



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**01.02.2023 Bulletin 2023/05**

(21) Application number: **22184170.3**

(22) Date of filing: **11.07.2022**

(51) International Patent Classification (IPC):  
**B65B 11/04** (2006.01) **B65B 57/12** (2006.01)  
**B65B 51/02** (2006.01) **B65B 61/02** (2006.01)  
**B65H 19/10** (2006.01) **B65B 41/16** (2006.01)  
**B65B 57/04** (2006.01)

(52) Cooperative Patent Classification (CPC):  
**B65B 11/045; B65B 41/16; B65B 51/023;**  
**B65B 57/04; B65B 57/12; B65B 61/025;**  
**B65H 19/10; B65B 2210/04**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB**  
**GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO**  
**PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**  
Designated Validation States:  
**KH MA MD TN**

(30) Priority: **09.07.2021 IT 202100018209**

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(54) **DEVICE FOR WRAPPING OBJECTS**

(57) A device (1) for wrapping stacked objects (SO) which comprises a rotating base (2) designed to support and rotate the stacked objects (SO), a wrapping head (3) mounted vertically sliding and designed to receive and conveying a film for wrapping such stacked objects (SO) supported and driven in rotation by the rotating base (2) and an electronic control unit (5) designed to control the vertical movement as a function of the rotation speed of said rotating base (2). In particular, the device (1) is designed to apply a paper film (4) around the stacked objects (SO) on the rotating base (2) for wrapping the latter.

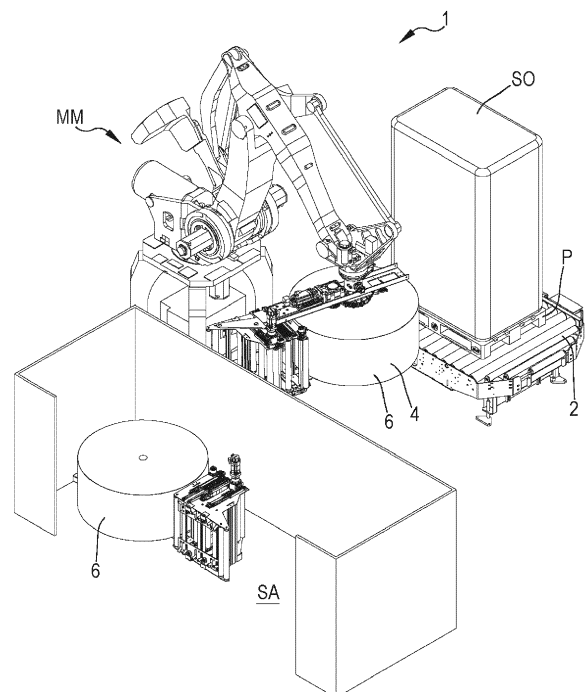


FIG.1

## Description

### TECHNICAL FIELD OF THE INVENTION

5 **[0001]** The present invention relates to a wrapping device for stacked objects. More particularly, the present invention relates to a wrapping device particularly suitable for wrapping stacked objects with a paper film.

**[0002]** Furthermore, the present invention also relates to a method for wrapping stacked objects using the aforementioned device.

### 10 STATE OF THE ART

**[0003]** In the logistics sector, various types of wrapping devices for stacked objects are known. These devices typically use extensible, heat-shrinkable, heat-sealable films or similar made of plastic material, such as for example polyethylene (PE), polyethylene terephthalate (PET), polypropylene (PP), mixtures of such materials, etc.

15 **[0004]** However, these materials have an impact on the environment which, due to the continuous increase in industrial production and, consequently, also in packaging films, is progressively growing.

**[0005]** The use of eco-sustainable materials for the packaging of products, or objects in general, could therefore be able to significantly reduce the high environmental impact that this technical sector currently entails.

20 **[0006]** Moreover, the legislation of many countries around the world is gradually imposing ever heavier management burdens on plastics, with the aim of orienting all possible realities towards sustainability.

**[0007]** However, the use of eco-sustainable materials, such as paper, for example, in the context of automatic or even semi-automatic wrapping devices, poses various problems relating to the dynamics of application of the paper covering on the products or objects to be packaged.

25 **[0008]** In fact, the physical properties, for example elasticity and the possibility of extending, of the films of plastic material used for wrapping are not present in the paper films.

**[0009]** To make it possible to use wrapping devices that use eco-sustainable materials, a new design or in any case a new adaptation to the new eco-sustainable materials of the wrapping devices still known in the state of the art is necessary.

30 **[0010]** Furthermore, consider that, typically, the reels of paper to be used for the execution of the wrapping can have a very high weight, even greater than about 400 kg. For this reason, in order to be able to use these reels in wrapping devices that operate in a fully automatic way, careful design and structural construction of the device is required so that it can easily handle such heavy weights. This is not yet possible with the wrapping devices taught by the prior art since none automatically manages such high weights.

35 **[0011]** It is therefore necessary to design and manufacture a wrapping device for stacked objects which allows to overcome the disadvantages of the known art listed above.

### OBJECTS OF THE INVENTION

40 **[0012]** The main object of the present invention is to provide a wrapping device which allows to optimally apply a paper film around stacked objects.

**[0013]** A further object of the present invention is to provide a wrapping device which allows to control in an optimal way the tensioning and unwinding of the paper film on such stacked objects.

**[0014]** Another object of the present invention is to provide a wrapping device for stacked objects which allows to support and use heavy paper reels in a completely automatic way.

45 **[0015]** Still another object of the present invention is to provide a wrapping device which allows a personalization of the film to be applied to the stacked objects.

**[0016]** A further object of the present invention is to provide a wrapping device that allows the application of a strong, safe wrapping and that allows to contain the stacked objects with high stability.

50 **[0017]** In accordance with an aspect of the invention, a wrapping device for stacked objects is provided according to claim 1.

**[0018]** According to another aspect of the invention, a method of wrapping stacked objects according to claim 23 is provided.

**[0019]** The dependent claims refer to preferred and advantageous embodiments of the invention.

### 55 BRIEF DESCRIPTION OF THE DRAWINGS

**[0020]** Other features and advantages of the invention will be more evident from the description of an example of embodiment of a wrapping device illustrated by way of example in the accompanying drawings in which:

figure 1 shows a perspective view of an example of embodiment of a wrapping device according to the present invention;

figure 2 shows a side view of the wrapping head of the device of figure 1;

figure 3 shows a top view of the wrapping head of the device of figure 1;

figure 4 shows a bottom view of the wrapping head of the device of figure 1;

figure 5 shows another side view of some details of the wrapping head referred to in the previous figures;

figure 6 shows a block diagram of an example of embodiment of the wrapping device according to the present invention;

figure 7 schematically shows an example of embodiment of the possible folding means of the wrapping device according to the present invention.

**[0021]** In the accompanying drawings, identical parts or components are indicated by the same reference numbers.

#### EXAMPLES OF EMBODIMENT OF THE INVENTION

**[0022]** With reference to the attached figures, the reference number 1 indicates a wrapping device according to an example of embodiment of the present invention.

**[0023]** The wrapping device 1 is particularly suitable for wrapping or, in any case packing, loads or, more particularly, stacked objects SO. The stacked objects SO can comprise any type of load, and are preferably positioned on and supported by a pallet P. By way of example, the pallet P can have dimensions equal to about 1000 mm in length and about 1200 mm in width, or even about 1000 mm in length and approximately 800 mm in width.

**[0024]** In general, the dimensions of the pallet P can have a length of up to about 1300 mm and a width of up to about 1100 mm.

**[0025]** In any case, the wrapping device according to the present invention can be easily adaptable to any dimension of pallet P and of the load to be palletized.

**[0026]** In the following description, by way of non-limiting example, reference will be made to a wrapping head 3, included in the wrapping device 1, mounted vertically slidably for wrapping stacked objects SO on a rotating base 2, for example positioned on and supported by a pallet P.

**[0027]** The rotating base 2 rotates around a vertical or substantially vertical axis, while the wrapping head 3 mainly performs vertical or substantially vertical movements.

