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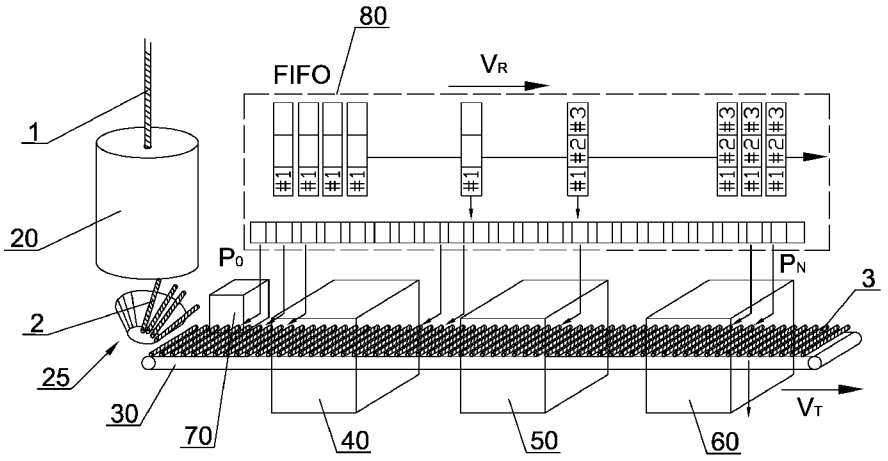

Fig. 2

(57) Abstract: The subject of the application is a apparatus (100) for manufacturing deformed paper spiral tubes (3), at least two-layered, provided with a functional deformation (3A, 3B, 3C, 3D) comprising in the first path (P1) at least two feeding units (S10, S11, S13) for feeding a material strand (10, 11, 12), at least one adhesive unit (13, 14, 15) for applying adhesive to the material strand (10, 11, 12) and a forming unit (4) comprising a forming mandrel (18) and a forming strip (19) winding about a fragment of the continuous spiral tube (1). The apparatus also includes a cutting unit (20) arranged to cut a single spiral tube (2) from the continuous spiral tube (1), a transfer unit (25) to alter the movement direction of a single spiral tube (2) from the direction along the axis (k) of a single spiral tube (2) in the first path (P1) to the direction transverse to the axis (k) of a single spiral tube (2) in the second path (P2), a conveyor (30) for receiving and transporting a stream of single spiral tubes (2) and deformed spiral tubes (3) along the second path (P2), and a

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forming module (40) for forming a functional deformation (3A, 3B, 3C, 3D) on the single spiral tube (2) in the second path (P2).

APPARATUS FOR MANUFACTURING DEFORMED PAPER SPIRAL TUBES

The subject of the invention is an apparatus for manufacturing deformed paper spiral tubes.

In the prior art, apparatuses for producing paper spiral tubes made of spirally overlaid paper strands bonded together by an adhesive connection are known.

In the publication EP3819113A, a method for manufacturing flexible paper straws is disclosed. This method involves the steps of preparing a paper tube, which includes manufacturing a spiral tube with the help of adhesive and paper, inserting a support roller axially into the paper tube, placing the paper tube with the support roller between a first forming roller and a second forming roller before the adhesive cures, while the first and second forming rollers are parallel and have multiple round grooves on their cylindrical surface, crimping the paper tube by the first and second forming rollers to create a corrugated section over a portion of the length of the paper tube, compressing the corrugated section to compress the corrugated section for a period to cure the adhesive and maintain the shape of the corrugated section, and removing the support roller to obtain a flexible paper straw that can be bent at the corrugated section.

A problem occurring in the industry associated with the application of known solutions is low efficiency and the large area occupied by the production apparatus.

The essence of the invention is an apparatus for manufacturing deformed paper spiral tubes, at least two-layered, provided with a functional deformation, comprising at least two feeding units for feeding a material strand, at least one adhesive unit for applying adhesive to the material strand, and a forming unit comprising a forming mandrel and a forming strip winding about a fragment of the continuous spiral tube. The apparatus comprises also a cutting unit arranged to cut a single spiral tube from the continuous spiral tube, a transfer unit to alter the movement direction of the single tube from the direction along the axis of the single spiral tube in the first path to the direction transverse to the axis of the single spiral tube in the second path, a conveyor to receiving and transporting a stream of single spiral tubes and deformed spiral tubes along the second path, and a forming module for forming a functional deformation on a single spiral tube in the second path.

Preferably, the apparatus is characterized in that the forming module is provided with a forming element movable in the direction of the axis of a single spiral tube, arranged to form the end part deformation of the single deformed spiral tube.

