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(54) Title: A WINDING DEVICE FOR A FIBROUS WEB AND A METHOD OF WINDING ROLLS OF PARTIAL WEBS IN THE WINDING DEVICE

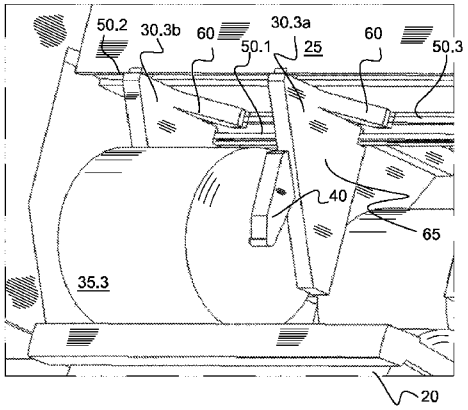

FIG. 3

(57) Abstract: The present invention relates to a winding device (10) for a fibrous web comprising at least two winding stations (30.1 a, 30.1 b, 30.2a, 30.2b, 30.3a, 30.3b) arranged to support a roll (35.1, 35.2, 35.3) to be wound in the winding device by means of centre support from the roll core, and at least one support roll (20) to support the roll (35.1, 35.2, 35.3) to be wound in the winding device by means of circumferential support. The winding stations (30.1 a, 30.1 b, 30.2a, 30.2b, 30.3a, 30.3b) are shaped so that they may be positioned so as to overlap each other at least partially. The invention also relates to a method of winding partial web rolls in the winding device (10).

WO 2010/031906 A2

A WINDING DEVICE FOR A FIBROUS WEB AND A METHOD OF WINDING ROLLS OF PARTIAL WEBS IN THE WINDING DEVICE

The invention relates to a winding device for a fibrous web according to the preamble of claim 1 comprising at least two winding stations arranged to support the roll to be wound in the winding device by means of centre support from the roll core, and at least one support roll to support the roll to be wound in the winding device by means of circumferential support, and in which winding device the winding stations are supported movably onto a support beam parallel to said support roll of the winding device.

The invention also relates to a method of winding rolls of partial webs in a winding device according to the preamble of claim 9, in which method partial webs are led to the rolls through the nip between the support roll and the rolls, at the same time supporting each roll by at least two winding stations from the roll core, in which method the rolls are formed alternately on the first and second side of the support roll with respect to the vertical plane passing through the rotation axis of the support roll, and in which method, as soon as the rolls are completed, the rolls formed on the first side of the support roll are removed from the winding device and thereafter the rolls formed on the second side of the support roll are removed via the first side of the support roll.

On the winder, the machine rolls produced by a fibre web machine are converted into customer rolls by unwinding the machine rolls, slitting the web of full width into partial webs and by winding up the partial webs into customer rolls.

Different types of winding devices are used on the winders depending e.g. of the type of the fibre web to be wound.

One winding device type is a so-called single drum winder. In a single drum winder the web rolls are supported partly by means of circumferential support against the support roll and partly by means of centre support by utilising seats

fitted in the hole in the spool that forms the roll core. One winding device of this type is disclosed in FI 100467. In the solution of this kind, the customer roll to be wound from slit partial webs is formed by placing every second roll to be formed on the other side of the support roll than the previous one, i.e. they are placed alternately with respect to the support roll. This makes it possible to accommodate the winding stations providing the centre support in the vicinity of each roll end.

In single drum winders the distance between the winding apparatus and the unwinding station is typically long. This is mainly due to the fact that the removal and moving away of completed rolls from the winding device traditionally takes place from that side of the support roll where the roll has been produced. Due to the long distance from the unwinding to the wind-up apparatus it is more crucial to keep the web travel stable and also a more complicated tail threading equipment is required.

DE 298 13 271 U1 discloses a single drum winder, in which the removal of all rolls is arranged to take place on the same side of the support roll. This is suggested to be is embodied so that the beam supporting the winding stations is arranged movably with respect to the support roll, whereby the winding stations can be lifted up, by shifting the beam after a completed roll set, to the extent that all the completed customer rolls can be removed from the winding device to the same side thereof over the support roll. This kind of a solution is, however, very difficult to put into practise. The beam supporting the winding stations needs to be very rigid and therefore its mass needs to be large as well. Moreover, the positioning of the beam requires precision, since the winding stations and the winding ends supported thereto need to be accurately controllable in order to form a roll of good quality. Further in practise, it is necessary to transmit different kind of information and/or energy to the winding stations and this is difficult to perform in a movable construction.