**[0028]** However, the present invention can also relate to a wrapping device 1 in which the stacked objects SO to be wrapped are locally stationary, while the wrapping head 3 is supported and driven to rotate around the aforementioned stacked objects SO locally stationary.

**[0029]** The wrapping device 1 comprises a rotating base 2 intended to support and drag the stacked objects SO in rotation, a vertically slidably mounted wrapping head 3 intended to receive and convey a film for wrapping said stacked objects SO supported and dragged in rotation from the rotating base 2 and an electronic control unit 5 intended to control the vertical movement of the wrapping head 3 as a function of the rotation speed of the rotating base 2.

**[0030]** In particular, the wrapping device 1 is intended to apply a paper film 4 around the stacked objects SO on the rotating base 2 for wrapping the latter.

**[0031]** It should be noted that the wrapping head 3, before starting the wrapping procedure of the stacked objects SO, can be moved through movement means MM, for example an anthropomorphic robotic arm, or even of another type, to be displaced easily in a wrapping start position.

**[0032]** In this regard, the wrapping head 3 can be operatively connected to an operational end of the movement means MM.

**[0033]** The wrapping device 1 preferably comprises a paper reel 6 for feeding the wrapping head 3. By way of example, the paper reel can have a diameter of between about 76 mm and about 1200 mm. As can be understood, the larger the diameter, the greater the weight of the paper reel 6. Therefore, in the case of a paper reel 6 having a diameter approximately close to about 1200 mm, the weight of the reel 6 can be even some hundreds of kilograms, for example about 460 kilograms.

**[0034]** With regard to this aspect, according to the non-limiting example of embodiment of the present invention shown in the figures, the paper reel 6 is supported, in use, from below by at least one support component or crosspiece 20 configured to support the weight of the paper reel 6 and to protect the wrapping device 1 from possible breakages and/or malfunctions of the wrapping head 3.

**[0035]** In this regard, think, for example, of the case in which the paper reel 6 has a weight of a few hundred kilograms, the support component 20 ensures adequate support of the paper reel 6 during the wrapping operating phase, and adequate protection of the wrapping device 1 from breakage and/or accidental malfunctions that could compromise the correct functionality of the device 1 itself as well as the safety of the operating environment.

**[0036]** Moreover, according to the non-limiting example of embodiment of the present invention shown in the figures,

the wrapping head 3 also comprises an impediment component 21 operatively associated with the paper reel 6 and configured to prevent accidental unwinding of the latter.

**[0037]** This impediment component 21 can advantageously comprise a central portion 21a and one or more perimeter or petal portions 21b, for example four perimeter or petal portions 21b, which radially branch outwards from the central portion 21a.

**[0038]** Preferably, the lying plane of the central portion 21a is aligned with that of the one or more perimeter or petal portions 21b so that this impediment component 21 rests or, in any case, is in contact without interruption of continuity with the bottom or, in use, lower portion of the paper reel 6.

**[0039]** Therefore, the wrapping device 1 must be able to withstand, from the mechanical point of view, of inertia, etc., the movement of heavy paper reels 6, in a completely automatic way.

**[0040]** As regards the rotating base 2, it can have any shape, for example square, circular, rectangular, etc. and is capable of rotating by an angular value between about 30°/sec and about 200°/sec. Naturally, the range of angular speeds just mentioned refers to an average angular speed of the rotating base 2, since, as can be understood, the latter initially starts at a standstill.

**[0041]** The aforementioned angular value can be set a priori, for example through a suitable software program for controlling the settings of the wrapping device 1, according to different application needs, for example a certain number of stacked objects SO to be wrapped in a certain interval of time, or also based on the need to maintain the stability of the load to be palletized.

**[0042]** In order for the electronic control unit 5 to correctly manage the vertical movement of the wrapping head 3 and therefore also the unwinding of the paper film 4 around the stacked objects SO, it is appropriate to know the dimensions of the stacked objects SO and/or, in the present case where these latter are positioned on a pallet P, the dimensions of this pallet P.

**[0043]** For this reason, the wrapping device 1 can comprise verification means 13 intended to verify at the beginning and/or during wrapping the dimensions of the stacked objects SO and/or of the pallet P, so as to consequently inform the electronic control unit 5 to control the rotation of the rotating base 2 and/or the vertical movement of the wrapping head 3 according to these dimensions.

**[0044]** The verification means 13 can comprise or be, for example, at least one ultrasonic sensor intended to detect the width of the load or of the stacked objects SO and/or one or more photoelectric sensors intended to detect the length of the load or of the stacked objects SO and/or at least a first encoder intended to detect the height of the load or of the stacked objects SO. To facilitate the detection of the length of the load or of the stacked objects SO, the verification means 13 can comprise at least a second encoder intended to be used in synergy with the one or more photoelectric sensors, if provided.

**[0045]** At the beginning of the wrapping process, it is preferable that the paper film 4 or better one of its ends 4a is held close to the stacked objects SO: for this reason, the wrapping device 1 can comprise gripping means 7 intended to retain the paper film 4 near the stacked objects SO on the rotating base 2.

**[0046]** In particular, the gripping means 7 are intended to maintain the paper film 4 at least for the first wrapping round of the stacked objects SO on the rotating base 2. By way of example, such gripping means 7 can be or comprise at least one gripper including a first element and a second element mutually movable between an open position and a closed position for gripping the end 4a of the paper film 4.

**[0047]** Basically, the gripping means 7 can hold the paper film 4 or better one end 4a thereof for at least the first wrapping round, and then eventually release said end 4a which will thus remain inside the wrapping, so as not to leave any protrusion of paper film 4 from the wrapping and thus giving a pleasant aesthetic effect to the packaging, as well as optimizing its handling and duration.

**[0048]** In order to have an efficient unwinding of the paper film 4, the wrapping device 1 or more particularly the wrapping head 3 comprises at least one motor 9, for example at least one electric motor, intended to command the unwinding of the paper film 4 from the paper reel 6. In particular, according to the non-limiting example of embodiment shown in the figures, the wrapping device 1 or, more particularly, the wrapping head 3 comprises a first axial motor 9a, i.e., intended to unwind the paper film 4 at a constant speed with respect to the geometry of the stacked objects SO or, if present, with respect to the pallet P, and a second perimeter or peripheral motor 9b, i.e., intended to unwind the paper film 4 with a speed dependent on the geometry of the stacked objects SO or, if present, on the geometry of the pallet P. The unwinding of the paper reel 6 with this hybrid motorized system, i.e., with a first axial motor 9a and a second perimeter or peripheral motor 9b, allows precise control of the masses and accelerations present in the wrapping device 1.

**[0049]** More in detail, according to the exemplary and non-limiting version of the present invention shown in the figures, the at least one motor 9 acts on an unwinding element 9c of the paper reel 6 operatively associated with it so that the action of the at least one motor 9 can rotate said unwinding element 9c which, in turn, allows rotation of the paper reel 6 allowing the unwinding of the paper film 4. The unwinding element 9c can be, for example, an expansion shaft.

**[0050]** Note that with the use of a paper material for wrapping, which therefore does not possess or in any case has minimal elastic components, the management of the tensioning forces of the paper film 4 is of fundamental importance.

In order to obtain a wrapping adhered in the best possible way to the stacked objects SO to be wrapped or packaged, i.e., a wrapping that best follows the geometries of the stacked objects SO, the unwinding speed of the paper film 4 changes according to the size of the stacked objects SO, possibly depending on the dimensions of the pallet P on which the stacked objects SO are positioned and supported, and/or also depending on the rotation speed of the rotating base 2.

**[0051]** To better manage these tensioning forces, the wrapping device 1 preferably comprises tensioning means 8 of the paper film 4 near the stacked objects SO.