Preferably, the apparatus is characterized in that the forming module is provided with forming elements movable in the direction of the axis of a single spiral tube and to the axis of the single spiral tube, arranged to form the deformation on the side surface of a single spiral tube.

Preferably, the apparatus is characterized in that the forming module is provided with forming elements movable in the direction of the axis of a single tube, arranged to form the deformation on the side surface of a single spiral tube.

Preferably, the apparatus is characterized in that it is moreover provided with a quality control module for the deformed spiral tube exiting the forming module on the second path.

Preferably, the apparatus is characterized in that the quality control module measures at least two quality parameters of a deformed spiral tube.

Preferably, the apparatus is characterized in that the quality control module carries out the measurement of parameters of at least one of the front surfaces of a deformed spiral tube.

Preferably, the apparatus is characterized in that the apparatus is also provided with a rejecting module arranged to reject single deformed spiral tubes for which the measurement result in the quality control module did not achieve threshold values for at least one of the quality parameters of a deformed spiral tube.

Preferably, the apparatus is characterized in that the apparatus is provided with at least one observation module, which is arranged to monitor and record in the controller memory the position of the deformed spiral tubes exiting the transfer unit.

Preferably, the apparatus is characterized in that the quality control module records the positions and data assigned to single deformed spiral tubes on the second path in a FIFO shift register synchronized with the transport speed of the deformed spiral tubes on the second path.

Preferably, the apparatus is characterized in that the observation module is placed in the FIFO shift register the position of the deformed spiral tubes on the second path and data including at least one of the parameters selected from the group comprising in particular: tube identifier, first quality parameter related to tube ovality and determined by the quality control module, second quality parameter related to the functional feature made by the forming module and determined by the quality control module.

Preferably, the apparatus is characterized in that the forming module is provided with a cutting module for cutting the deformed spiral tubes obliquely.

The advantage of the solution according to the invention is providing a production apparatus that ensures increased efficiency and occupies less space in the limited area of the production hall. The apparatus allows for the control of individual tubes having functional deformations before they are fed to the next technological operation and rejection of defective tubes.

The subject of the invention is further illustrated in a preferred embodiment in the drawing, in which:

Fig. 1 shows schematically an apparatus according to the invention in the first embodiment,

Fig. 2 shows schematically an apparatus according to the invention in another preferred embodiment,

Fig. 3a, 3b show the forming unit in the first embodiment,

Fig. 4a, 4b show the forming unit in the second embodiment,

Fig. 5 shows the forming unit in the third embodiment,

Fig. 6a, 6b show the forming unit in the fourth embodiment.

In Fig. 1, an apparatus 100 for manufacturing deformed paper spiral tubes 3, at least two-layered and provided with functional deformations 3A, 3B, 3C, 3D, is shown. The apparatus 100 comprises in the first path P1 at least two feeding units S10, S11 for feeding material strands 10, 11, preferably also a third feeding unit S12 for feeding the third material strand 12. Furthermore, at least one adhesive unit 13, preferably each material strand is provided with a dedicated adhesive unit 14, 15 for applying adhesive to each material strand 10, 11, 12. The apparatus 100 in the first path P1 includes a forming unit 4 comprising a forming mandrel 18 and a forming strip 19 stretched over tensioning rollers 16, 17, winding about a fragment of the continuous spiral tube 1. Additionally, the apparatus 100 includes a cutting unit 20 arranged to cut a single spiral tube 2 from the continuous spiral tube 1, and a transfer unit 25 to change the movement direction of the single spiral tube 2 from the direction along the axis of the single spiral tube 2 in the first path P1 to the direction transverse to the axis of the single spiral tube 2 in the second path P2. The transfer unit 25, which alters the direction of transport of single spiral tubes 2, is preferably a conical conveyor, but it may be another type of feeder, e.g., a vacuum gripper feeder (spider). Furthermore, the apparatus 100 is provided with a conveyor 30 for

receiving and transporting single spiral tubes 2 along the second path P2, and a forming module 40 for forming functional deformation on single spiral tubes 2, creating functionally deformed spiral tubes 3 moving transversely to the axis of the spiral tube 3 in the second path P2.

In a preferred embodiment shown in Fig. 3a, the forming module 40 is provided with a forming element 41 movable in the direction of the axis of the single spiral tube 2, and arranged to form the end part deformation of the single spiral tube 3. In Fig. 3b, the forming element 41 is shown in the position after forming the functional deformation 3A in the form of a conical expansion of the end of the deformed spiral tube 3. By using another forming element, it is also possible to crimp the end of the spiral tube 3 inward. Such deformations of the spiral tube 3 are axisymmetric.

