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(54) Block formation system and method for controlling the folding of a block

(57) A block formation system for forming a block of folded material, preferably of nonwoven material or tissue, comprising a folding means (11, 12) between which web material (10) is passing for folding the web material (10) to a block (50), and pressing means (17, 20) acting on the block (50). The block of web material (10) is layered on a lifting element (24) being movable relative to the folding means (11, 12), whereby means for controlling the relative movement of the lifting element (24) to the folding means (11, 12) with respect to the degree of compression of the block (50) are provided. The block formation system can be used for high-speed festooning with high quality requirements. According to the proposed method for controlling the folding of a block, web material (10) is fed to a folding device (11, 12), web material (10) is folded in a zigzag-like manner, building a block (50) of folded material on a lifting element (24), whereby pressing means act on the uppermost web layer and the degree of compression is measured and used for controlling the relative movement of the lifting element (24) with respect to the pressing means (17, 20).

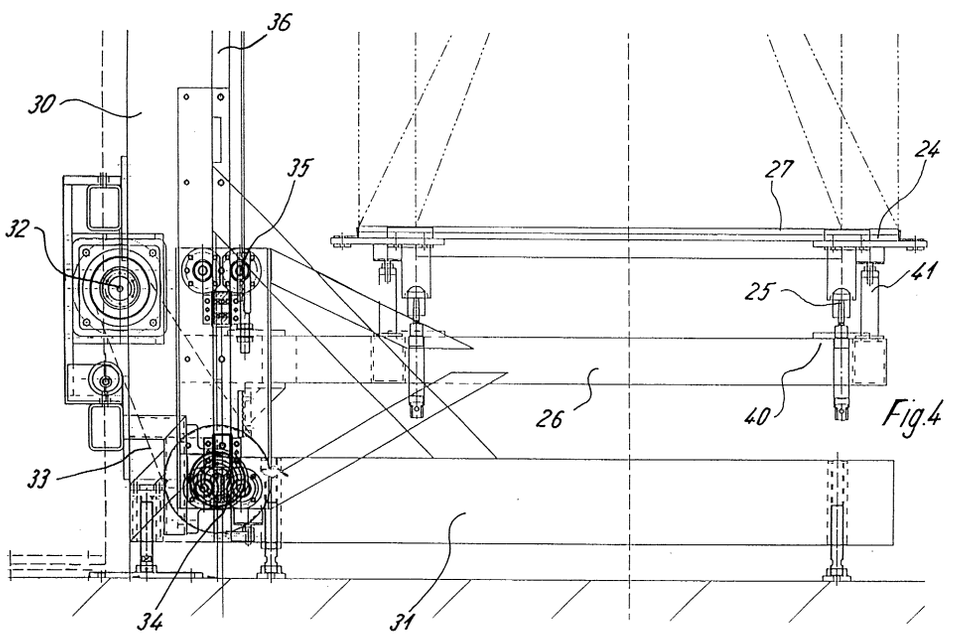

Fig.4

EP 1 123 889 A1

Description

[0001] The present invention refers to a system for forming blocks of folded web material, preferably of nonwoven material or tissue, comprising folding means between which the web is passing for folding it in a zigzag-like manner to a block, and pressing means acting on the block, whereby the block is laid on a lifting element being movable relative to the folding means. Such a block formation system is mainly used for a process generally known under the term "festooning", making blocks of nonwoven materials which are used for the production of hygienic articles.

[0002] Most materials used for the production of hygienic goods are still shipped from the suppliers to the end users in rolls. With the development of new, often thicker materials, such as airlaid, as well as the desired increase in production speed, supplying materials in rolls is no longer a cost-effective way of delivery. Thus, an alternative method has been developed, which is delivering materials in festooned blocks. This way of delivery is a great improvement in terms of handling and material management, and cuts down material shipping and warehousing costs considerably, due to its space saving shape, and also reduces the cost of equipment needed to supply the materials to the production line, as well as improves material runnability on high-speed converters.

[0003] The general technique of folding material is quite old. US-A 1985676 discloses a method and an apparatus for folding a paper block from a continuous web of paper. First, paper material is fed to an indenting mechanism providing folding lines in certain intervals. The folded material is received by helicoidal members assisting to obtain correct stacking of the folded sheets of band material. The folded block of material is arranged on a lifting table being movable in vertical direction, to keep the distance between the folding device and the upper surface of the block as constant as possible. Although this apparatus can produce festooned blocks, it has a complicated structure and is not suitable for high-speed applications.

