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(71) Applicant: **Neopost Technologies**
92220 Bagneux (FR)

(72) Inventor: **WILLIAMS, Christopher Hugh**
Woodford Green, Essex IG8 0BE (GB)

(74) Representative: **Freeman, Jacqueline Carol**
W.P.Thompson & Co.
55 Drury Lane
London WC2B 5SQ (GB)

(54) Vacuum Sheet Feeder

(57) A vacuum feeding mechanism for a document handling apparatus, the feeding mechanism comprising: an adjustable pick for separating a stack of documents from a downstream transport system; a rotatable wheel connected to a vacuum port and operable to pull a document by suction from the top of the stack toward the wheel and move the document over the pick to the downstream transport system; the wheel and the pick being separated by a clearance distance; means for determining adjustment coordinates in dependence upon characteristics of a document in the stack; wherein the position of the pick is automatically adjustable in two independent dimensions in dependence upon said adjustment coordinates.

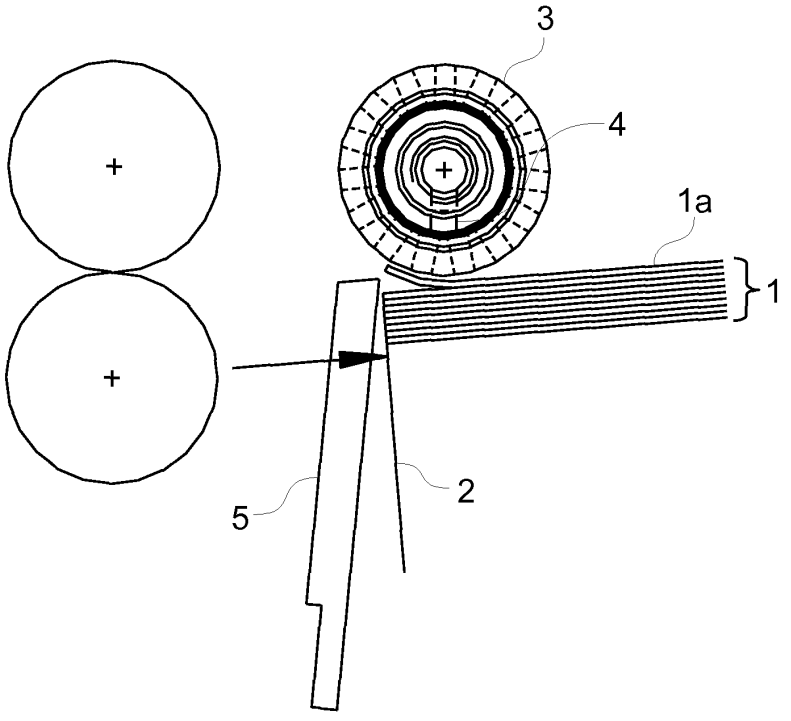

Fig. 1

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Description

[0001] The present invention relates to a vacuum sheet feeder for a paper handling machine, and particularly to a singulating mechanism for feeding sheets seriatim.

[0002] Sheet feeding mechanisms are required to feed sheets from a stack of identical sheets, which may, for example, be stored in a hopper, one at a time to a processing device. The sheets may, for example, be documents such as recently printed letters, preprinted inserts, or envelopes, and a feeding mechanism may be used for different types of documents at different processing times or for different batch runs.

[0003] Vacuum feeding mechanisms are well known and use suction to transport documents / envelopes from a stack of such documents to a downstream device. Vacuum feeding is particularly favoured for documents which are printed by methods which do not fully fix the toner to the paper (e.g., "cold fusion" techniques used in high speed printers) because the toner can easily smear when fed by conventional friction feeders. A vacuum is applied to the top sheet of a stack through a vacuum wheel or drum to lightly pull the top sheet toward the wheel and move it downstream as the wheel rotates. A partial vacuum is usually used to avoid causing damage or distortion to the document and to ensure that only the top sheet is held by the wheel. In this way the wheel lifts the top sheet over a stop known as a "pick" which prevents the rest of the stack moving.

[0004] It is desirable to be able to adjust the feeding mechanism to handle documents of various size, shape, thickness, weight and texture. Known feeding mechanisms tend to be very sensitive to variations in such characteristics and are difficult to adjust to exactly the right parameters. Mostly such adjustment is done manually by an operator and thus can be time consuming, requires considerable skill and experience by the operator and is prone to operator error.