One object of the invention is thus to provide a winding device, which solves the above-mentioned problems related to prior art.

The objects of the invention are achieved primarily by a winding device disclosed in the appended claim 1 and by a method disclosed in claim 9.

A winding device for a fibrous web according to one embodiment of the invention comprises at least two winding stations arranged to support the roll to be wound in the winding device by means of centre support from the roll core, and at least one support roll to support the roll to be wound in the winding device by means of circumferential support. The invention is primarily characterised in that the winding stations are shaped so that they can be positioned so as to overlap each other at least partially.

A winding device for a fibrous web according to one embodiment of the invention comprises at least two winding stations arranged to support the roll to be wound in the winding device by means of centre support from the roll core, and at least one support roll to support the roll to be wound in the winding device by means of circumferential support, and in which winding device the winding stations are supported movably onto a support beam or the like parallel to said support roll of the winding device, and in which each individual winding station has a width parallel to the support beam or the like. In this case, the winding stations are shaped so that their combined width parallel to individual support beams is larger than their total width, when the stations are in conjunction with one other or in the vicinity of each other.

In practise, this makes it possible to position the winding stations so as to overlap each other, at least partially, in a space-saving manner.

A winding station is preferably supported from its body part onto a first and second guide and the winding station comprises at least one support arm or the like, by means of which the winding station is supported onto the support beam or the like from a different supporting point than the body part.

Said support arm or the like extends from the plane passing through the supporting points of the body part of the winding station and the supporting

point of the roll to a distance, whereby the winding station can be supported rigidly enough in operational situations. It is important that by means of the support arm it is possible to support the winding station at a distance from said plane, and a similar effect may, instead of an arm structure, be also provided by other kinds of solutions.

The support arm and the body part of the winding station are arranged so that their areas are, at least partially, non-intersecting in the lateral plane of projection of the winding station. This being the case, it is possible to position two adjacent winding stations so as to overlap one another at least partially.

In the method of winding rolls of partial webs in a winding device according to one embodiment of the invention partial webs are led onto the rolls through the nip between a support roll and the rolls, at the same time supporting each roll by two winding stations from the roll core, in which method the rolls are formed alternately on the first and second side of the support roll with respect to the vertical plane passing through the rotation axis of the support roll, and in which method, as soon as the rolls are completed, the rolls formed on the first side of the support roll are removed from the winding device and thereafter the rolls formed on the second side of the support roll are removed via the first side of the support roll. The invention is mainly characterised in that before the rolls formed on the second side are removed, the winding stations on the first side are relocated so that there will space for the removal of the rolls formed on the second side.

The winding stations on the first side are preferably relocated so that at least a part of the winding stations are taken to a position overlapping one another at least partially, away from the path of the rolls formed on the second side of the support roll.

The winding station of a winding device according to one embodiment of the invention comprises a body part, at which at least two connecting members are arranged for connecting the winding station to the guide system of the winding

device. Further, the winding station comprises a support arm, on which a third connecting member is arranged for connecting the support arm to the guide system of the winding device.

Preferably, the support arm and the body part the winding station are arranged so that their areas are non-intersecting, at least partially, in the lateral plane of projection of the winding station in order to make it possible for two winding stations to overlap one another at least partially.

Additional characteristic features of the invention are disclosed in the appended claims.

Numerous advantages are achieved by the present invention. By the winding device according to the invention, which is provided with winding stations according to the invention, the rolls can be delivered to only one side of the winding apparatus, which shortens the distance between the winding apparatus and the unwinder. This means less work at the construction stage, since the space requirement is smaller, and simplifies the transfer of the web/partial webs between the unwinder and the winding device.

The solution according to the invention provides a technically reliable winding device with a simple structure.