**[0052]** Assuming, by way of non-limiting example, that the stacked objects SO are positioned and supported by a substantially rectangular pallet P, the unwinding speed of the paper film 4 changes according to the current application point of the same on the load that is being wrapped. In fact, the unwinding speed of the film 4 can be calculated with the well-known mathematical equation (1) which relates the tangential speed  $v_T$  of a point to a generic circumference of radius  $r$ :

$$v_T = \frac{r \Delta \theta}{\Delta t} \quad (1)$$

where  $\frac{\Delta \theta}{\Delta t}$  represents the angular variation  $\Delta \theta$  traveled by the point in a given time variation  $\Delta t$ . As can be seen from equation (1) the radius  $r$  is directly proportional to the tangential speed  $v_T$  and therefore, with the same rotation speed of the rotating base 2, an increase in the radius  $r$  also follows an increase in the tangential speed  $v_T$ . Therefore, at the edges of the pallet P, the unwinding speed of the paper film 4 will be maximum while, at the midpoints of the sides of the pallet P, the unwinding speed of the paper film 4 will reach two distinct minimum values, since a substantially rectangular shaped pallet P has been assumed. If the pallet P were, for example, substantially square, there would be a maximum value at the edges of the same while a minimum value at each midpoint of its sides. As can be understood, the management of the tangential speed  $v_T$  of unwinding of the paper film 4 is of fundamental importance for the outcome of the wrapping.

**[0053]** For this purpose, the tensioning means 8 can comprise at least one actuator 8b, for example at least one adjustable-pressure pneumatic actuator, which pressure can be adjusted by means of the electronic control unit 5 according to set wrapping modes. In this regard, suitable means of connection may be provided (not shown in the figures) to put in electrical and/or electronic communication the at least one actuator 8b with the electronic control unit 5.

**[0054]** Moreover, the tensioning means 8 preferably also comprise accumulation and/or release means of the paper film 4 intended to accumulate and/or release such film according to the geometry of the stacked objects SO and/or according to the speed of the rotating base 2.

**[0055]** Assume, by way of example, that the stacked objects SO are positioned on a 1200x800 mm pallet P and that the rotating base rotates at a speed of about 135°/sec. The at least one motor 9 or more particularly the first axial motor 9a would require an average unwinding speed of the paper film 4 equal to about 1500 mm/s while the second perimeter or peripheral motor 9b would require an unwinding of the paper film 4 with speed variations from 940 mm/s to 1700 mm/s and with accelerations even up to about 2530 mm/s<sup>2</sup>.

**[0056]** In order to be able to manage these unwinding speed variations and in general the delivery variations of the paper film 4, the wrapping device 1 or, more particularly, the wrapping head 3 can use the accumulation and/or release means 8a. In particular, said accumulation and/or release means 8a can be or comprise one or more movable rollers, for example three movable rollers, which, depending on the geometry of the stacked objects SO or, if present, of the pallet P, accumulate or release the paper film 4.

**[0057]** More in detail, the movement of the accumulation and/or release means 8a, or of the one or more movable rollers, is preferably managed through at least one actuator 8b.

**[0058]** According to the non-limiting example of embodiment of the present invention shown in the figures, an adjustable-pressure pneumatic actuator 8b is operatively associated with each movable roller of the accumulation and/or release means 8a: the electronic control unit 5 can adjust the pressure of the at least one pneumatic actuator 8b to move the respective movable roller associated therewith so as to accumulate or release the paper film 4 according to the geometry of the load being wrapped.

**[0059]** In general, the greater the number of mobile rollers, the greater the sensitivity to variations in the unwinding speed of the paper film 4, however, this number cannot be infinitely increased due to both mechanical/structural and economic constraints.

**[0060]** It should be considered that, before wrapping each load of stacked objects SO the at least one motor 9 of the wrapping head 3 or, more particularly, the first axial motor 9a and the second perimeter or peripheral motor 9b, can preferably unwind or wind the paper film 4 so that the accumulation and/or release means 8a accumulate an

average quantity of paper film 4, i.e., an amount such as to be able to start wrapping the stacked objects SO with a correct tensioning of the paper film 4 itself.

**[0061]** Basically, through the electronic control unit 5 a maximum quantity of paper film 4 that can be accumulated by the accumulation and/or release means 8a can be predefined, for example about 800 mm, and before wrapping each load of stacked objects SO, the accumulation and/or release means 8a can preferably accumulate about half of the predefined quantity of paper film 4, for example 400 mm. The predefined maximum quantity of paper film 4 that can be accumulated by the accumulation and/or release means 8a is set in such a way that it is possible to wrap different geometries of stacked objects SO, if desired on pallets P of different dimensions.

**[0062]** By way of non-limiting example, considering a pallet P with dimensions of approximately 800x1200 mm, and an initial accumulation of paper film 4 equal to approximately 400 mm, the variation in the accumulation of paper film 4 during the wrapping of the pallet P, considering an average unwinding speed of the paper reel 6 equal to about 1500 mm/sec, it is between about 315 mm and about 430 mm.

**[0063]** Again, by way of non-limiting example, considering instead a pallet P of dimensions equal to about 1200x800 mm, and an initial accumulation of paper film 4 always equal to about 400 mm, the variation in the accumulation of paper film 4 during wrapping of the pallet P, considering an average unwinding speed of the paper reel 6 equal to about 1500 mm/sec, is between about 394 mm and about 511 mm. These examples show that, in both cases, the accumulation and/or release interval is very narrow compared to the maximum interval of accumulable and/or releasable paper film 4, which would theoretically be from about 0 mm to about 800 mm.

**[0064]** As can be understood, the setting of a maximum predefined value of quantity of paper film 4 that can be accumulated by the accumulation and/or release means 8a, and the consequent initial accumulation of paper film 4 of a median value with respect to the maximum predefined value, allows to optimally manage any load of any geometry of stacked objects SO to be wrapped, even considering different average unwinding speeds of the paper film 4.

**[0065]** The wrapping device 1 therefore allows to carry out a real-time control of the unwinding of the paper film 4 through an optimized management of the accumulation and/or release means 8a.

**[0066]** In order to be able to easily guide the paper film 4 unwinding from the paper reel 6 mounted on the wrapping head 3, the tensioning means 8 can comprise film guiding means 10, for example one or more idle rollers, intended to guide the paper film 4 through a certain path.

**[0067]** The unwinding of the paper film 4 is clearly managed by the at least one motor 9 and by the tensioning means 8, however, it is necessary for the electronic control unit 5 to check that the unwinding is taking place in accordance with what is established on the base of the set wrapping mode(s). For this, the wrapping device 1 can comprise at least a first encoder, operatively associated with the guiding means 10 or, more particularly, with the one or more idle rollers, in electrical and/or electronic communication with the electronic control unit 5, at least a second encoder, operatively associated with the at least one motor 9, in electrical and/or electronic communication with the electronic control unit 5 and detection means (not shown in the figures) of the position, for example at least one position sensor, of the accumulation and/or release means 8a or, more particularly, of the one or more movable rollers, also in electrical and/or electronic communication with the electronic control unit 5. Basically, the first encoder, the second encoder and the detection means can advantageously be used to detect and transmit values relating to the electrical angular position of the at least one motor 9 and the guiding means 10 and values relating to the spatial position of the accumulation and/or release means 8a. The electronic control unit 5 can then interpret these values in order to check if the wrapping operation is proceeding correctly according to set wrapping modes. In this regard, the electronic control unit 5 can check whether the at least one motor 9 is unwinding the paper film 4 at the right speed, whether the accumulation and/or release means 8a are accumulating and/or releasing the paper film 4 correctly following the geometry of the load being wrapped, etc.

**[0068]** As is known, paper has a lower breaking strength than plastic films made of extensible material. To mitigate this disadvantage, the wrapping device 1 or, more particularly, the wrapping head 3 can comprise folding means 11 of the paper film 4 so as to allow the wrapping of the stacked objects SO with folded paper film 4. Basically, the folding means 11 allow to fold, at least once, one or both flaps 4b, 4c of the paper film 4 unwinding from the paper reel 6 so as to reinforce the same during the wrapping of the stacked objects SO. By way of example, the portion of paper film 4 folded for one or both flaps 4b, 4c can be for example between about 0.5 cm and about 1.5 cm. This allows to increase the containment capacity of the wrapping and at the same time decrease the possibility of tears during the application of the same without substantially changing the covering surface.

**[0069]** Moreover, during the initial wrapping phase, in which the gripping means 7 can hold the paper film 4 or better one end 4a thereof for at least the first wrapping round, the folding of one or both flaps 4b, 4c reduces the risk that the gripping means 7 damage the paper film 4.