[0005] It is particularly difficult to adjust vacuum feeding devices correctly because there are many influencing factors, including the strength of the vacuum, the position of the vacuum and the position of the pick. Adjustment is particularly difficult in top feeding devices, where the documents are fed from the top of a stack, because the parts which require adjustment are below the document path.

[0006] US 5,163,669 and US 5,975,519 both describe mechanical adjustment assemblies in friction sheet feeders for accommodating documents of different thicknesses.

[0007] US 5,273,269 also describes a friction feeding mechanism and uses a plurality of separating surfaces having different coefficients of friction for separating sheets of varying characteristics. The separating surface can be changed automatically depending upon feedback from a detector downstream.

[0008] A vacuum assembly for a sheet feeder is shown in US 6,189,883 comprising a continuously rotating feed drum having inner and outer circumferences, suction openings and a vacuum assembly inside the drum.

[0009] Some of the problems encountered with vacuum feeding mechanisms are described in US 6,698,748 in which documents are fed from the bottom of a stack. Frictional and adhesive contact between sheets, which tends to cause double and overlap feeding problems, is reduced by providing a wedge shaped structure at the base of the stack.

[0010] It is desirable to improve the adjustability of vacuum feeding devices and to make adjustment automatic and more accurate.

[0011] According to one aspect of the present invention there is provided a vacuum feeding mechanism for a document handling apparatus, the feeding mechanism comprising: an adjustable pick for separating a stack of documents from a downstream transport system; a rotatable wheel connected to a vacuum port and operable to pull a document by suction from the top of the stack toward the wheel and move the document over the pick to the downstream transport system; the wheel and the pick being separated by a clearance distance; means for determining adjustment coordinates in dependence upon characteristics of a document in the stack; wherein the position of the pick is automatically adjustable in two independent dimensions in dependence upon said adjustment coordinates.

[0012] Preferably the adjustment coordinates are determined also in dependence upon the position of the pick relative to the vacuum wheel and the desired clearance distance. The desired clearance distance is preferably calculated as a function of at least the thickness of the document, and advantageously also the flexure characteristics of the document.

[0013] According to one embodiment of the invention the feeding mechanism further comprises means to automatically adjust the suction applied by the wheel to the top document of the stack.

[0014] According to a second aspect of the invention there is provided a vacuum feeding mechanism for a document handling apparatus, the feeding mechanism comprising: an adjustable pick for separating a stack of documents from a downstream transport system; a rotatable wheel connected to a vacuum port and operable to pull a document by suction from the top of the stack toward the wheel and move the document over the pick to the downstream transport system; the wheel and the pick being separated by a clearance distance; means for determining adjustment coordinates in dependence upon characteristics of a document in the stack; wherein the suction applied by the wheel to the top document of the stack is automatically adjustable in dependence upon said adjustment coordinates.

[0015] The suction adjustment may comprise adjustment of the strength of the suction and / or the spread of suction application across the width of the document, for example the number of suction orifices or the size of the orifices. Such adjustment means may include a feedback

loop. The feedback may include data corresponding to any one or combination of factors such as:

- the delay between a request for a document being made and arrival of the document at a position downstream;
- the time or distance between successive documents;
- whether two or more documents are fed together;
- whether two or more documents overlap.

[0016] Such factors may be detected by sensors downstream of the feeding mechanism.

[0017] Preferably the initial settings for the pick position and/or the vacuum port are automatically calculated from parameters of the documents which may be stored with other job settings for a particular feed run. Such parameters will typically include details of the nature of the documents so as to identify, for example, weight, thickness and flexibility. These details will usually be known for particular documents - for example for particular grades of paper or particular manufacturer's envelopes - and can be preset as standard settings for an operator to choose. Alternatively the parameters can be measured prior to operation of a feed run.

[0018] Preferably the position of the pick and/or the settings for the vacuum port are stored for each job and can be used each time the same job is to be re-run.

[0019] For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made to the accompanying drawings, in which:

Figures 1 and 2 are schematic cross-sections of a known vacuum sheet feeding mechanism showing two stages of a document feeding process;

Figure 3 is a schematic cross-section of a sheet feeding mechanism according to the first aspect of the present invention;

Figure 4 is a schematic cross-section of part of a sheet feeding mechanism according to the second aspect of the present invention;

Figure 5 shows the part of the sheet feeding mechanism of Figure 4 in a different position;

Figure 6 is a schematic cross-section of the part of the sheet feeding mechanism of Figure 4 viewed from below.

