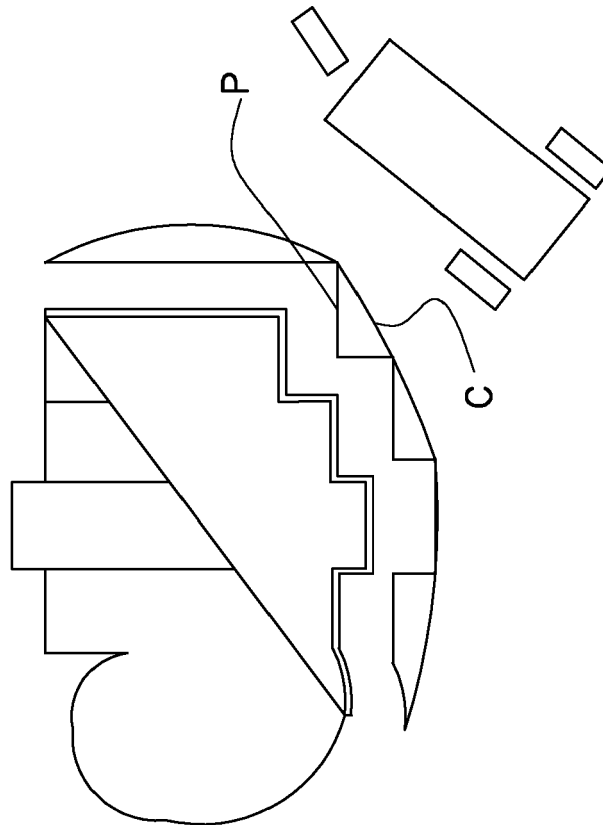


Fig.4





EUROPEAN SEARCH REPORT

Application Number
EP 21 15 3066

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2019/002138 A1 (LAGHI PIERANGELO [IT]) 3 January 2019 (2019-01-03) * Figures; description of figures 1,3. * -----	1-9	INV. B65B11/02 B65B57/10
A	WO 2013/050832 A1 (ITALDIBIPACK SPA [IT]; BUTTURINI LUCIANO [IT]) 11 April 2013 (2013-04-11) * Figures and description thereof * -----	1-9	
			TECHNICAL FIELDS SEARCHED (IPC)
			B65B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 May 2021	Examiner Ngo Si Xuyen, G
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