**[0070]** According to the exemplary and non-limiting version of the present invention shown in the figures, and with particular reference to figure 7, the folding means 11 are or comprise at least one guide element 11a, for example a suitably shaped sheet, and abutment means 11b for the paper film 4, for example one or more rotating or even fixed disks, intended to abut in at least one point of contact with the paper film 4 to carry out the folding. Basically, the paper film 4 unwinding from the wrapping head 3 is guided through the profile of the at least one guiding element 11a by means

of the abutment means 11b which allow, encountering with the paper film 4 in at least one point of contact, for example a point at a curvature of the at least one guide element 11a, the realization of the fold.

**[0071]** Furthermore, the wrapping device 1, to suitably manage the overlaps of the paper film 4 during wrapping of the stacked objects SO, can comprise tilting means 12 of the wrapping head 3 designed to tilt the wrapping head 3 at different angles depending on the processing phases. The tilting means 12 are controlled by the electronic control unit 5 so that the latter can synchronize the action of the tilting means 12 with the vertical translation of the wrapping head 3, for example on the basis of the rotation speed of the rotating base 2. It is therefore possible to customize the wrapping of the stacked objects SO, for example by providing a wrapping with more overlaps of winding for less stable loads and/or, conversely, a wrapping with fewer overlaps of winding for more stable loads.

**[0072]** A further parameter to be taken into consideration for the correct unwinding of the paper film 4 is that relating to the measurement of the diameter of the paper reel 6. In fact, the progressive decrease in the diameter of the paper reel 6 affects the tensioning means 8 since it increases the actual length of paper film 4 unwound, consequently modifying the ideal tension values.

**[0073]** It should be noted that this aspect takes on increasing importance with the increase in the dimensions of the paper reel 6 used. As it can be understood, by using, for feeding the wrapping head 3, very heavy and dimensionally very large paper reels 6, the impact of the progressive decrease in the diameter of the paper reel 6 on the tensioning of the paper film 4 impacts in increasing way on the ideal tensioning values, which must be suitably adjusted also according to this.

**[0074]** For this, the wrapping device 1 preferably comprises acquisition means 18, for example at least one optical sensor, intended to acquire the dimensions of the paper reel 6. In particular, the acquisition means 18 are in electrical and/or electronic communication with the electronic control unit 5, so as to transmit these dimensions to the latter to regulate the unwinding of the paper film 4 and prevent the breaking of the latter.

**[0075]** More in detail, the acquisition means 18 are capable of continuously acquiring the current diameter value of the paper reel 6, for example by correlating the angle traveled by the paper reel 6 set in motion by the at least one motor 9 with the linear amount of paper film 4 actually unwound. As an example, the diameter could be calculated every certain period according to the following equation (2):

$$D = \frac{L_f}{(\theta_f - \theta_o)\pi} \quad (2)$$

where D is the current diameter of the paper reel 6,  $L_f$  is the linear quantity in mm of paper film 4 unwound in the given period while  $\theta_f - \theta_o$  represents, in radians, the angular change of the paper reel 6 in the given period of time. The value of  $L_f$  can be calculated, for example, by means of the first encoder operatively associated with the guiding means 10 while the value of  $\theta_f - \theta_o$  can be calculated, for example, by means of the second encoder operatively associated with the at least one motor 9 or more in particular to the first axial motor 9a.

**[0076]** Basically, the acquisition means 18 and the verification means 13, if present, allow, by detecting and communicating certain dimensional parameters to the electronic control unit 5, to continuously implement, both individually and synergistically, retroactive controls necessary or, in any case, advantageous to optimize the tensioning and, therefore, the wrapping of the stacked objects SO and/or of the pallet P with the paper film 4, which as previously mentioned, not having an elastic component comparable to the classic plastic packaging film, requires a special adjustment of the tension.

**[0077]** Moreover, it should be considered that these retroactive controls allow a very rapid response time and adjustment of the unwinding and, therefore, of the tensioning of the paper film 4 since the electronic control unit 5 can promptly control the speed of the at least one motor 9 according to these dimensional parameters, preventing the breaking of the paper film 4.

**[0078]** At the end of the wrapping process of the stacked objects SO, it is preferable to cut the paper film 4. For this purpose, the wrapping device 1 or, more particularly, the wrapping head 3 can comprise cutting means 14 of the paper film 4 controlled by the electronic control unit 5. The cutting means 14 can comprise or be at least one blade, for example a rotating blade, if desired a circular rotating blade: during wrapping, the cutting means 14 remain in a rest position inside of a suitable housing while at the end of wrapping, in particular when it is necessary to cut the paper film 4, the same can be moved, for example through a pneumatic cylinder, from the rest position to an active cutting position to cut the film of paper 4. After the cutting has been performed, the cutting means 14 can be moved from the active cutting position to the rest position.

**[0079]** To connect the portion of paper film 4 just cut to the wrapping of the stacked objects SO, the wrapping device 1 or, more particularly, the wrapping head 3 can comprise glue or adhesive application means 15 to the paper film 4 applied to the stacked objects SO on the rotating base 2. This application means 15 are controlled by the electronic control unit 5 so as to apply the glue or adhesive in a synchronized manner with the various wrapping steps. In fact, the

application means 15 can apply glue or adhesive not only at the end of the wrapping, but also in intermediate steps thereof, to optimize the overall seal of the packaging. More specifically, the application means 15 apply glue or adhesive preferably by means of a cold gluing process, which, unlike a hot gluing process, consumes less quantities of energy, does not produce CO<sub>2</sub> and requires lower maintenance and cleaning costs.

**[0080]** The glue or adhesive application means 15 may comprise dispensing means 15a of glue or adhesive, for example one or more dispensing guns, and pick-up means (not shown in the figures), for example a pump, for picking-up the glue or adhesive from a container of glue or adhesive positioned in the vicinity of the wrapping device 1. The pick-up means are operatively connected with the dispensing means 15a, for example through suitable connection pipes, and can take and supply the glue or adhesive to the dispensing means 15a which will provide for the effective application of the same.

**[0081]** In order to better adhere the last portion of paper film 4 cut by the cutting means 14 and glued, for example to the previous wrapping layer, by the glue or adhesive application means 15, the wrapping device 1 can comprise a pressing component or device (not shown in the figures) of the paper film 4 intended to press the paper film 4 at the final phases of a wrapping. This expedient allows complete adhesion of the portion of paper film 4 cut by the cutting means 15 to the stacked objects SO on the rotating base 2, so as to limit any problems related to the so-called "out of shape" that could arise during handling and automatic storage of the load just wrapped.

**[0082]** Moreover, the wrapping device 1 or, more particularly, the wrapping head 3 can comprise printing means 17, preferably inkjet, of the paper film 4 intended to print the paper film 4. Such printing means 17 are in electrical and/or electronic communication with the electronic control unit 5 so as to print the paper film 4 in a synchronized manner with various wrapping steps. This allows to place desired graphic or written information, such as a logo or the like, in certain points of the wrapping, effectively eliminating the use of adhesive labels.

**[0083]** It should be noted that to allow both the possible electrical communication of the various components of the wrapping device 1 or more in particular of the wrapping head 3 with the electronic control unit 5 or with any other intermediate components, and the power supply of these components, an electrical connector can be provided (not shown in the figures) to which respective connection cables of the components themselves can be connected.

**[0084]** Furthermore, the wrapping device 1 can also provide for the possibility of automatically replacing a finished paper 6. For this purpose, it is possible to supply, in a storage area SA in the vicinity of the wrapping device 1, one or more spare paper reels 6. The movement means MM of the wrapping head 3 can unhook the finished paper reel 6 in the storage area SA and hook the new reel, so as to be able to resume wrapping operations quickly.

**[0085]** For this reason, in order to facilitate quick hooking and unhooking of the paper reel 6, the wrapping head 3 can comprise fast hooking and unhooking means 19.

**[0086]** A non-limiting example of operation of the wrapping device 1 according to a preferred version of the invention is described below.

**[0087]** It is assumed that stacked objects SO must be wrapped on a pallet P of dimensions equal to about 800x600 mm positioned on the rotating base 2 whose angular speed is set equal to about 100°/sec.