[0020] Figures 1 and 2 illustrate a conventional sheet feeding mechanism at two different stages of feeding a document. A plurality of documents 1 are stacked in a hopper 2, one on top of each other. The documents are biased toward a vacuum wheel 3 by a spring bias (not shown) or other means well known in the art. The vacuum wheel 3 has holes around its circumference and an adjustable vacuum port 4 comprising a slot which aligns to a greater or lesser degree with the holes to allow a variable suction to be applied to the top document 1a.

[0021] In Figure 1 the document 1a is shown with its leading edge picked up by the vacuum wheel 3 and lifted away from the other documents 1 in the hopper 2. The wheel 3 lifts the document 1a over the top edge of a pick 5 which holds back the other documents in the stack. In Figure 2 the document 1a is shown passing over the pick 5 and being moved further downstream of the feeding mechanism by rollers 6 and 7. When the trailing edge of the top document 1a passes the holes in the wheel 4, the holes become exposed and exert suction on the second document to lift it to the vacuum wheel 3 and over the pick 4. When the mechanism is correctly adjusted a constant gap will be achieved between successive single documents.

[0022] Figure 3 illustrates an example of a drive mechanism for positioning the pick 5 relative to the vacuum wheel 3. This drive mechanism comprises a first motor 9 to drive the pick in the "x" direction as illustrated by two-headed arrow 10. This positions the pick closer to or further away from the wheel 3 in a generally horizontal direction. A second motor 11 drives the pick in the "y" direction as illustrated by two-headed arrow 12 to adjust the vertical position of the pick relative to the wheel 3. An air blower nozzle 13 is also provided.

[0023] Figures 4, 5 and 6 illustrate the operation of the vacuum wheel 4 and how the vacuum strength and position can be adjusted.

[0024] As previously mentioned, the stack of documents 1 is held in hopper 2. The top document 1a is picked up by the vacuum wheel 3 because of suction caused by a slot in the vacuum port 4 aligning with holes 14 in the wheel 3. This lifts the leading edge of document 1a into abutment with the wheel 3 and as the wheel 3 rotates it pulls the document 1a over the pick 5, whilst leaving the other documents of the stack 1 in the hopper 2.

[0025] The vacuum port 4 is supported by vacuum port bearings 15 and bearing housings 16 at each end. The position of the vacuum port 4 is determined by vacuum port drive motor 17 which can move the vacuum port 4 through a relatively limited angle as shown in Figures 4 and 5. In figure 4 the vacuum port 4 is in a relatively vertical position and in figure 5 it has been rotated clockwise to subtend an angle to the vertical by the motor 17. This moves the region of suction closer to the pick 5 which is advantageous for some types of document and holds the leading edge of the document to the wheel further round the wheel 4.

[0026] Figure 6 illustrates this in more detail. The motor 17 has a motor arm 18 connected to a motor arm collar which is connected to the vacuum port 4. The vacuum wheel 4 is supported on bearings 20 allowing the wheel 4 to rotate about the vacuum port 4 (which is fixed in position in use) under the influence of the wheel drive pulley 21 and drive belt 22 which usually drive both ends of the wheel but are only shown at one end in this figure for ease of illustration. A vacuum port bearing and bearing housing 23 is shown at the lower end of the vacuum port

4 in figure 6 but is also usually repeated at both ends of the vacuum port 4.

[0027] The invention has been described with particular effect in the paper handling industry but could be applied to other technical areas such as other production lines which use vacuum feeds which need adjustment to cope with different parameters.

Claims

1. A vacuum feeding mechanism for a document handling apparatus, the feeding mechanism comprising:

an adjustable pick for separating a stack of documents from a downstream transport system;
a rotatable wheel connected to a vacuum port and operable to pull a document by suction from the top of the stack toward the wheel and move the document over the pick to the downstream transport system;
the wheel and the pick being separated by a clearance distance;
means for determining adjustment coordinates in dependence upon characteristics of a document in the stack;

wherein the position of the pick is automatically adjustable in two independent dimensions in dependence upon said adjustment coordinates.

2. A vacuum feeding mechanism according to claim 1 wherein the adjustment coordinates are determined also in dependence upon the position of the pick relative to the vacuum wheel and the desired clearance distance.

3. A vacuum feeding mechanism according to claim 1 or 2 wherein the desired clearance distance is calculated as a function of the thickness of the document.