[0004] EP 0 939 054 A2 discloses an apparatus for folding a continuous strip of material which uses a pair of cylinders having means for deviating and gripping the strip for building a block of folded material. Each cylinder has the gripping means arranged on one side and the deviating means on the opposite side. In order to move the strip material from a position between the cylinders to the upper surface of the block, the gripping means clamp the strip material and move it by a rotation of less than 180° to the upper surface of the block of folded material. Although this method is also applicable for relatively light material, such as airlaid, the finished block is only of medium quality and the process speed of forming the block is quite limited. If the cylinders rotate with high speed, the material strips are not accurately laid one on top of each other, and some frictional engagement between the rotating cylinders and the upper surface of the block may lead to damages in the block, in particular if the material is nonwoven fabric such as airlaid, which is very delicate to handle, as every undue friction or tension will result in an undesirable elongation of the web. In particular when starting the folding of a new block, there is a certain distance between the surface of the lifting element and the folding cylinders, which normally results in instability of the folding process, so that the first layers tend to slip away, are not folded accurately and have to be discarded.

[0005] It is an object of the present invention to provide a block formation system and a method for controlling the folding of a block to allow high accuracy even in the beginning of the folding process and thus avoid wasting the first layers of web material, and which produces a block of folded material with high stability.

[0006] This object is solved by a block formation system for forming a block of folded material, preferably of nonwoven material or tissue, comprising folding means between which web material is passing for folding it to a block, and pressing means acting on the block, whereby the block is laid on a lifting element being movable relative to the folding means, and whereby means for controlling the relative movement of the lifting element to the folding means with respect to the degree of compression exerted on the block are provided.

[0007] Due to the controlling means, a feedback signal for the compression is provided, to increase the speed of the lifting element, as soon as the pressure on the block is exceeding a pre-determined value, or to reduce the speed as soon as the pressure is getting too low. In this way, the pressure is maintained within a given range, allowing to obtain an optimised process in terms of stability, with very accurate and symmetric blocks. Additionally, by maintaining a physical pressure on the block, i.e. assuring a continuous contact between folding cylinders and uppermost material layer during block formation, a significant increase in the overall process speed is obtained.

[0008] In a preferred embodiment of the invention, the lifting element has a flexible support device allowing a swinging movement of the lifting element. Such a "floating" support is mainly used at the beginning of each block to improve handling of the web material in the first layers to be put on the lifting element. Due to the movement of the lifting element in the beginning of the folding process, now also the first layers are accurately laid one on top of the other, eliminating material damage and waste in consequence of unstable layers. As soon as the first layers are formed, the load cells integrated to the system begin to pick up data from the pressure between the folding means and the block surface. At this moment, the rocking mechanism of the lifting element is blocked, and the overall process speed can be increased during formation of the rest of the block.

[0009] According to a preferred flexible support device, air cushion members are provided to support the

lifting element, so that damping of vibrations and other movements is achieved. As soon as some layers of web material are formed, and a stable block-to-block folding interface is achieved, the flexible support device can be fixed in order to avoid any further swinging movement of the lifting element.

[0010] In order to improve the handling of web material at the beginning of the block formation, a board is provided on the lifting element, receiving the lowermost portion of the web material. The board has a rough surface for providing a frictional engagement between the lowermost portion of the web material and the board, as the adherence of nonwoven materials to smooth surfaces is not good.

[0011] According to a preferred embodiment of the invention, the pressing means include a measuring unit for detecting the degree of compression on the block, and a control unit analysing the data and comparing them to a pre-set optimum pressure, which is then used as a signal for adapting the speed for the vertical movement of the lifting element. The feedback of the control unit is immediate, so that the handling of the material is easily adaptable with respect to different material properties and thicknesses.

[0012] The above object is also solved by a method for controlling the folding of a block, comprising the steps of:

- feeding web material to a folding device;
- folding the web in a zigzag-like manner, thus building a block of folded material on a lifting element; whereby pressing means act on the uppermost web layer and the degree of compression is measured and used for controlling the relative movement of the lifting element with respect to the pressing means.

[0013] In a preferred embodiment of the method, the lifting element is allowed to swing in a perpendicular direction to the folding edges of the block in the beginning of the folding process, in order to improve the stability of the overall process even during folding the first layers. Additionally, high-speed operations benefit from an increasing pressure on the block, as this provides a damping effect to the material already folded.