In another preferred embodiment shown in Fig. 4a, the forming module 40 is provided with movable forming elements 42 arranged to form the deformation on the side surface of the single spiral tube 2, movable in the direction parallel to the axis k and in the transverse direction to the axis k. In Fig. 4b, the movable forming element 42 is shown in the position after moving in the direction R towards the axis k and in the direction S transverse to the axis k, forced by the stationary limiter 43, so that a functional deformation 3B in the form of a crimping is created in the spiral tube 3. Multiple crimps can be formed on the tube at diverse distances from each other.

Alternatively, the forming module 40 is provided with forming elements movable towards the axis of the single spiral tube 2, arranged to form the deformation on the side surface of the single spiral tube 3. In the embodiment shown in Fig. 5, the forming module 40 comprises a rotary mandrel 44 provided with grooves 45 and a rotary roll 46 provided with circumferential projections 47. Moving the rotary roll 46 causes the formation of functional deformation 3C in the form of circumferential grooves on the spiral tube 3, during forming, the spiral tube 3 is in the groove 48.

In another preferred embodiment shown in Fig. 6a, the forming module 40 is provided with movable forming elements 49 arranged to form a functional deformation 3D in the form of flattening of the end of the spiral tube 3 cut at an angle, where the flattening is done in a direction essentially perpendicular to the axis of the tube 3. The movable forming elements 49 can also take the form of a cutting module with a knife for obliquely cutting the spiral tube 3 (the cutting module is not shown in Fig. 6a). The cutting module with a knife is arranged to obliquely cut the

spiral tube 3 in the middle, so that two obliquely cut tubes are formed. Other embodiments are possible, in which the oblique cutting of the spiral tube 3 occurs at the end of the spiral tube 3, by cutting off a fragment of the tube. It should be emphasized that the cutting itself can be treated as a deformation of the tube 3. The forming elements 49 are also arranged to move in the direction S and squeeze the end of the spiral tube 3 at a right angle. The functional deformation 3D in the form of deformation of the end of the spiral tube 3, resulting from the compression of the tube by the forming elements 49 in the direction S, causes the end to become stiffer, which is significant for piercing a beverage package.

In another preferred embodiment shown in Fig. 2, the apparatus 100 is additionally provided with a quality control module 50 for the deformed spiral tube 3 exiting the forming module 40 on the second path P2.

The quality control module 50 measures at least two quality parameters of the deformed spiral tube 3. Quality parameters of the deformed spiral tube 3 can include parameters related to the tube itself, such as length, diameter, and ovality. The quality control module 50 measures these parameters using optical methods by measuring the image of the front or side surface of the deformed spiral tube 3, or by other measurement methods ensuring non-destructive testing of the parameters of the deformed spiral tube 3, such as its moisture content, wall thickness using measurement methods utilizing penetrating or infrared radiation.

The quality control module 50 is preferably arranged to measure at least two quality parameters of the deformed spiral tube 3, whereas the second parameter relates to the functional deformation performed in the forming module 40, such as the depth of indentations, the distance between indentations, and the maintenance of the linearity of the indentations. The measured parameters can be absolute parameters expressed in SI units, or relative measurements expressed as a percentage of the base or expected value, such as the percentage penetration of the indentations formed in the forming module 40, defined as the ratio of the indentation depth made in the side wall of the deformed spiral tube 3 to the total thickness of the side wall of the deformed spiral tube 3.

In a preferred embodiment of the apparatus 100, the quality control module 50 provides the measurement of parameters of at least one of the front surfaces of the deformed spiral tube 3.

In a preferred embodiment, the apparatus 100 is also provided with a rejecting module 60 arranged to reject individual deformed spiral tubes 3 for which the measurement result in the

quality control module 50 did not achieve threshold values for at least one of the quality parameters of the tube.

In another preferred embodiment, the apparatus 100 is provided with at least one observation module 70, which is arranged to monitor and record in the controller memory the position of the tubes exiting the transfer unit 25.