4. A vacuum feeding mechanism according to claim 1, 2 or 3 wherein the desired clearance distance is calculated as a function of the flexure characteristics of the document.

5. A vacuum feeding mechanism according to claim 1, 2, 3 or 4 further comprising means to automatically adjust the suction applied by the wheel to the top document of the stack.

6. A vacuum feeding mechanism according to claim 5 wherein the suction is automatically adjustable in dependence upon said adjustment coordinates.

7. A vacuum feeding mechanism for a document handling apparatus, the feeding mechanism comprising:

an adjustable pick for separating a stack of documents from a downstream transport system;
a rotatable wheel connected to a vacuum port and operable to pull a document by suction from the top of the stack toward the wheel and move the document over the pick to the downstream transport system;
the wheel and the pick being separated by a clearance distance;
means for determining adjustment coordinates in dependence upon characteristics of a document in the stack;

wherein the suction applied by the wheel to the top document of the stack is automatically adjustable in dependence upon said adjustment coordinates.

8. A vacuum feeding mechanism according to claim 6 or 7 wherein the suction adjustment comprises adjustment of the strength of the suction.

9. A vacuum feeding mechanism according to claim 5, 6 or 7 wherein the suction adjustment comprises adjustment of the spread of suction application across the width of the document.

10. A vacuum feeding mechanism according to claim 5, 6 or 7 further comprising a feedback loop.

11. A vacuum feeding mechanism according to claim 10 wherein the feedback includes data corresponding to any one or any combination of the following factors:

a) the delay between a request for a document being made and arrival of the document at a position downstream;
b) the time or distance between successive documents;
c) whether two or more documents are fed together;
d) whether two or more documents overlap.

12. A vacuum feeding mechanism according to claim 11 wherein at least one of the factors is detected by a sensor located downstream of the feeding mechanism.

13. A vacuum feeding mechanism according to any one of the preceding claims wherein the initial settings for the pick position are automatically calculated from parameters of the documents.

14. A vacuum feeding mechanism according to any one of the preceding claims wherein the initial settings for the vacuum port are automatically calculated from parameters of the documents.

15. A vacuum feeding mechanism according to claim 13 or 14 wherein the initial settings are stored with other job settings for a particular feed run.

16. A vacuum feeding mechanism according to any one of claims 13, 14 or 15 wherein the parameters comprise details of one or more of weight, thickness and flexibility of the documents.

17. A vacuum feeding mechanism according to any one of claims 13 to 16 wherein the parameters are preset as standard settings for an operator to choose.

18. A vacuum feeding mechanism according to any one of claims 13 to 17 wherein at least one of the parameters is measured prior to operation of a feed run.

19. A vacuum feeding mechanism according to any one of claims 13 to 18 wherein the initial settings are stored for each job and can be used each time the same job is to be re-run.