In the following, the invention and its operation will be explained with reference to the appended schematic drawings, of which

- Figure 1 shows a winding device for partial webs according to one embodiment of the invention as a side elevation,
- Figure 2 shows the winding stations and rolls of the winding device according to Figure 1 as a view from above,
- Figure 3 shows a part of the winding device according to Figure 1 seen from behind, i.e. from the delivery side of the rolls,

- Figure 4 shows the operation of the winding station according to one embodiment of the invention,
- Figure 5 shows a lateral projection of the winding station according to one embodiment of the invention,
- Figure 6 shows a lateral projection of the winding station according to another embodiment of the invention,
- Figure 7 shows the winding device of Figure 1 in another method step,
- Figure 8 shows the winding stations of the winding device and the rolls according to Figure 7 as a view from above,
- Figure 9 shows the winding device of Figure 1 in yet another method step,
- Figure 10 shows the winding stations of the winding device and the rolls according to Figure 9 as a view from above,
- Figure 11 shows the winding device of Figure 1 in yet another method step,
- Figure 12 shows the winding stations of the winding device and the rolls according to Figure 9 as a view from above,
- Figure 13 shows the principle of the winding station according to yet another embodiment of the invention,
- Figure 14 shows a lateral projection of the winding station according to another embodiment of the invention,
- Figure 15 shows the winding stations of the winding device and the rolls according to Figure 14 as a view from above in one method step,
- Figure 16 shows the winding stations of the winding device and the rolls according to Figure 14 as a view from above in another method step, and
- Figure 17 shows yet another embodiment of the invention.

Figures 1 and 2 show schematically a winding device 10 for partial webs W according to one embodiment of the invention in a situation, where the rolls to be formed are wound to a desired diameter or to a desired web length and are ready to be removed. It is to be noted that only the elements relevant to the invention and its operation are shown in the figures and therefore it is clear that in practise the winding device comprises a number of such elements that are

not shown in the figures. Figure 3 shows also a similar situation in the case of one customer roll 35 seen from behind the winding device 10.

Referring to Figures 1, 2 and 3, the winding device 10 comprises a support roll 20, the ends of which are rotatably mounted in bearings on a separate body and/or foundation. The roll 35 to be wound in the winding device 10 is supported by circumferential support by means of the support roll 20. A support beam 25 is arranged above the support roll, which beam extends in the transverse direction of the winding device 10 over the shell of the support roll 20. The direction of the longitudinal axis of the support roll 20 may in this context also be called the transverse direction of the device. The support beam 25 is supported onto the bodywork 10 of the winding device 10. Winding stations 30, 31 are arranged in conjunction with the support beam, by which stations the roll 35 to be wound is supported. Figure 2 shows the positioning of the winding stations 30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b, 31 of the winding device and the web rolls 35 of Figure 1, when winding a specific roll set.

In the winding, partial webs W are led to the support roll 20 from the front side of the winding device, they travel around the support roll 20, from which they are led via a winding nip to the rolls 35. The rolls of the set are formed alternately on the first and second side of the support roll 20, i.e. in this embodiment on the front and back side with respect to the vertical plane passing through the rotation axis of the support roll. Once the rolls are completed, the rolls formed on the first side of the support roll 20 are removed from the winding device and subsequently, the rolls 35 formed on the second side of the support roll are removed via the first side of the support roll. The completed rolls are delivered to a cross-directional roll conveyor 55 located on the backside of the winding device.

Since all the rolls are delivered from the same side of the winding device, the winding stations 30, 31 of the winding device shown herein are different on the first and second side, respectively. This is not, however, necessary, but all the winding stations may also be winding stations according to the invention.

The winding stations 30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b are arranged movably in conjunction with the support beam 25. Each winding station 30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b is provided with a winding end 40, which supports the roll from the roll core by means of its seat 45. The winding end 40 is movably adapted in conjunction with the winding station 30. Typically, the roll core comprises a spool. Even axial torque force may be transmitted to the roll by means of the seats in order to affect the forming of the roll. Three separate guides 50.1, 50.2, 50.3 for the winding stations 30 are arranged on the support beam. The guides are arranged in the transverse direction of the winding device 10.