[0014] In another preferred embodiment of the invention, the degree of compression on the block is maintained within a given range during the block formation, in order to assure a stable process with similar properties of the finished block in upper and lower portions. Such a continuos compression can be achieved by two folding cylinders, each being provided with pressing means, whereby one set of fingers is pressing on the block on one side while web material is laid down on the opposite side of the block, and a system integrated in the folding system to obtain data on the pressure exerted on the top layer of the block which data is used to adjust the speed of the lifting table automatically.

[0015] The invention will now be described in detail with reference to the appended drawings:

Fig. 1 shows a schematic drawing of the overall manufacturing method;

Fig. 2 shows a schematic side view of a first embodiment of the apparatus according to the present invention;

Fig.3 shows a side view of the lifting element with a lower portion of the block, and

Fig. 4 shows an enlarged side view of the lifting element of Fig. 3.

[0016] After fabrication, a mother roll 1 of web material is delivered to the festooning system. The full width of the mother roll is unwound so that a web 10 is fed to the processing station.

[0017] The web 10 is guided through a tension control system comprising two rollers 2 and a pneumatic dancing roller 3 being connected to a potentiometer to feedback the system on the dancing roller position. The tension control system assures process stability, since the quality of the festooning process is indexed to tension steadiness and avoidance of web elongation.

[0018] Then the web 10 passes through a web guiding system comprising an automatic web guiding device tracking the web material 10 within narrow tolerances and thus controlling the position of the web in the slitting station.

[0019] When the festooner is used for multilane production, the material has to be slit into lanes of the required width. This operation is performed at the slitting station with unique crush cut perforations knives 7 that provide multiple width variation capabilities, depending on machine configuration. The slitters are pneumatically loaded with a constant and uniform slit pressure against an anvil roll 6. The slitting system includes a precise S-wrap material metering system. Trim cut of the product edges is also performed in this station, reducing material waste to a minimum.

[0020] In the next station, the web 10 is guided between two rolls 8 having another tension control system 9. The tension control system 9 comprises a lever with a roll pressing against the web 10 to assure constant web tension during the festooning process. Then the web 10 is fed to two folding cylinders 11 and 12 to build a block 50 of folded material.

[0021] The block 50 is arranged on a lifting element which is moved downwards during the festooning process. As soon as the required height of the material block 50 is reached, the block 50 is transferred to another position and a new block is built by the festooner system.

[0022] The folding of the web 10 by the folding cylinders 11 and 12 will now be described in detail with reference to Fig. 2.

[0023] The web 10 of airlaid material is passing with constant web tension through a gap between the right folding cylinder 11 and the left folding cylinder 12. Each folding cylinder 11 and 12 has a gripping means 13 and 16, and a pushing means 14 and 15. Below the right folding cylinder 11, a swinging set of fingers 17 is mounted on a holder 19. Integrated into the fingers 17 are measuring means 18 for measuring the actual pressure of the fingers 17 on the material block 50 during the festooning process. On the opposite side, a set of fingers 20 mounted to a holder 22 is provided, having another measuring means 21 for measuring the pressure of the fingers 20 on the material block 50.

[0024] The folding cylinders 11 and 12 as well as the holders 19 and 22 are mounted to a frame 23. Below the frame 23, a movable lifting element 24 is provided for receiving the block 50 during the festooning process. The lifting element 24 is arranged on a pneumatic system 25 that allows the element 24 to rock while the first block layers are formed in order to maintain a continuous contact between the lifting element 24 and the material web 10. The pneumatic system 25 is mounted to a lifting frame 26 being movable together with the lifting element 24.

[0025] The process of folding the web 10 will now be described with reference to Fig. 2.

[0026] First of all, this is a cyclical process, where the respective elements of the counterrotating folding cylinders 11 and 12 are alternating between an operative and a non-operative position. This rotation is indicated by arrows $\alpha$and β. With each rotation of the cylinders, two layers of the block 50 are formed. The web material 10 is pushed to the gripping means 13 mounted in the folding cylinder 11. The gripping means 13 comprises a gripping element being pivoted around an axis. The gripping element is mounted to a holding member which is biased by a cam. Accordingly, the holding member is biased to a closed position. In order to clamp the web 10 between the gripping element and a receiving element mounted in the folding cylinder 11, the pushing element 15 tucks a portion of the web 10 between the gripping element and the receiving element. The gripping means 13 is cam-driven and opens and closes with respect to the angular position of the folding cylinder 11. Before reaching the position where the gripping means 13 and the pushing means 15 are in an adjacent position, the gripping means 13 opens to receive a portion of the web 10, and clamp it between the gripping element and the receiving element. Then the gripping means 13 closes and the web 10 is transmitted to an angular position of about 120°. In this position the gripping means 13 opens to release the web 10. Subsequently, the folding cylinder 11 rotates another 60°, so that the pushing means 14 can tuck the web 10 to the gripping element 16. The gripping element 16 grips the web 10 and transmits it to a position approximately 120° further before releasing the web 10. Finally, with a rotation of another 60°, the folding cylinders 11 and 12 move to the original position shown in Fig. 2, and the cycle starts again.