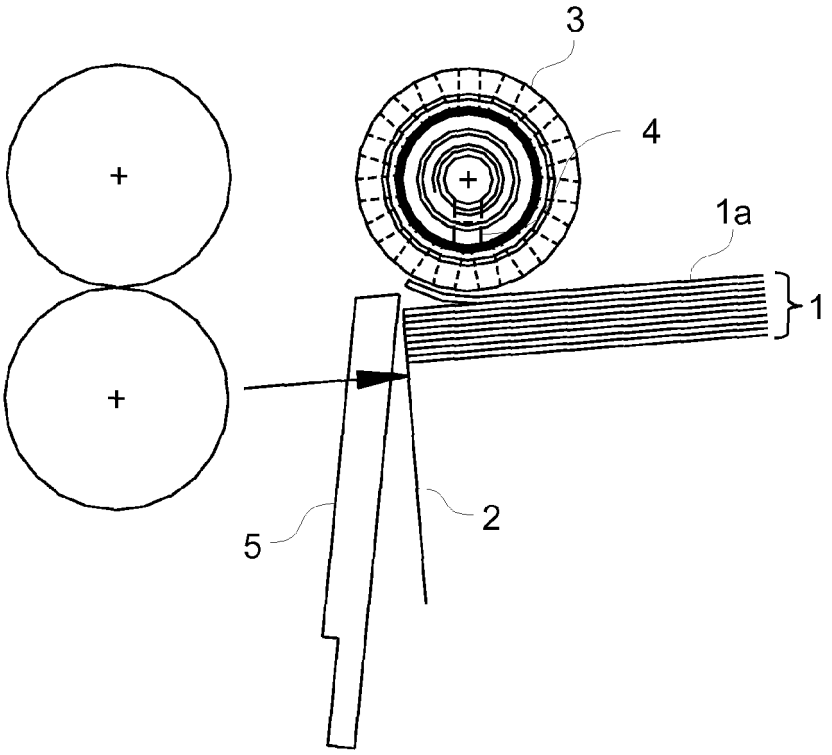

Fig. 1

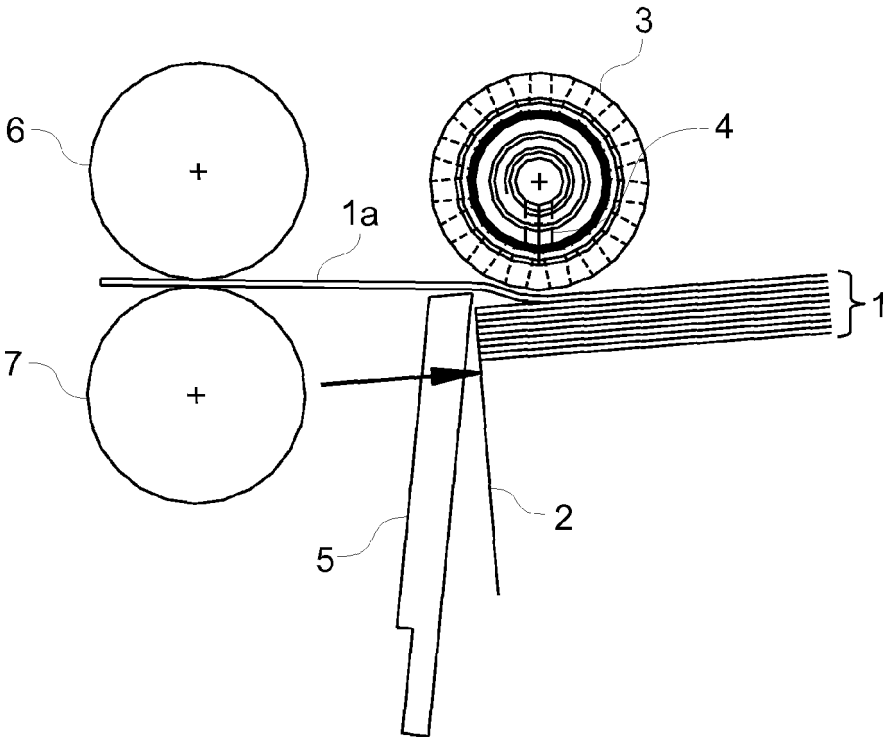

Fig. 2

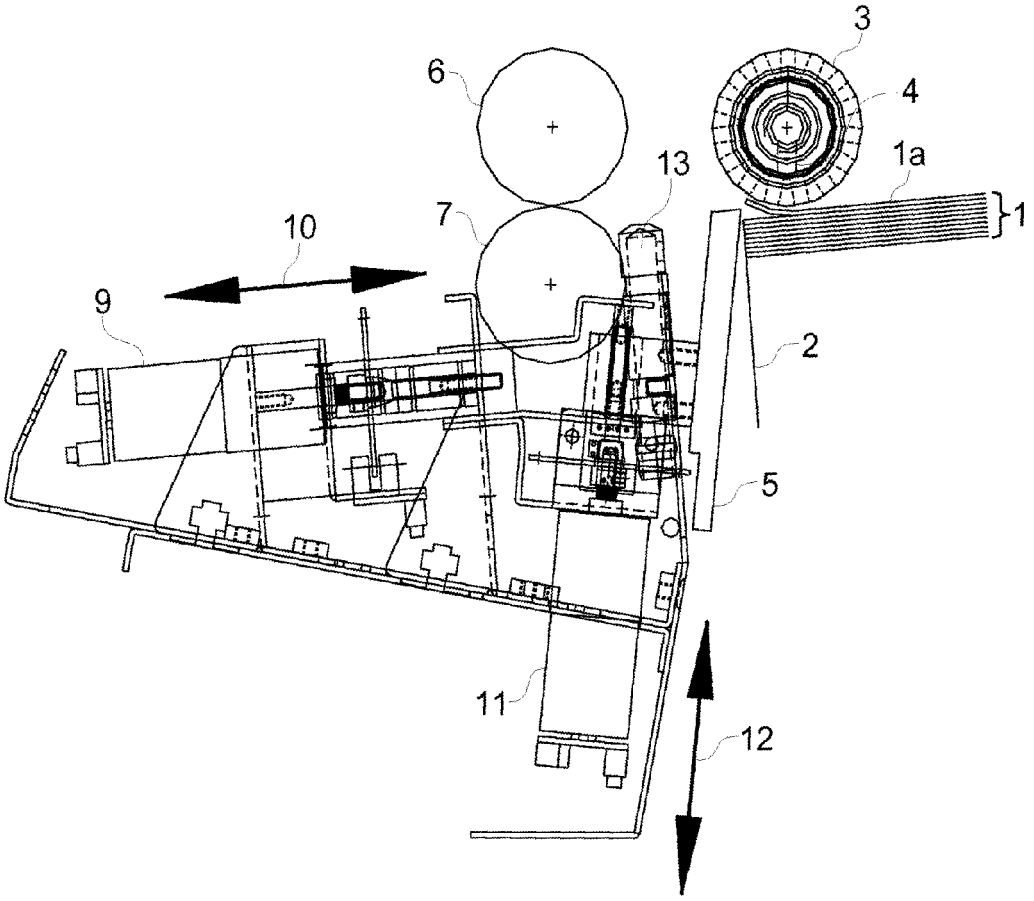