**[0088]** The verification means 13 controls and verifies the dimensions of the pallet P so as to consequently inform the electronic control unit 5 to control the rotation of the rotating base 2 and the vertical movement of the wrapping head 3 as a function of the dimensions of the pallet P and of the set angular speed.

**[0089]** In an initial wrapping phase, the gripping means 7 hold the end 4a of the paper film 4 close to the stacked objects SO at least for the first wrapping round.

**[0090]** The tensioning means 8 and the motors 9a, 9b allow the unwinding of the paper film 4 with the correct tensioning, so that it can adhere optimally to the geometry of the load to be wrapped.

**[0091]** The tilting means 12, if desired, can tilt the wrapping head 3, for example according to set wrapping modes, so as to allow wrapping with a greater or lesser number of overlapping wraps.

**[0092]** In the case in which it is desired to obtain an even more robust and resistant wrapping, it is possible to use the folding means 11 so as to fold, for example once, the flaps 4b, 4c of the paper film 4 to obtain a wrapping with reinforced winding.

**[0093]** During the wrapping procedure, the acquisition means 18 can acquire, every determined time interval, the measurement of the diameter of the paper reel 6 in order to better control the ideal tension values of the paper film 4.

**[0094]** Moreover, for any given number of wraps it is possible, by means of the application means 15, to apply a given amount of glue or adhesive to improve the tightness of the wrapping.

**[0095]** If desired, it is possible by means of the printing means 17 to print the paper film 4 by positioning graphic or written information at certain positions of the wrapping.

**[0096]** At the end of the wrapping process, it is possible to cut the paper film 4 by means of the cutting means 14, then to glue to the wrapping, by means of the application means 15, the cut portion of paper film 4 and finally to press, through the pressing component or device, the portion of paper film 4 just glued so as to make it adhere to the wrapping.

**[0097]** The present invention also relates to a method of wrapping stacked objects SO.

**[0098]** This method initially comprises the step of providing a wrapping device 1 and a paper film 4 to be applied



around the stacked objects SO.

[0099] Then there is the step of arranging the stacked objects SO, if desired positioned on and supported by a pallet P, on the rotating base 2.

[0100] Finally, there is the step of commanding the rotating base 2 and the wrapping head 3 so as to wrap said stacked objects SO by means of a paper film 4.

[0101] In particular, the step of commanding may comprise the sub-steps of tilting, by means of tilting means 12, the wrapping head 3 according to the processing steps, and synchronizing the action of the tilting means 12 with the vertical movement of the wrapping head 3.

[0102] The step of commanding can also comprise the sub-step of checking, by means of checking means 13, at the beginning and/or during wrapping the dimensions of the stacked objects SO so as to consequently inform the electronic control unit 5, and command the rotation of the rotating base 2 and/or the vertical movement of the wrapping head 3 as a function of these dimensions.

[0103] Furthermore, the step of commanding can also comprise the sub-step of retaining the paper film 4 by gripping means 7 near the stacked objects SO on the rotating base 2, preferably at least for the first wrapping round.

[0104] On the other hand, the controlling step can also comprise the sub-phase of tensioning, by means of tensioning means 8, the paper film 4 near the stacked objects SO, in which the sub-tensioning phase preferably comprises the phase of accumulating and/or releasing, by means of accumulation and/or release means 8a, the paper film 4 as a function of the rotation speed of the rotating base 2.

[0105] Furthermore, the step of controlling can comprise the sub-step of folding the paper film 4 by means of folding means 11 so as to allow the wrapping of the stacked objects SO with folded paper film.

[0106] Finally, the step of commanding can also comprise the sub-step of applying, by means of application means 15, glue or adhesive on the paper film 4 applied to the stacked objects SO on the rotating base 2 in a synchronized manner with the various wrapping steps, for example during or at the end of the wrapping.

[0107] The wrapping method can also comprise the step of cutting the paper film 4 by means of cutting means 14, for example at the end of wrapping.

[0108] Furthermore, the wrapping method can comprise the step of printing the paper film 4 by means of printing means 17, for example in a synchronized manner with various wrapping steps.

[0109] If the wrapping device 1 provided in the step of providing comprises a paper reel 6, the step of commanding may also comprise the sub-steps of acquiring the dimensions of the paper reel 6 by means of acquisition means 18, transmitting these dimensions to the electronic control unit 5 and modify the tension of the paper film 4 on the basis of the dimensions of the paper reel 6 transmitted to the electronic control unit 5.

[0110] Finally, the wrapping method can also comprise the step of pressing the paper film 4 by means of a pressing component at the final wrapping steps.

[0111] The wrapping device 1 as well as the related wrapping method make it possible to optimally apply a paper film 4 around stacked objects SO.

[0112] Through a precise control of the tensioning of the paper film, it is possible to obtain an unwinding that follows in the best possible way the geometry of the stacked objects SO to be wrapped.

[0113] Furthermore, the mechanical structure of the wrapping device 1 allows the handling of paper reels 6 of high weight.

[0114] Moreover, the wrapping device 1, besides allowing a personalization of the film to be applied to the stacked objects SO, also allows to obtain a strong and safe wrapping which contains the stacked objects SO with high stability.

[0115] It has thus been seen how the invention fully achieves the proposed objects.

[0116] The invention thus conceived is susceptible of modifications and variations, all of which are within the scope of the inventive concept.

[0117] Furthermore, all the details can be replaced by other technically equivalent elements.

[0118] In practice, the materials used, as well as the contingent shapes and dimensions, may be any according to requirements without thereby abandoning the scope of the protection of the following claims.

## Claims

1. Wrapping device (1) for stacked objects (SO), comprising a rotating base (2) intended to support and drag said stacked objects (SO) in rotation, a vertically slidably mounted wrapping head (3) intended to receive and convey a film for wrapping said stacked objects (SO) supported and dragged in rotation by said rotating base (2), an electronic control unit (5) intended to control the vertical movement of said wrapping head (3) as a function of the rotation speed of said rotating base (2) and tensioning means (8) of said film near said stacked objects (SO), **characterized in that** said film is a paper film (4) to be applied around said stacked objects (SO) on said rotating base (2) for wrapping the latter, and **that** said tensioning means (8) comprise film accumulation and/or release means (8a)

intended to accumulate and/or release said film (4) as a function of the geometry of said stacked objects (SO) and/or rotation speed of said base (2), said wrapping device (1) comprising a paper reel (6) for feeding said wrapping head (3) and acquisition means (18) intended to acquire the dimensions of said paper reel (6), said acquisition means (18) being in electrical and/or electronic communication with said electronic control unit (5) so as to transmit said dimensions to the latter to regulate the unwinding of said paper film (4) and prevent the breaking of the latter.