[0027] At the same time, the fingers 17 and 20 alternately press on the block 50 of folded material. In the position shown in Fig. 2, the fingers 17 are in a rest position between ribs integrated in the folding cylinder 11. Between the circumference of the fingers 17 and the circumference of the folding cylinder 11, a small gap is provided with a size sufficient to allow passing the clamped portion of the web 10 around to the block 50. When the gripping means 13 has moved about 120°, the gripping means 13 opens and releases a clamped portion of the web. Then the fingers 17 are pivoted around the holder 19 in order to press on the uppermost layer of web material on the block 50. Thus, the web 10 being moved along the folding cylinder 11 with high speed can be stopped abruptly in order to put down each layer of web material in an accurate position. As soon as the fingers 17 are pressing on the block 50, a new portion of web material 10 is fed between the folding cylinders 11 and 12 until the pushing means 14 press a portion of the web 10 to the gripping means 16 of the folding cylinder 12. Subsequently, the folding cylinder 12 rotates with the gripped portion of the web 10 around the fingers 20, which are in a rest position, while the fingers 17 are pressing on the block 50. When the gripping means 13 releases the web 10, the fingers 20 are pressing on the block 50, while the fingers 17 are moved to a rest position.

[0028] In Fig. 3 and 4, the lifting element 24 and its driving mechanism is shown.

[0029] The lifting element 24 supports a board 27 with rough surface for providing some frictional engagement between the lowermost layer of web material 10 of the block 50 and the board 27, so that during folding of the lower portion of the block 50 the web material 10 cannot slip away.

[0030] The driving mechanism of the lifting element 24 comprises a control unit (not shown) for controlling a motor 32, which is driving a lifting frame 26 via a transmission band 33. The lifting frame 26 provides a vertical movement of the lifting element 24 during the folding process. Therefore, the lifting apparatus 34 is guided on a rail 30 by rollers 35 contacting a guide element 36 of the rail 30. The driving mechanism itself can comprise toothed wheels and other appropriate means for transmitting the driving force of the motor 32 to the lifting element 24.

[0031] The lifting frame 26 drives a holder 40 supporting the lifting element 24 with a floating mechanism. On the holder 40, four cylinders with air cushion members 25 are provided for a flexible support of the lifting element 24. The air cushion members 25 can be locked, so that the lifting element 24 is fixed to the holder 40. In the lower position, the lifting element 24 is arranged on support members 41 being connected with the holder 40.

[0032] During the festooning of the web 10 to a block 50 of folded material, the degree of compression is

measured by wire strain gauge elements 18 and 21, respectively. The degree of pressure on the block 50 is transferred to a control unit analysing the data and comparing them to the pre-set optimum pressure. If the pressure on the block 50 is too high, the control unit sends a signal to increase the speed of the lifting element 24. If the pressure on the block 50 is too low, the control unit sends a signal to decrease the speed of the lifting element 24. Accordingly, the pressure on the block 50 can be maintained within a given range during the festooning process. It is also possible to adjust the degree of compression in relation to the height of the block 50, i. e. the higher the block 50, the higher the pressure on the block 50.

[0033] After festooning of the block 50, the web 10 can be cut before transporting the block 50 to another station. It is also possible to move the block 50 to a rest station and to festoon another block so that the block 50 and the other block are linked by a continuous portion of web material.

Claims

1. Block formation system for forming a block of folded material, preferably of nonwoven material or tissue, comprising folding means (11, 12) between which web material (10) is passing for folding the web (10) to a block (50), and pressing means (17, 20) acting on the block (50), whereby the block is layered on a lifting element (24) being movable relative to the folding means (11, 12), **characterized in that** means for controlling the relative movement of the lifting element (24) to the folding means (11, 12) with respect to the degree of compression of the block (50) are provided.

2. Block formation system according to claim 1, **characterized in that** the lifting element (24) has a flexible support device allowing a swinging movement of the lifting element (24).