The observation module 70 records the positions and data assigned to individual single tubes 2 and deformed spiral tubes 3 on the second path in a FIFO shift register synchronized with the transport speed of single tubes 2 and deformed spiral tubes 3 on the conveyor 30 in the second path P2. The FIFO shift register reflects the geometry of the conveyor 30, meaning that the segment of memory in the controller occupied by the FIFO shift register reflects the individual sections of the length of the conveyor 30. This means that the conveyor 30 is assigned a model in the controller memory, the model being divided into segments pN in the range from p0 to pN, where N denotes the number of segments into which the model of the conveyor 30 is divided. The segments p are assigned numerical values corresponding to the consecutive single spiral tubes 2 and deformed spiral tubes 3 introduced onto the conveyor 30, such parameters, marked on the drawing as #1, #2, #3, are, e.g., tube identifier, first quality parameter, second quality parameter, process operation markers, etc. The set of parameters #1, #2, #3 in the FIFO shift register 80 in segment pN corresponding to the single spiral tube 2 and deformed spiral tube 3 successively shifts to the next segment pN+1 synchronously with the movement of the conveyor 30. The speed of the FIFO shift register VR is synchronized with the transport speed VT of the single spiral tubes 2 and deformed spiral tubes 3 on the conveyor 30 along the second path P2. This allows obtaining in the controller memory a dynamic model reflecting the position and state of the single spiral tubes 2 and deformed spiral tubes 3 located on the conveyor 30 in the second path P2. As the single spiral tubes 2 and deformed spiral tubes 3 move along the path P2, the set of data describing the individual single spiral tubes 2 and deformed spiral tubes 3 changes as a result of performing technological operations or quality measurements.

The observation module 70 places in the FIFO shift register 80 the position of the single spiral tubes 2 and deformed spiral tubes 3 on the second path P2, and data including at least one of the parameters #1, #2, #3 selected from the group comprising in particular: tube identifier, the first quality parameter related to the ovality of the tube and determined by the quality control module 50, the second quality parameter related to the functional feature made by the forming module 40 and determined by the quality control module 50. The data concerning the single spiral tubes 2 and deformed spiral tubes 3 in the FIFO shift register 80 are preferably also placed

by the other modules 40, 50, 60, while the information concerning the speed VT of the conveyor 30 comes from measurement units, e.g., from encoders of the drive systems or independent measurement sensors.

List of designations:

1 - continuous spiral tube

2 - single spiral tube

3 - deformed spiral tube

3A - functional deformation in the form of a conical expansion of the end

3B - functional deformation in the form of a crimp

3C - functional deformation in the form of circumferential grooves

3D - functional deformation in the form of end flattening

4 - forming unit

10 - material strand

11 - material strand

12 - material strand

13 - adhesive unit

14 - adhesive unit

15 - adhesive unit

16 - tensioning roller

17 - tensioning roller

18 - forming mandrel

19 - forming strip

20 - cutting unit

25 - transfer unit

30 - conveyor

40 - forming module

41 - forming element

42 - movable forming elements

43 - stationary limiter

44 - rotary mandrel

45 - grooves

46 - rotary roll

47 - circumferential projections

49 - forming elements

50 - quality control module

60 - rejecting module

70 - observation module

80 - FIFO shift register

100 - apparatus for manufacturing single spiral tubes

P1 - first path

P2 - second path

VT - tube transport speed

VR - FIFO shift register speed

k - axis

R - tube/mandrel rotation direction

S - forming element movement direction

N - number of segments of shift register

pn, p0, pN - shift register segments

S10, S11, S12 - feeding units for feeding material strands

Claims

1. An apparatus (100) for manufacturing deformed paper spiral tubes (3), at least two-layered, provided with a functional deformation (3A, 3B, 3C, 3D) comprising in the first path (P1)

at least two feeding units (S10, S11, S13) for feeding a material strand (10, 11, 12),

at least one adhesive unit (13, 14, 15) for applying adhesive to the material strand (10, 11, 12),

a forming unit (4) comprising a forming mandrel (18) and a forming strip (19) winding about a fragment of the continuous spiral tube (1),

a cutting unit (20) arranged to cut a single spiral tube (2) from the continuous spiral tube (1),

a transfer unit (25) to alter the movement direction of the single tube (2) from the direction along the axis (k) of the single spiral tube (2) in the first path (P1) to the direction transverse to the axis (k) of the single spiral tube (2) in the second path (P2),

a conveyor (30) for receiving and transporting a stream of single spiral tubes (2) and deformed spiral tubes (3) along the second path (P2), and

a forming module (40) for forming a functional deformation (3A, 3B, 3C, 3D) on a single spiral tube (2) in the second path (P2).

2. The apparatus according to claim 1, characterized in that the forming module (40) is provided with a forming element (41) movable in the direction of the axis (k) of the single spiral tube (2), arranged to form the end part deformation (3A) of a single deformed spiral tube (3).