2. Wrapping device (1) according to claim 1, wherein said paper reel (6) is supported, in use, from below by at least one support component or crosspiece (20) configured to support the weight of said paper reel (6) and to protect said wrapping device (1) from any breakages and/or malfunctions of said wrapping head (3).
3. Wrapping device (1) according to claim 1 or 2, comprising tilting means (12) of said wrapping head (3) intended to tilt said wrapping head (3) at different angles according to the processing steps, said tilting means (12) being controlled by said electronic control unit (5), said electronic control unit (5) being intended to synchronize the action of said tilting means (12) with the vertical translation of said wrapping head (3).
4. Wrapping device (1) according to claim 1 or 2 or 3, comprising verification means (13) intended to control the dimensions of said stacked objects (SO) at the beginning and/or during the wrapping so as to accordingly inform said electronic control unit (5) to command the rotation of said rotating base (2) and/or the vertical movement of said wrapping head (3) as a function of said dimensions.
5. Wrapping device (1) according to any one of the preceding claims, comprising gripping means (7) of the film intended to retain said paper film (4) near said stacked objects (SO) on said rotating base (2).
6. Wrapping device (1) according to claim 5, wherein said gripping means (7) are intended to maintain said paper film (4) at least for the first wrapping round of said stacked objects (SO) on said rotating base (2).
7. Wrapping device (1) according to claim 5 or 6, wherein said gripping means (7) are or comprise at least one gripper.
8. Wrapping device (1) according to the preceding claim, wherein said tensioning means (8) comprise at least one adjustable-pressure pneumatic actuator (8b), said pressure being adjustable by means of said electronic control unit (5) as a function of set wrapping modes.
9. Wrapping device (1) according to the preceding claim, wherein said film accumulation and/or release means (8a) are or comprise one or more movable rollers.
10. Wrapping device (1) according to any one of the preceding claims, comprising detection means of the position of said accumulation and/or release means (8a), said detection means being in electrical and/or electronic communication with said electronic control unit (5).
11. Wrapping device (1) according to any one of the preceding claims, wherein said tensioning means (8) comprise film guiding means (10) intended to guide said paper film (4) through a given path.
12. Wrapping device (1) according to the preceding claim, wherein said guiding means (10) are or comprise one or more idle rollers.
13. Wrapping device (1) according to claim 11 or 12, comprising at least a first encoder operatively associated with said guiding means (10), said at least a first encoder being in electrical and/or electronic communication with said electronic control unit (5).
14. Wrapping device (1) according to any one of the preceding claims, comprising at least one motor (9) intended to command the unwinding of said paper film (4) from said paper reel (6).
15. Wrapping device (1) according to the preceding claim, comprising at least a second encoder operatively associated with said at least one motor (9), said at least a second encoder being in electrical and/or electronic communication with said electronic control unit (5).
16. Wrapping device (1) according to any one of the preceding claims, comprising cutting means (14) of said paper film (4), said cutting means (14) being controlled by said electronic control unit (5).

17. Wrapping device (1) according to any one of the preceding claims, comprising a pressing component or device of said paper film (4) intended to press said paper film (4) at the final wrapping steps.

18. Wrapping device (1) according to any one of the preceding claims, comprising glue or adhesive application means (15) on said paper film (4) applied to said stacked objects (SO) on said rotating base (2), said application means (15) being controlled by said electronic control unit (5) so as to apply the glue or adhesive synchronously with the various wrapping steps.

19. Wrapping device (1) according to any one of the preceding claims, wherein said wrapping head (3) comprises folding means (11) of said paper film (4) so as to allow the wrapping of said stacked objects (SO) with folded paper film.

20. Wrapping device (1) according to any one of the preceding claims, comprising inkjet printing means (17) of said paper film (4) intended to print said paper film (4), said printing means (17) being in electrical and/or electronic communication with said electronic control unit (5) so as to print said paper film (4) synchronously with various wrapping steps.

21. Wrapping device (1) according to claim 14, wherein said acquisition means (18) are capable of continuously acquiring the current diameter value of said paper reel (6) by correlating the angle traveled by said paper reel (6) set in motion by said at least one motor (9) with the linear quantity of said paper film (4) actually unwound.

22. Wrapping device (1) according to the preceding claim, wherein said acquisition means (18) are or comprise at least one optical sensor.

23. Method for wrapping stacked objects (SO) comprising the steps of:

providing a wrapping device (1) according to any one of the preceding claims;  
providing a paper film (4) to be applied around said stacked objects (SO),  
arranging said stacked objects (SO) on said rotating base (2),  
commanding said rotating base (2) and said wrapping head (3) so as to wrap said stacked objects (SO) by means of said paper film (4),

**characterized in that** said step of commanding comprises:

acquiring by means of acquisition means (18) the dimensions of said paper reel (6);  
transmitting said dimensions to said electronic control unit (5); and  
modifying the tensioning of said paper film (4) on the basis of said dimensions transmitted to said electronic control unit (5),  
tensioning said paper film (4) near said stacked objects (SO) by tensioning means (8), and  
accumulating and/or releasing said paper film (4) by means of accumulation and/or release means (8a) as a function of the rotation speed of said rotating base (2).

24. Wrapping method according to the preceding claim, wherein said step of commanding comprises:

tilting said wrapping head (3) by tilting means (12) according to the processing steps; and  
synchronizing the action of said tilting means (12) with the vertical displacement of said wrapping head (3).

25. Wrapping method according to claim 23 or 24, wherein said step of commanding comprises:

controlling at the beginning and/or during the wrapping by verification means (13) the dimensions of said stacked objects (SO) so as to accordingly inform said electronic control unit (5); and  
commanding the rotation of said rotating base (2) and/or the vertical displacement of said wrapping head (3) as a function of said dimensions.

26. Wrapping method according to any one of claims 23 to 25, wherein said step of commanding comprises:

retaining by gripping means (7) said paper film (4) near said stacked objects (SO) on said rotating base (2) at least for the first wrapping turn.

27. Wrapping method according to any one of claims 23 to 26, wherein said step of commanding comprises:

folding said paper film (4) by folding means (11) so as to allow the wrapping of said stacked objects (SO) with folded paper film.

5      **28.** Wrapping method according to any one of claims 23 to 27, wherein said step of commanding comprises:  
applying glue or adhesive on said paper film (4) by application means (15) applied to said stacked objects (SO) on  
said rotating base (2) synchronously with the various wrapping steps.

10      **29.** Wrapping method according to any one of claims 23 to 28, comprising:  
cutting said paper film (4) by cutting means (14) at the end of the wrapping.

15      **30.** Wrapping method according to any one of claims 23 to 29, comprising:  
printing said paper film (4) by printing means (17) synchronously with various wrapping steps.

20      **31.** Wrapping method according to any one of claims 23 to 30, wherein said step of commanding comprises:  
pressing said paper film (4) by a pressing component at the final wrapping steps.

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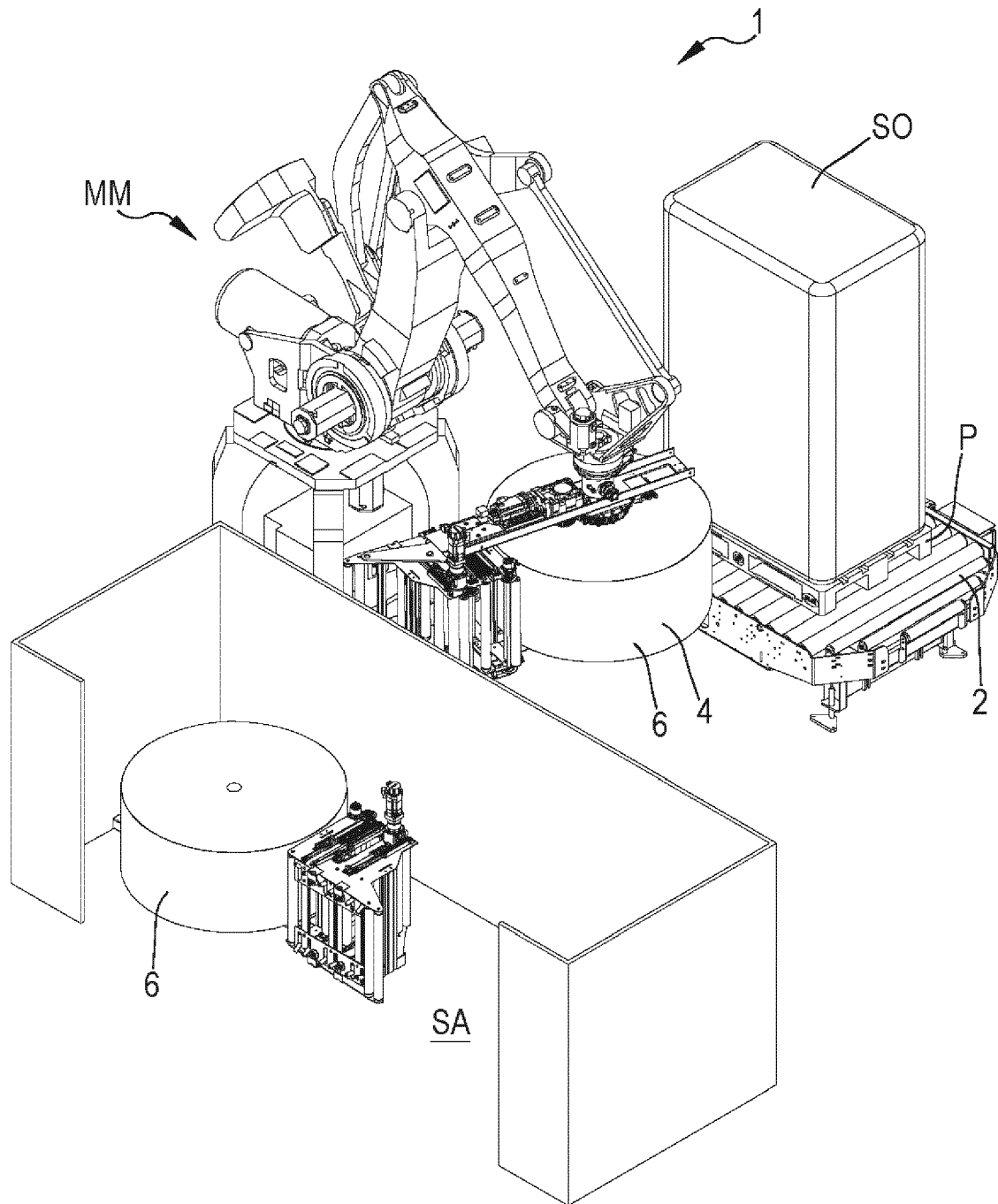