The significance of this will be explained in the following especially with reference to Figure 4. The winding stations 30.1a, 30.1b, 30.2a, 30.2b are shaped so that their combined width n x D (4a) parallel to the support beam (i.e. in cross direction) is larger than their total width D_{Σ}, when the stations are in conjunction with each other (4b). According to one embodiment of the invention the winding station is supported from its body part 65 to a first and second guide 50.1, 50.2 and further comprises at least one support arm 60, by means of which the winding station is supported onto a third guide 50.3. In this manner, the winding station can be supported from a number of points and also so that there are supporting points in transverse direction at a distance from one another. When the support arm 60 of a specific winding station 30.2a is supported onto the third guide 50.3, the support arm and the connecting member 60.1 adapted thereto, by means of which the support arm is movably engaged to the guide 50.3, may travel in transverse direction past the connecting member 65.1 of the body part 65 of the adjacent winding station 30.1b. In this manner, the sides of two adjacent winding stations 30.1b, 30.2a facing each other may be positioned essentially tightly against one another. The winding stations are sufficiently rigid and stiff also in transverse direction, as the support arm 60 is engaged to the guide 50.3 in transverse direction at a different point compared to the location of the supporting points of the body part. Since the winding stations may be positioned so as to overlap each other

at least partially, their total width D_Σ is smaller than their combined cross-directional width. Although the denotation 'support arm' is used in this context, the element may also be shaped differently, as shown in Figure 13. In Figure 13, the shapes of the lateral parts of the body part 65 and the support arm 60 of the winding station are arranged so as to form a combination of plane and taper surfaces corresponding each other. The support arm 60 and the body part 65 form uniform lateral surfaces in this embodiment. The support arm forms an extension of the body part shaped as a split taper protruding in transverse direction. Thus, the lateral parts 65a, 65b of the winding stations comprise at the same points such surface profiles that correspond each other at least partially, in this case those of the support arm of the body part. These shapes, when running the winding stations close to each other, are in opposite direction in the lateral parts facing one another, whereby they may overlap each other at least partially. Then, it is possible to place the winding stations in an at least partially overlapping position with respect to each other according to the invention.

When studying the winding station 30 shown in Figure 5 as a lateral projection, which corresponds to transverse direction when the winding station 30 is mounted in the winding apparatus, the support arm 60 and the body part 65 of the winding station 30 are arranged so that their areas are, at least partially, non-intersecting in the lateral plane of projection of the winding station. In this embodiment, they do not intersect at all. By this arrangement, the shapes of the surfaces of two adjacent winding stations facing each other coincide to some extent, whereby they can be positioned so as to overlap one another at least partially and their combined width n x D (4a) parallel to the support beam is larger than their total width D_Σ, when the stations are in conjunction with each other (4b).

The support arm may also be embodied in another way as long as its effect e.g. on the diameter of the roll to be wound is taken into consideration. Figure 6 shows one other embodiment of the winding station 30 from behind (the figure

on the left) and as a side view (the figure on the right), where the support arm 60 extends to a distance from the lateral projection plane of the winding station.

In the method of winding partial web rolls in the winding device 10 according to the invention, partial webs W are led to the rolls 35 through the nip between the support roll and the rolls, at the same time supporting each roll by two winding stations 30 from the roll core. In the method the rolls 35 are formed alternately on the first and second side of the support roll 20 with respect to the vertical plane passing through the rotation axis of the roll, and as soon as the rolls 35 are completed the rolls formed on the first side of the support roll are removed first from the winding device 10. Figures 7 and 8 show the winding device for a fibrous web according to the invention in a method step, in which the completed rolls 35 facing the conveyor 55 are delivered to the conveyor. This can be performed while the winding seats 45 of the winding stations 40 are retracted. The winding stations need not to be moved from their place, as there is enough space between them for transferring the rolls 35 to the conveyor 55. The removal of the rolls is assisted by a first 70.1 and second 70.2 roll remover, which are arranged so that they are movably supported by the support roll on both sides thereof.

Figures 9 and 10 show the next step of the method. The winding stations 30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b located behind the support roll 20 of the winding device 10, or generally on that side of the support roll, to which the rolls are delivered, are relocated so that there is enough space for the rolls in front of the winding device to move between the winding stations. In this case, the winding station 30.1b is transferred in transverse direction to meet the roll 35.1, which was supported by it during the winding. Then, the connecting member 60.1 of the support arm of the winding station 30.1b goes past the connecting member 65.1 of the body part 65 of the winding station 30.1a in transverse direction, and the winding stations are positioned so as to overlap each other at least partially. The winding stations 30.2a and 30.2b are moved towards each other and positioned at the roll 35.2 in a similar way, i.e. overlapping each other at least partially. Also the winding station 30.3a is transferred to the roll 35.3.