3. The apparatus according to claim 1, characterized in that the forming module (40) is provided with forming elements (42) movable in the direction of the axis (k) of the single spiral tube (2) and to the axis (k) of a single spiral tube (2), arranged to form the deformation (3B) on the side surface of a single spiral tube (2).

4. The apparatus according to claim 1, characterized in that the forming module (40) is provided with forming elements (42, 49) movable in the direction of the axis (k) of the single tube (2), arranged to form the deformation on the side surface of a single spiral tube (2).

5. The apparatus according to any of claims 1 to 4, characterized in that it is moreover provided with a quality control module (50) for the deformed spiral tube (3) exiting the forming module (40) on the second path (P2).

6. The apparatus according to claim 5, characterized in that the quality control module (50) measures at least two quality parameters of a deformed spiral tube (3).

7. The apparatus according to claim 5 or 6, characterized in that the quality control module (50) carries out the measurement of parameters of at least one of the front surfaces of a deformed spiral tube (3).

8. The apparatus according to any of claims 5 to 7, characterized in that the apparatus (100) is also provided with a rejecting module (60) arranged to reject single deformed spiral tubes (3), for which the measurement result in the quality control module (50) did not achieve threshold values for at least one of the quality parameters of a deformed spiral tube (3).

9. The apparatus according to any of claims 1 to 8, characterized in that the apparatus (100) is provided with at least one observation module (70), which is arranged to monitor and record in the controller memory the position of spiral tubes (2) exiting the transfer unit (25).

10. The apparatus according to claim 9, characterized in that the quality control module (50) records the positions and data assigned to single deformed spiral tubes (3) on the second path (P2) in a FIFO shift register (80) synchronized with the transport speed (V_T) of the deformed spiral tubes (3) on the second path (P2).

11. The apparatus according to claim 10, characterized in that the observation module (70) is placed in the FIFO shift register (80), the position of the deformed spiral tubes (3) on the second path (P2), and data including at least one of the parameters selected from the group

comprising in particular: tube identifier, first quality parameter related to the ovality of the tube and determined by the quality control module (50), second quality parameter related to the functional feature made by the forming module (40) and determined by the quality control module (50).

12. The apparatus according to any of the preceding claims, characterized in that the forming module (40) is provided with a cutting module for obliquely cutting the deformed spiral tubes (3).