FIG.1

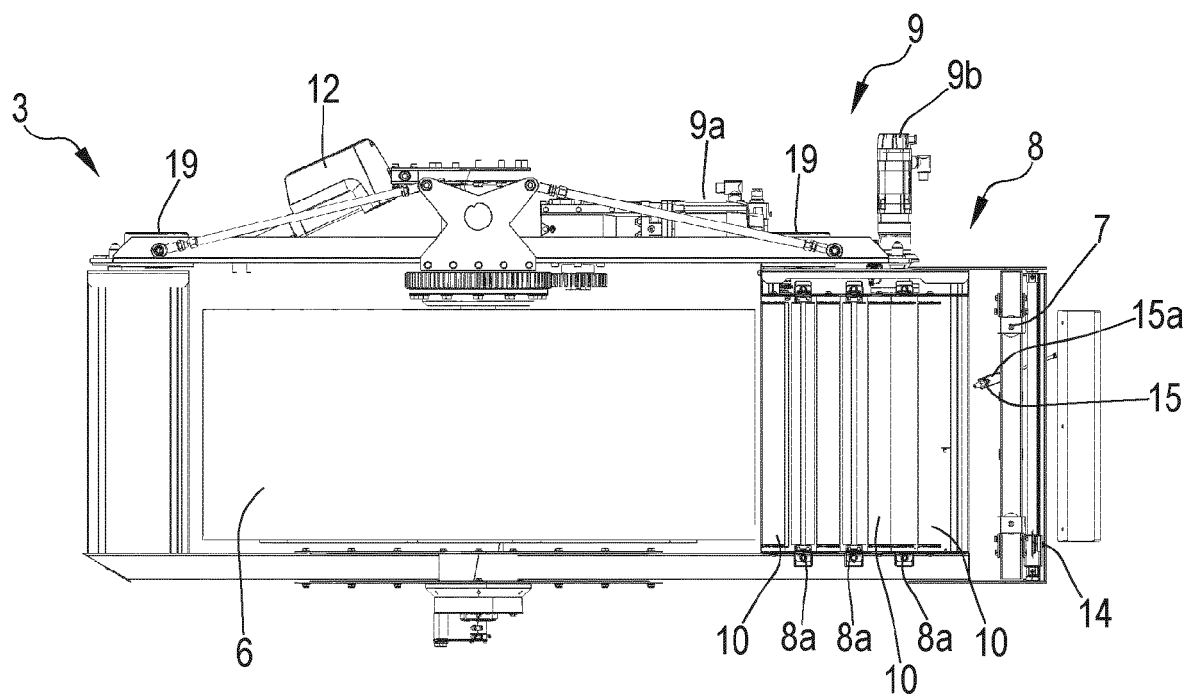


FIG. 2

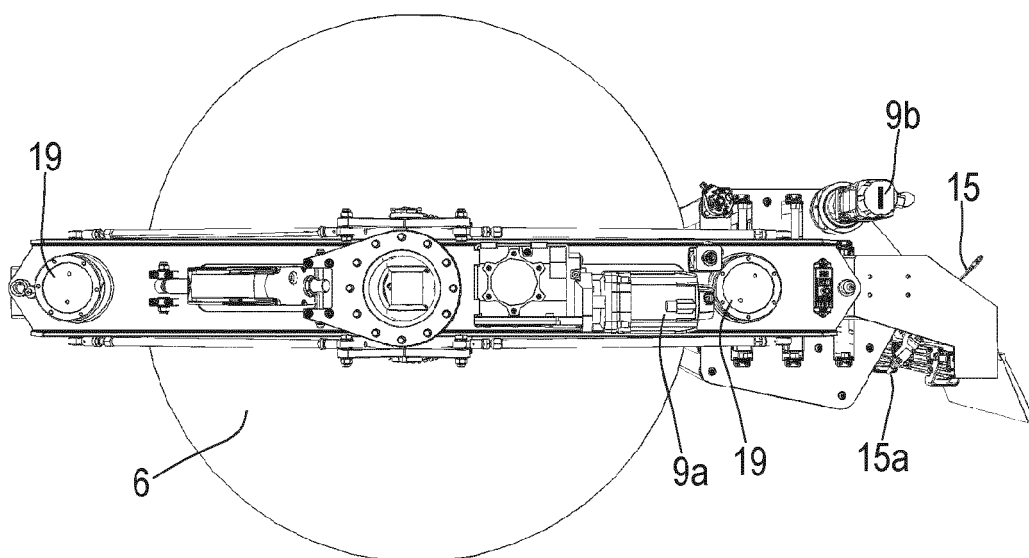


FIG. 3

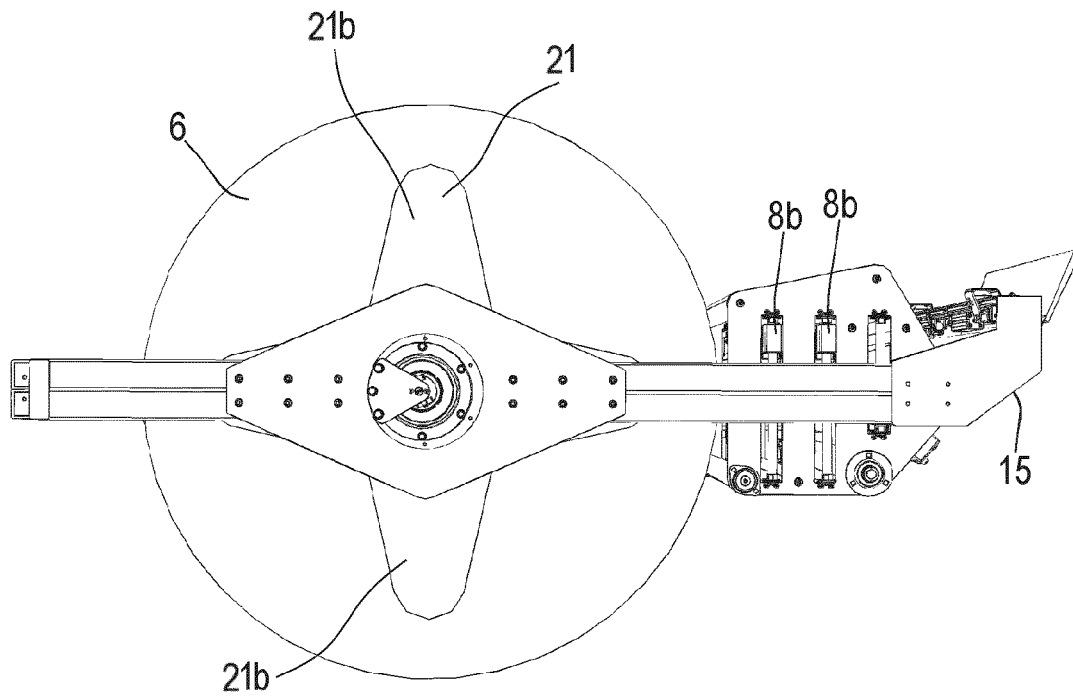