3. Block formation system according to claim 2, **characterized in that** the flexible support device comprises air cushion members (25) supporting the lifting element (24).

4. Block formation system according to claim 2 or 3, **characterized in that** the flexible support device can be fixed in order to avoid any further swinging movement of the lifting element (24).

5. Block formation system according to one of claims 1 to 4, **characterized in that** a board (27) is provided on the lifting element (24) receiving the lowermost portion of the web material (10).

6. Block formation system according to claim 5, **characterized in that** the board (27) has a rough surface for frictional engagement between the lowermost portion of the web material (10) and the board (27).

7. Block formation system according to one of claims 1 to 6, **characterized in that** the lifting element (24) is formed as flat surface with holding elements to receive a board (27).

8. Block formation system according to one of claims 1 to 7, **characterized in that** the pressing means comprise a measuring unit for measuring the degree of compression on the block (50).

9. Block formation system according to claim 8, **characterized in that** the measuring unit is connected to a control unit, analysing the degree of compression and providing input data for controlling the vertical movement of the lifting element (24).

10. Method for controlling the folding of a block, comprising the steps of:

    - feeding web material (10) to a folding device (11, 12);
    - folding the web material (10) in a zigzag-like manner, thus building a block (50) of folded material on a lifting element (24);

    characterized in that
    pressing means (17, 20) act on the uppermost web layer and the degree of compression is measured and used for controlling the relative movement of the lifting element (24) with respect to the pressing means (17, 20).

11. Method according to claim 10, **characterized in that** the lifting element (24) is swinging in a perpendicular direction to the folding edges of the web material (10) in the beginning of the folding process.

12. Method according to claim 10 or 11, **characterized in that** the degree of compression on the block (50) is maintained within a given range during the block formation.

13. Method according to one of claims 10 to 12, **characterized in that** two folding cylinders (11, 12) are used for folding the web material (10) each being provided with pressing means (17, 20), and one set is pressing on the block (50) on one side while web material (10) is laid down on the opposite side of the block (50).

14. Method according to one of claims 10 to 13, **characterized in that** a board (27) is laid on the lifting element (24) before the block formation is started.

15. Method according to claim 14, **characterized in that** the board (27) and the block (50) are transported together as a package unit.