Fig. 3

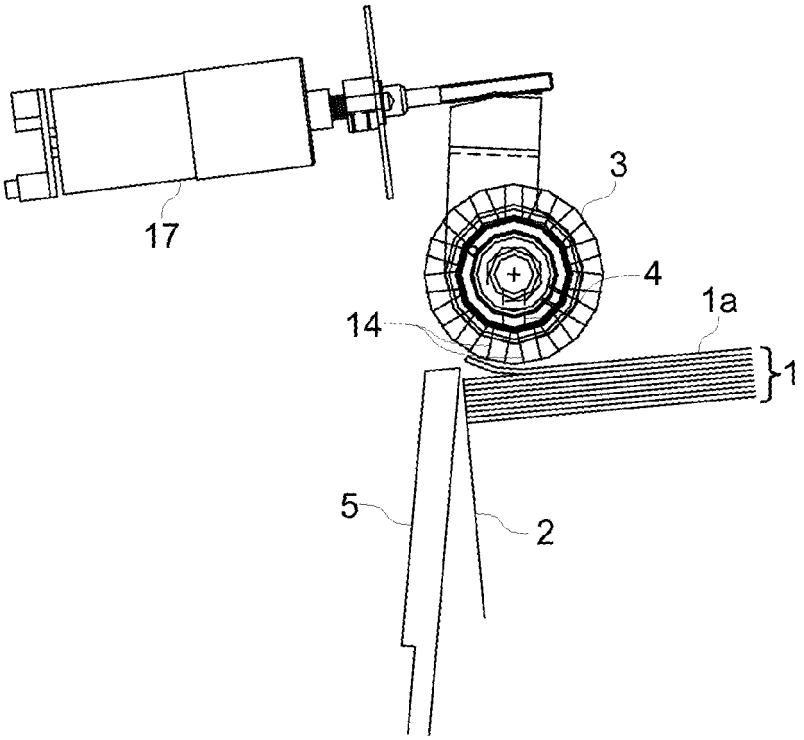

Fig. 4

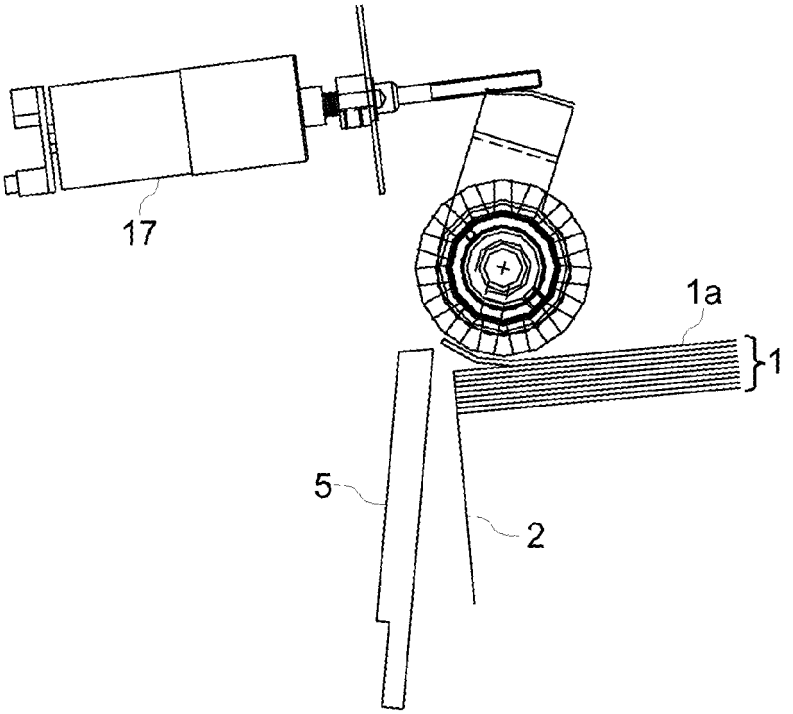

Fig. 5