FIG.4

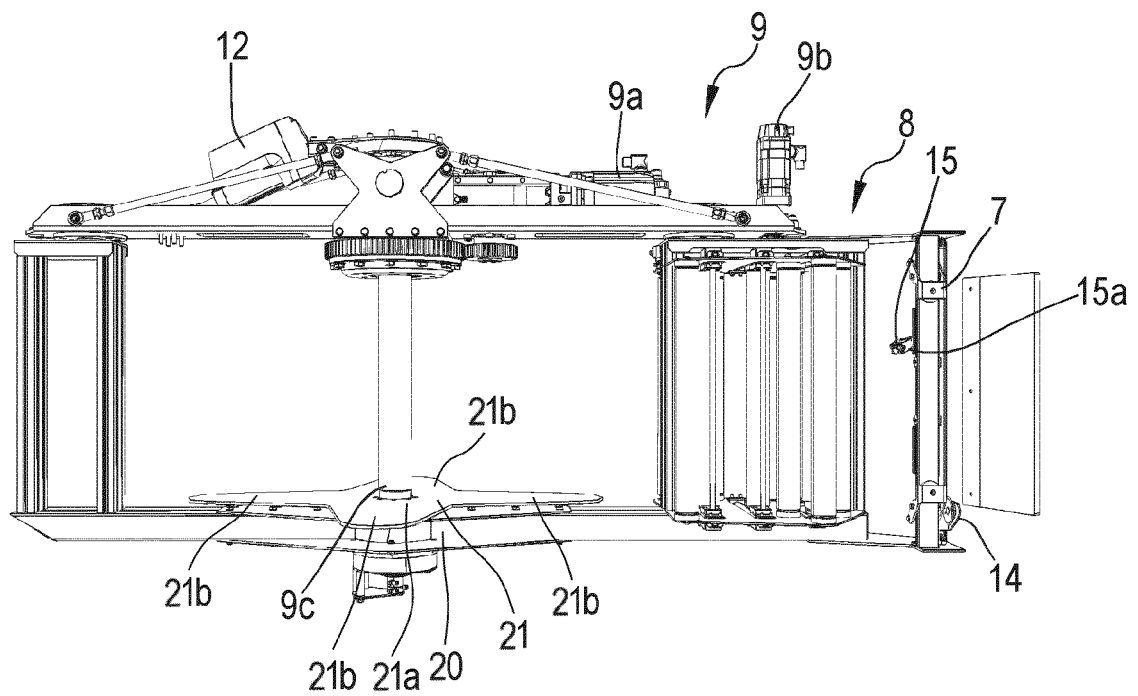


FIG.5

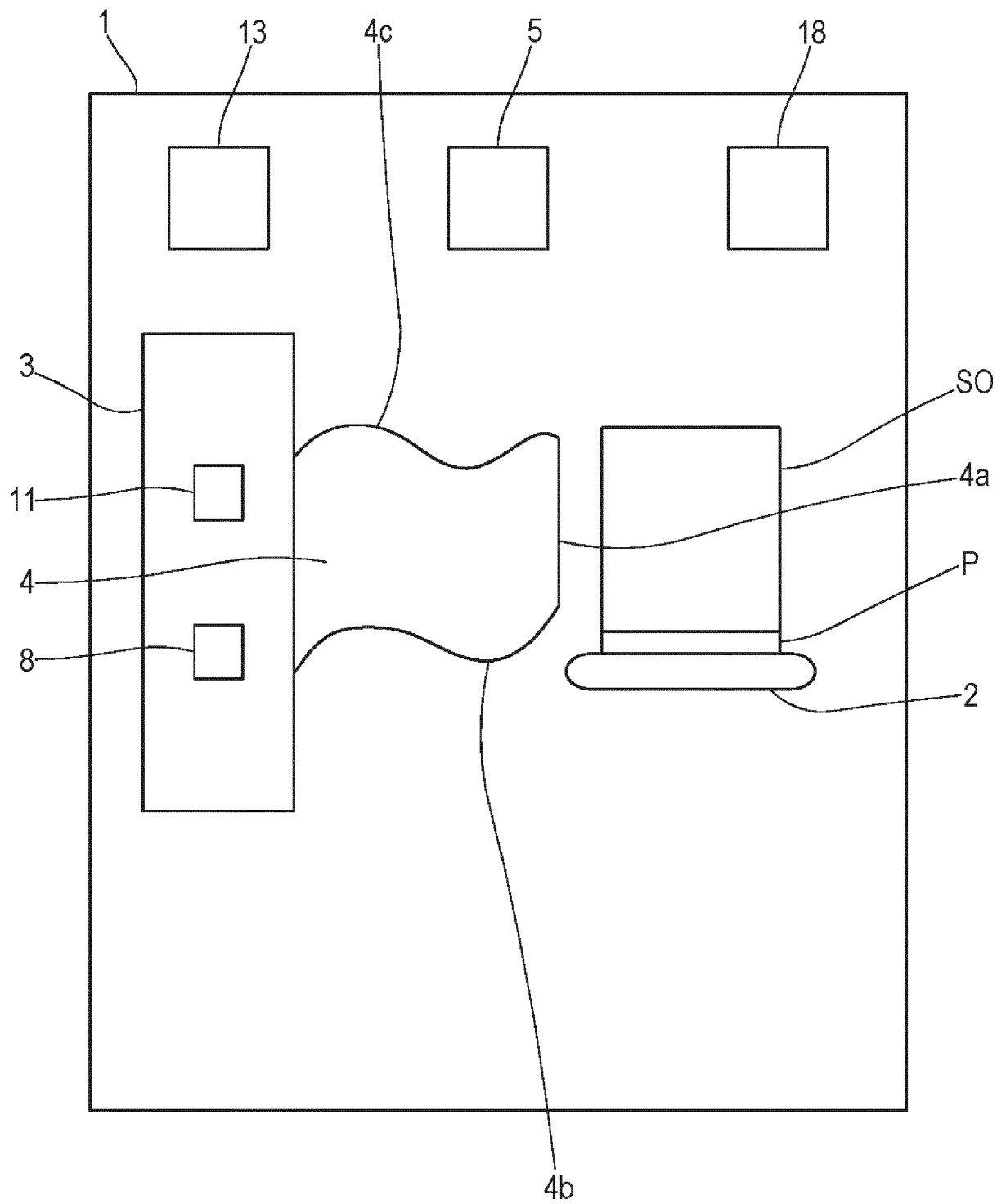


FIG.6



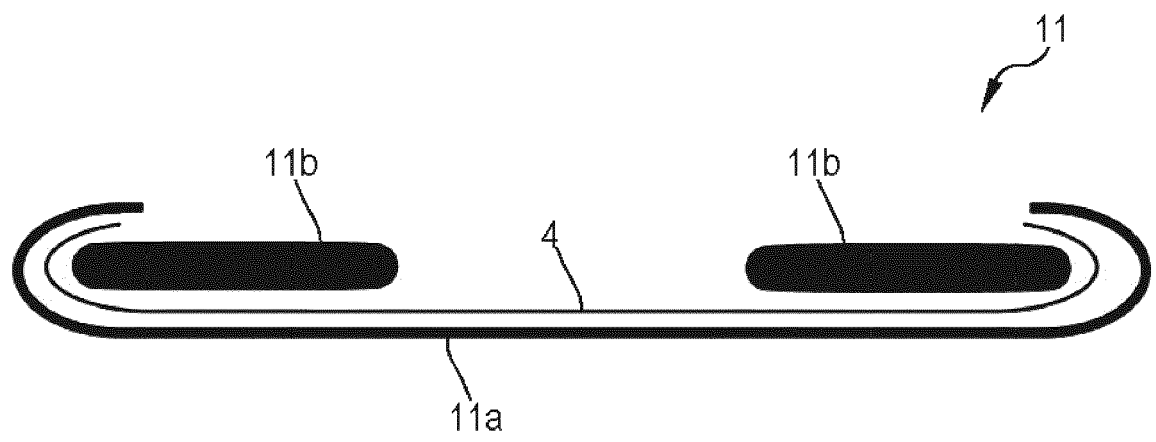


FIG.7