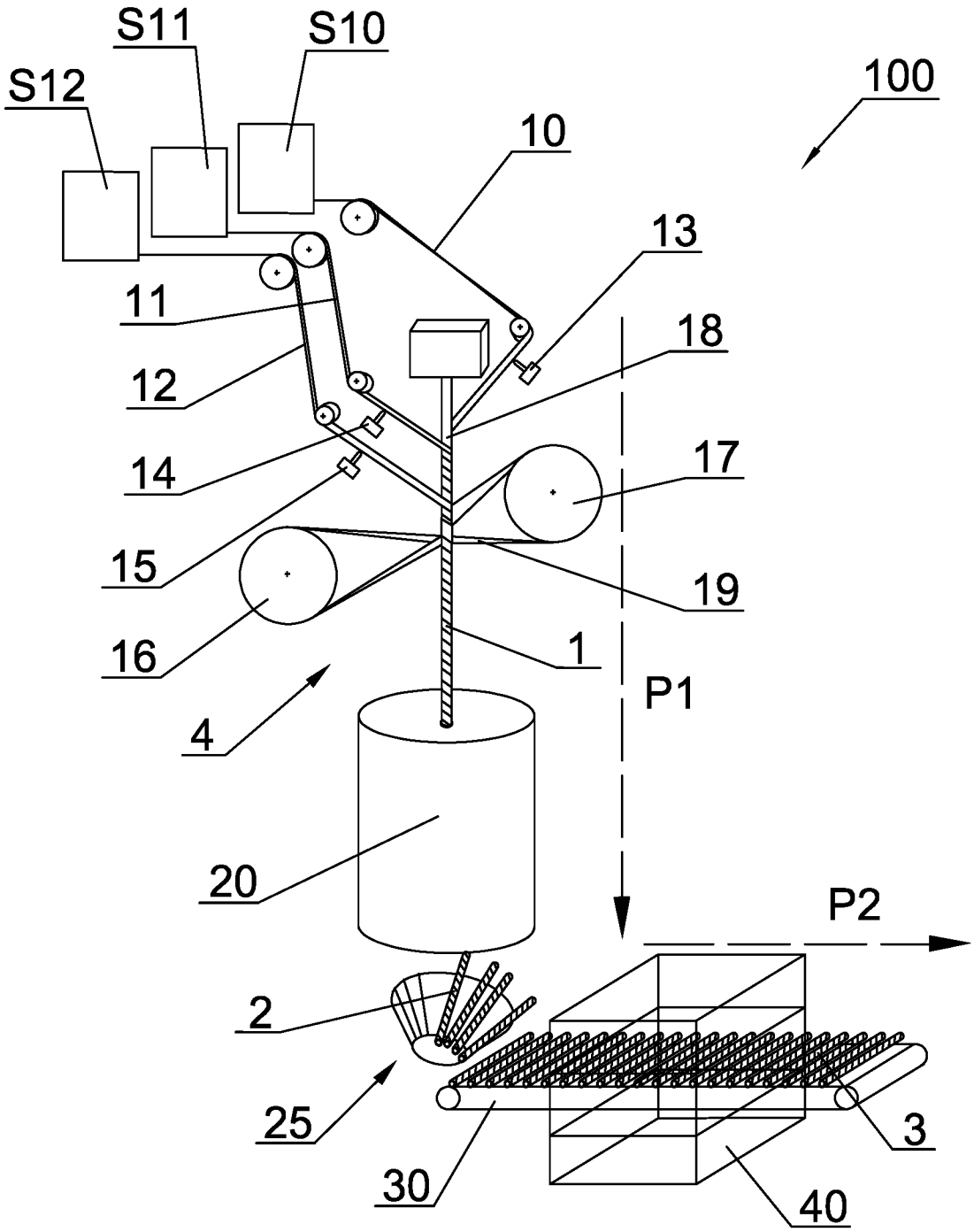

Fig. 1

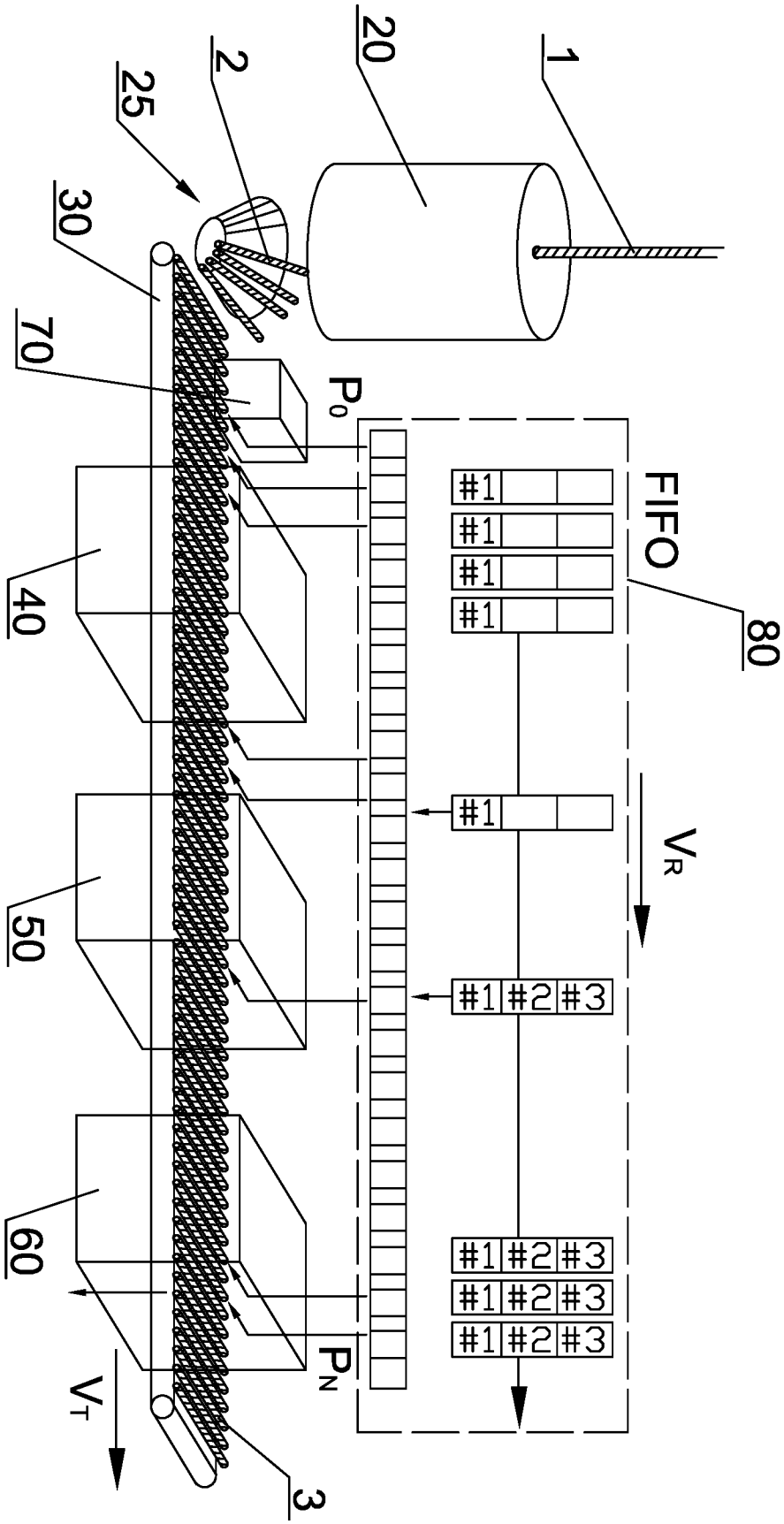

Fig. 2

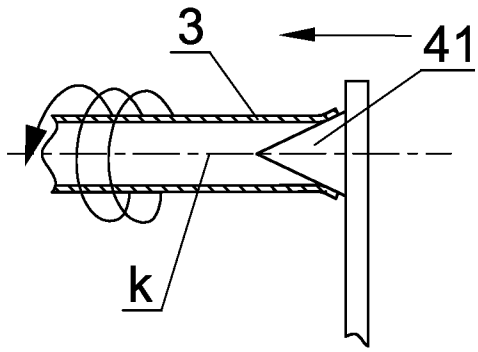

Fig. 3a

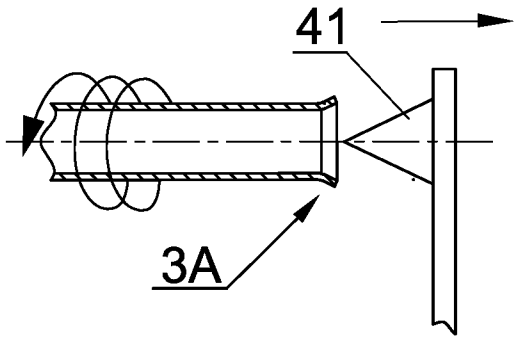

Fig. 3b

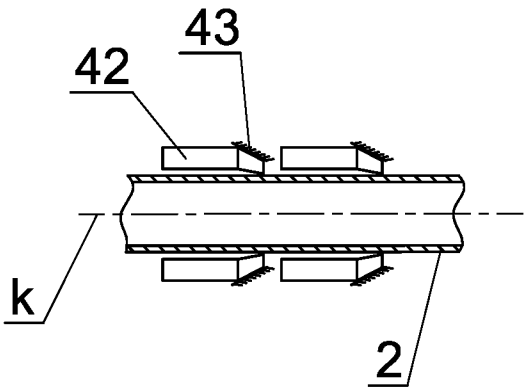

Fig. 4a

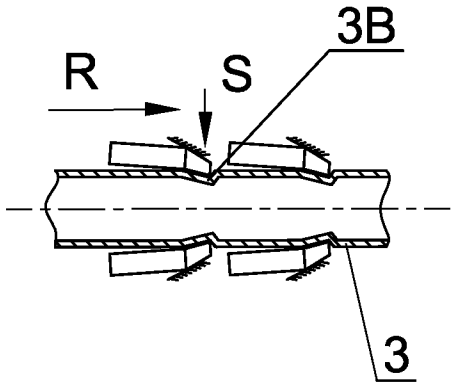

Fig. 4b

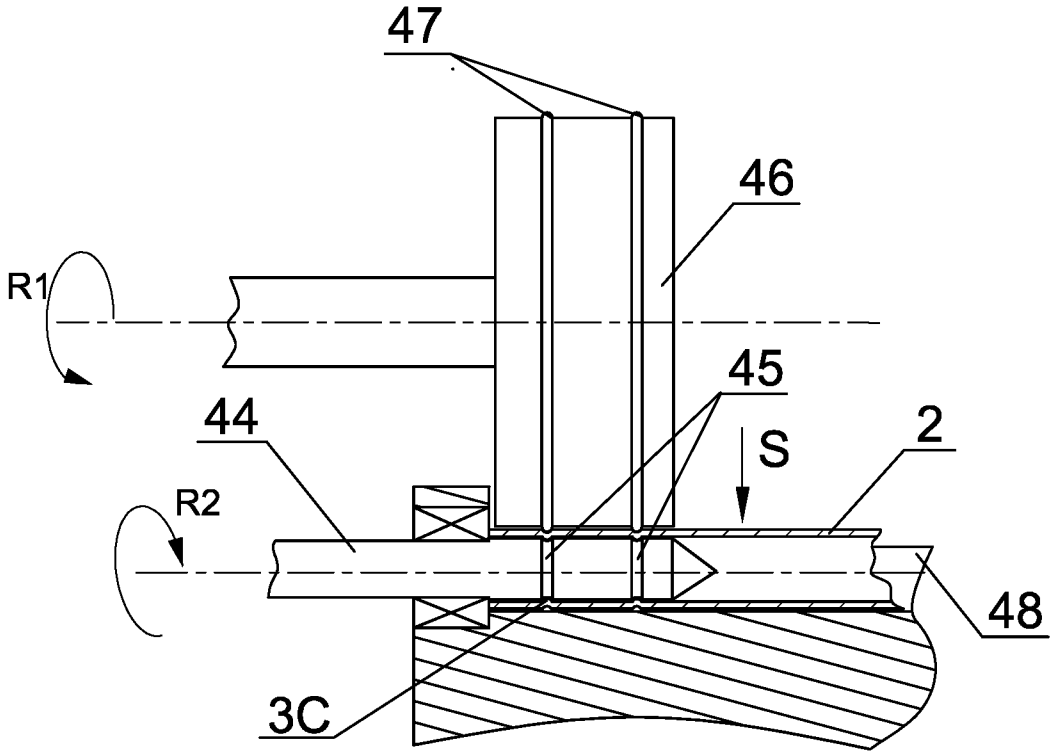

Fig. 5

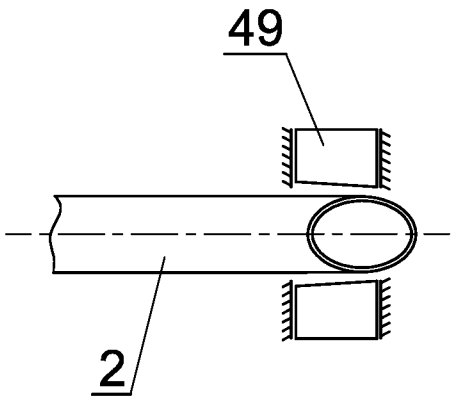

Fig. 6a

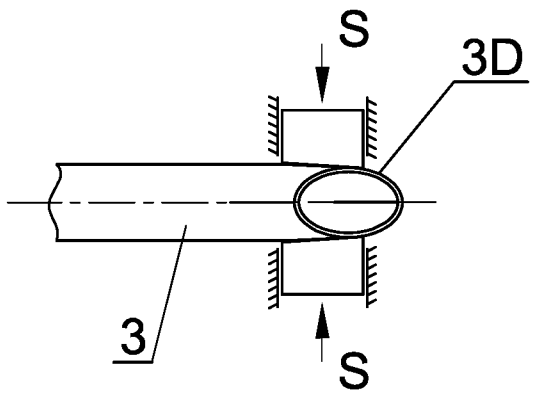

Fig. 6b

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2024/055432

A. CLASSIFICATION OF SUBJECT MATTER

INV. B31C3/00 B31C11/02 B31D5/00 B31F1/00 B31F1/20
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B31C B31D B31F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 3 981 585 A1 (INT TOBACCO MACHINERY POLAND SP ZOO [PL]) 13 April 2022 (2022-04-13)	1,2,4-6, 8,12
A	paragraph [0033] - paragraph [0034]; figure 1	3,7,9-11

Y	DE 10 2019 104588 A1 (5G INVEST GMBH & CO KG [DE]) 27 August 2020 (2020-08-27)	1,2,4-6, 8,12
A	paragraph [0037]; figures 4-8,11 paragraph [0039] - paragraph [0051] paragraph [0054]	3,7,9-11

Y	DE 34 27 732 A1 (OVERBECK GMBH & CO) 20 March 1986 (1986-03-20) page 19, line 5 - page 20, line 8; figures 15-17	4

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[x] Further documents are listed in the continuation of Box C.

[x] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
13 September 2024	27/09/2024

Name and mailing address of the ISA/	Authorized officer
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