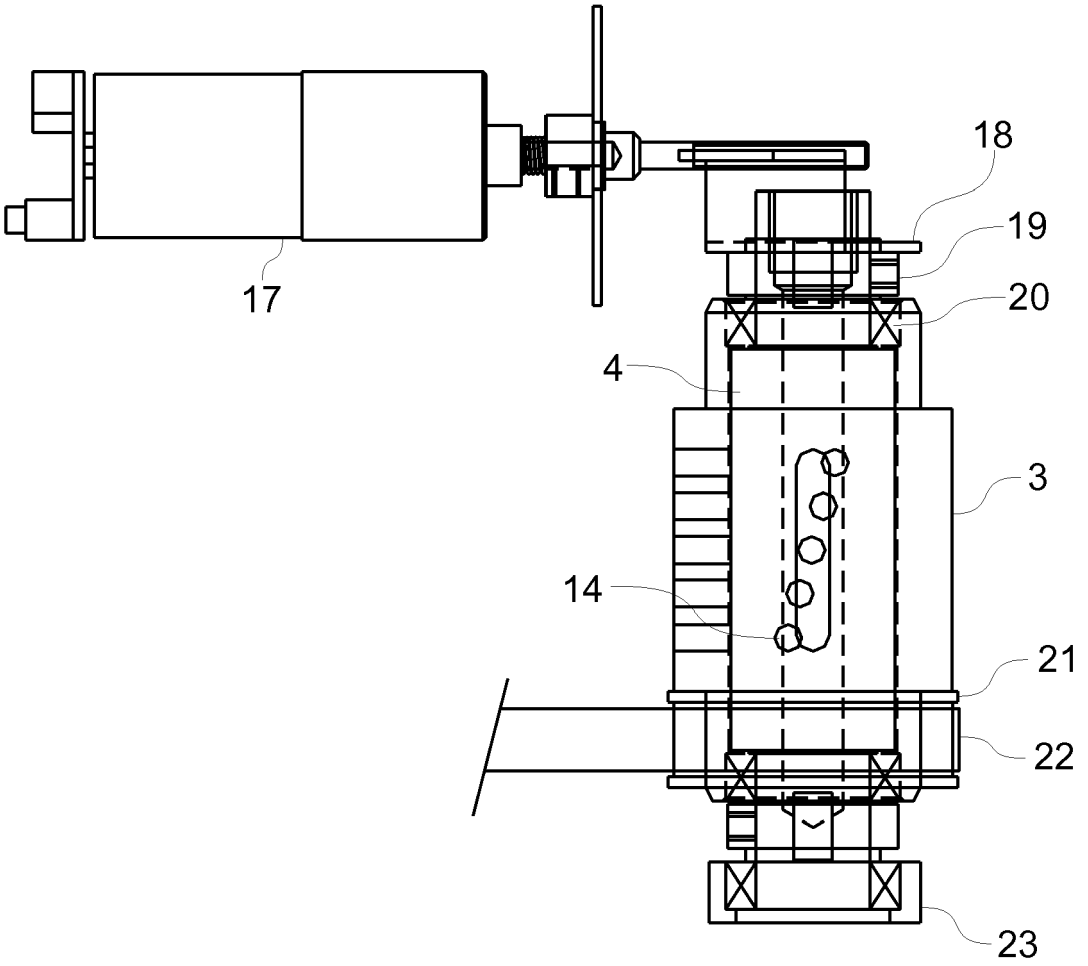

Fig. 6

REFERENCES CITED IN THE DESCRIPTION

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