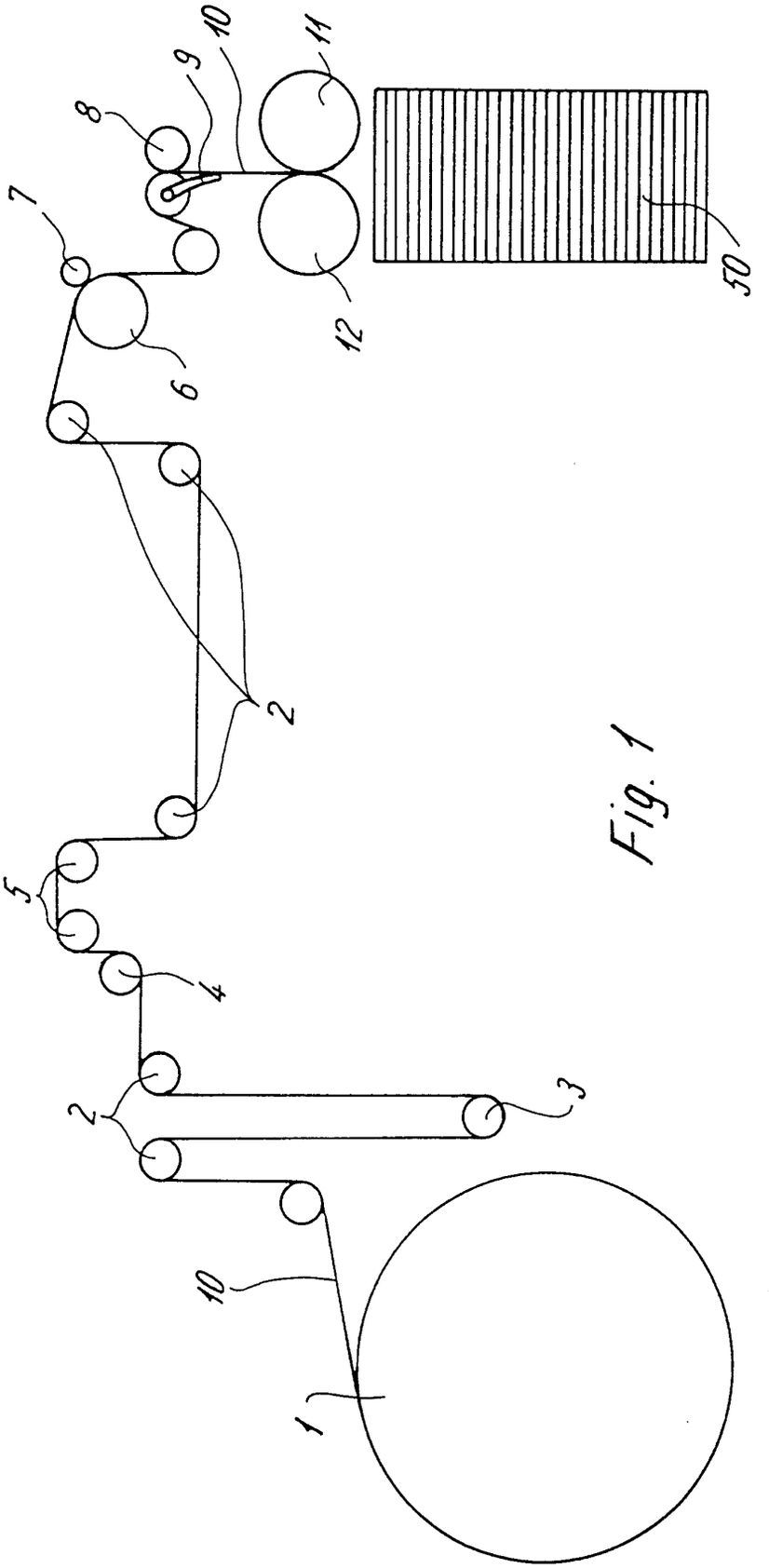

Fig. 1

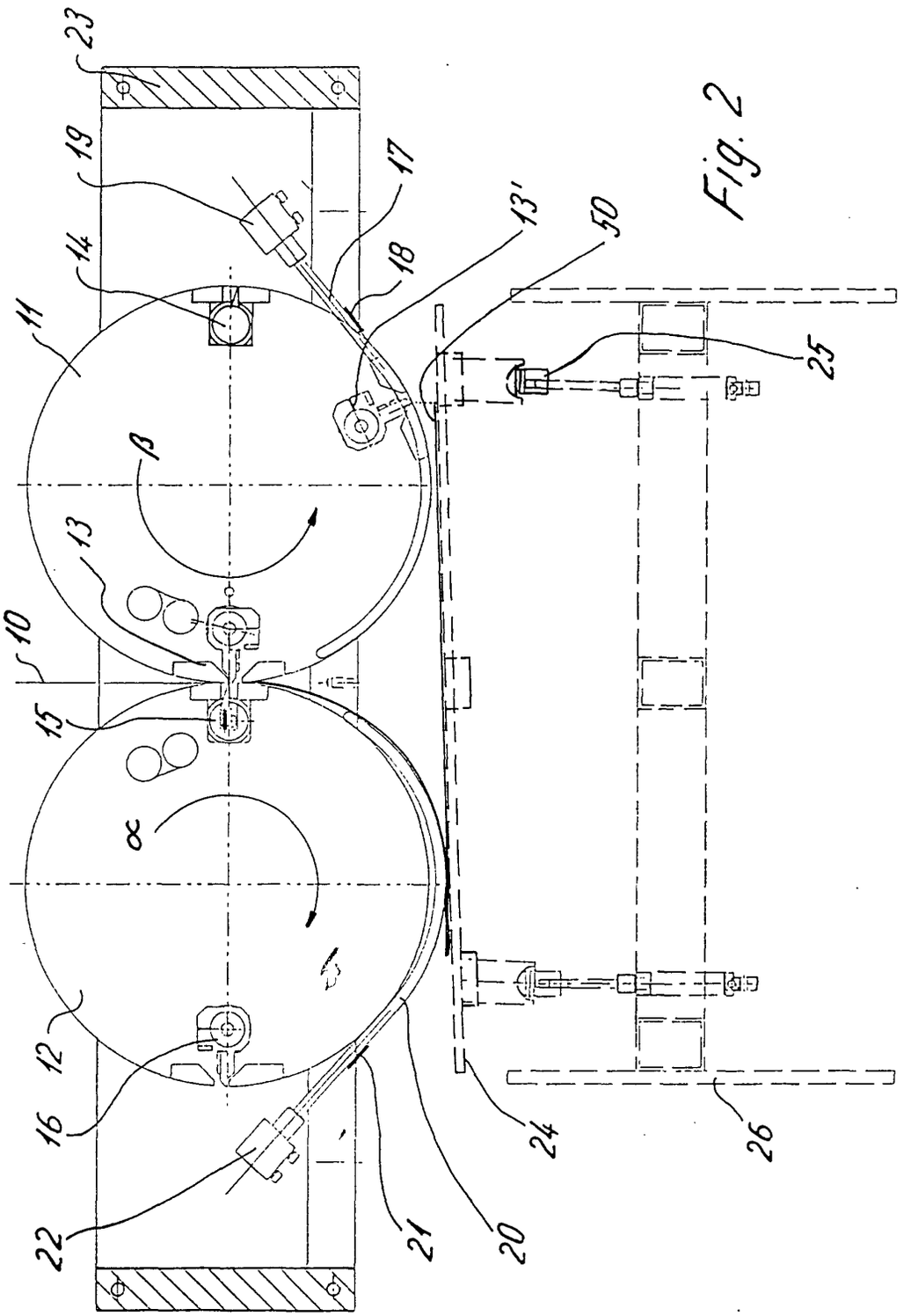

Fig. 2

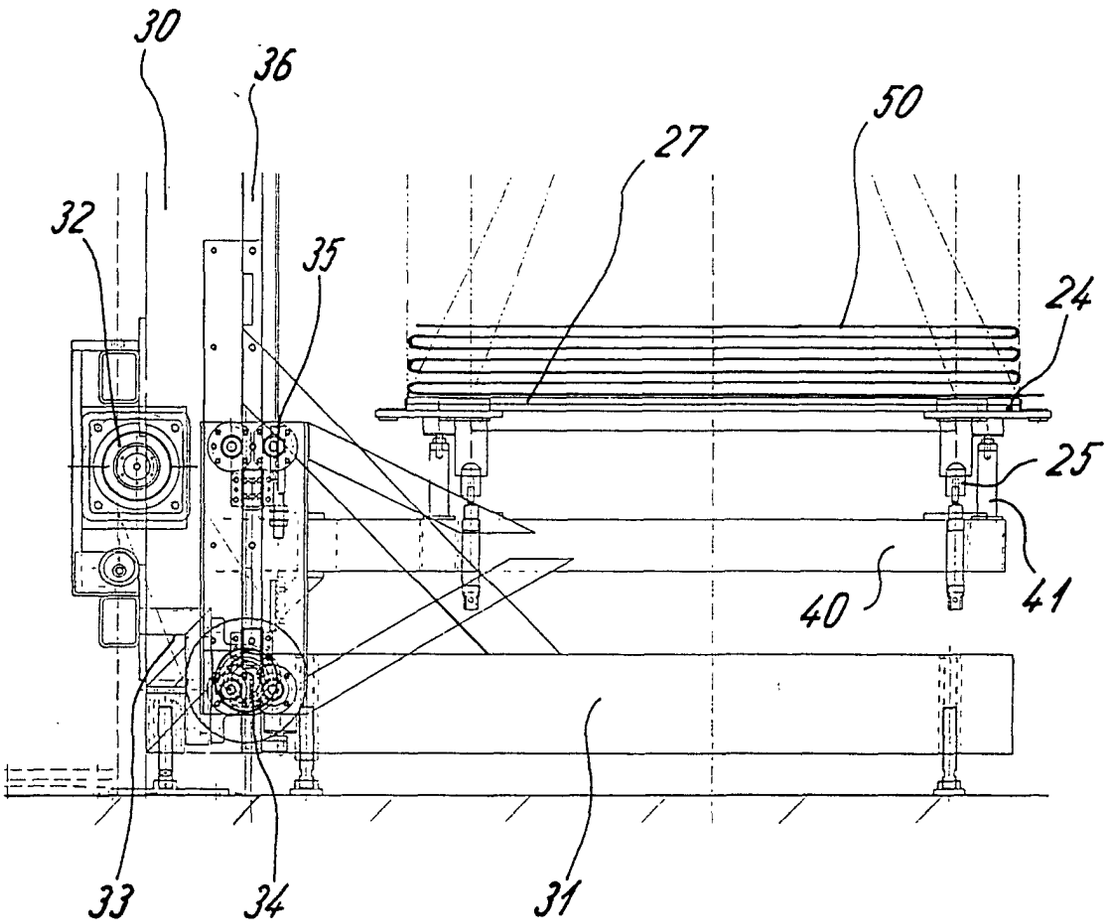

Fig. 3

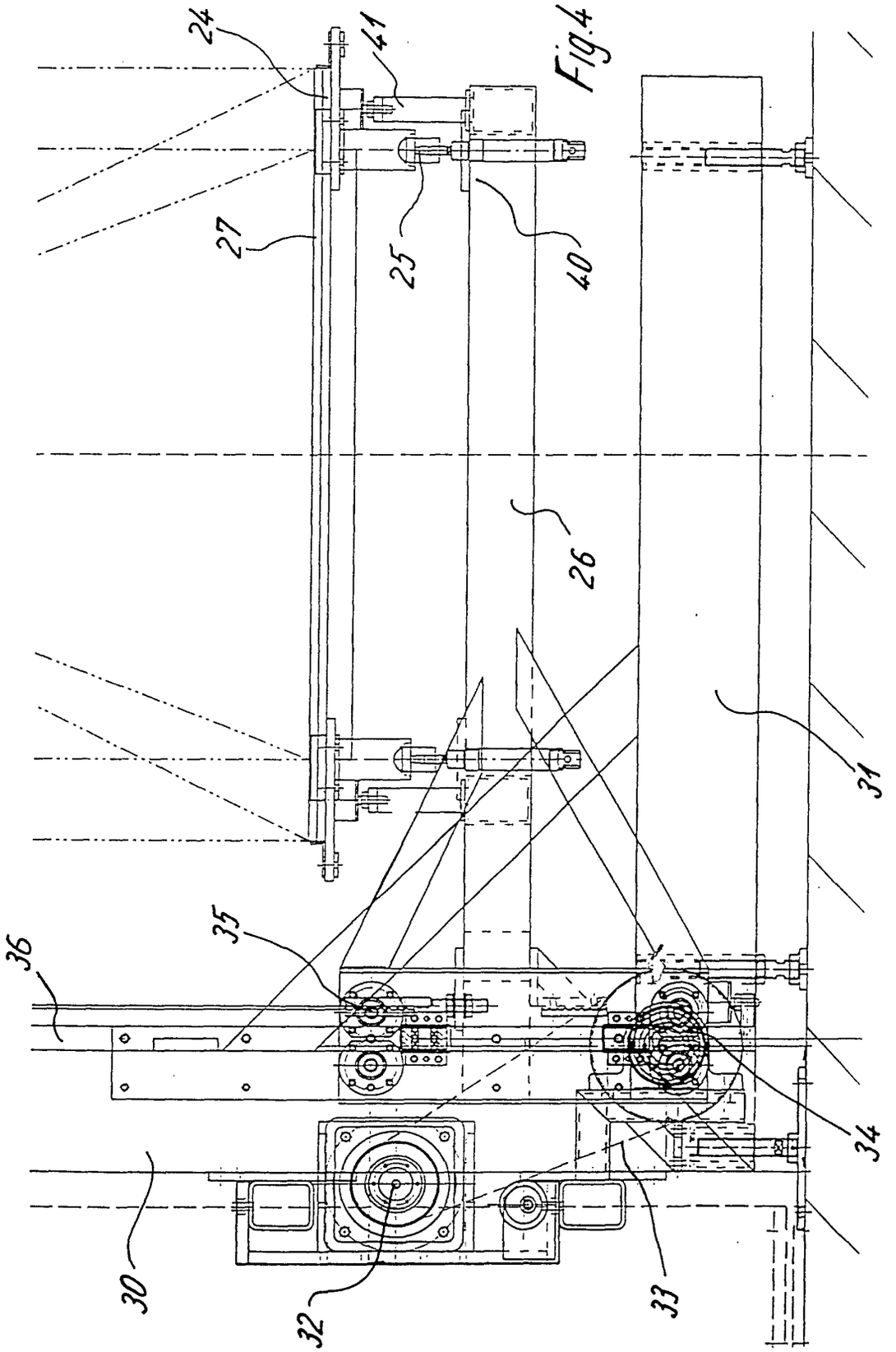

Fig.4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 12 6354

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	WO 92 02443 A (DALREN ENGINEERING AND MACHINERY LTD.) 20 February 1992 (1992-02-20) * page 4, line 19 - page 6, line 26; figures 2,3 *	1,10	B65H45/101 B65H45/20 B65H31/12
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 June 2001	Raven, P

CATEGORY OF CITED DOCUMENTS

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18-06-2001

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