The relocation of the winding stations is performed as required by each individual set.

After the relocation of the winding stations the rolls 35, on the front side of the winding device 10 may be transferred over the support roll 20 by means of the first 70.1 and second roll remover 70.2 to the conveyor 55, as shown in Figures 11 and 12. The first roll remover 70.1 moves against the roll set 35 and lifts it over the support roll 20, while the second roll remover 70.2 receives the roll set and delivers it to the conveyor 55.

Figures 14 and 15 show a winding device 10 for partial webs W according to one embodiment. The embodiment shown herein corresponds in many ways to the embodiment according to Figure 1 and therefore equivalent parts have been denoted with the same reference numerals. As distinct from the embodiment of Figure 1, the winding stations 31 on the first side of the winding device are supported onto a support beam 25 and the winding stations 30 of the second side are supported onto the winding station 31 of the first side. The support beam 25 is provided with guides 50.4, 50.5, which carry the winding stations 31 of the first side. The guides 50.4, 50.5 extend essentially over the entire length of the support beam, whereby the winding stations may be positioned to a desired place according to the lengths and number of the rolls to be produced. Every winding station 31 is provided with guides 50.6, 50.7, which are arranged to carry each winding station 30 of the second side. In Figure 14, next to the guides 50.6, 50.7, the guides 50.8, 50.9 of the adjacent winding station are shown by a dashed line. The winding station 30 of the second side is thus in transverse direction movably supported onto the winding station 31 of the first side, which is further movably supported onto the support beam 25. A substantially similar effect is provided by the guides as by the support arm 60 of the winding station (Figure 1).

In other words, the guides on the second side of the winding stations 30 adapted in the winding device 10 are arranged so as to overlap each other at

least partially in case the adjacent winding stations 31 are run close to one another.

In Figures 14 and 15, the number of guides is two, but it is obvious that in practise the arrangement and number of the guides may be different. Figure 15 shows the positioning of the winding stations 30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b, 31 of the winding device and the web rolls 35 according to Figure 14, when winding a specific roll set. Figure 15 shows the winding device according to Figure 14 in a method step, in which the completed rolls 35 facing the conveyor 55 are being delivered to the conveyor. The winding stations need not to be moved from their place, as there is enough space between them for transferring the rolls 35 to the conveyor 55. The removal of the rolls is assisted by a first 70.1 and second 70.2 roll remover, which are arranged rotatably supported on both sides of the support roll 20.

The roll 35.1 ahs been formed supported by the winding stations 30.1a and 30.1b and in the situation according to the figure it has already been transferred to the conveyor 55. Rolls 35.2 and 35.3 are in a similar situation. In order to be able to transfer rolls 35.4 and 35.5 to the conveyor over the support roll 20, the winding stations 30.1b and 30.2a are run aside by moving them with respect to the winding stations 31 in guides 50.6, 50.7, 50.8, 50.9. This is shown in Figure 16 with the winding stations 30.1b and 30.2a. The winding stations 30.1b and 30.2a have been run essentially to the same point with respect to the winding stations 31 in transverse direction. The guides 50.6, 50.7 may partially overlap the guides 50.8, 50.9 and thus the winding stations can be positioned so as to overlap one another at least partially and their combined width n x D parallel to the support beam 25 is larger than their total width D_{Σ}, when the stations are in conjunction with each other. This feature may be also be clarified so that the width of an individual winding station is considered to be the distance between two supporting points parallel to the support beam of the winding station.

Figure 17 shows yet another embodiment according to the invention. The principle of this embodiment corresponds to the winding station solution

according to Figure 1 with the difference that the support arm 60 and the body part 65 are supported by a common guide 50.1, 50.3. Now, the supporting points of the winding stations are arranged to go past one another so that the support arms of successive winding stations are supported onto adjacent guides alternately. The body part of every other winding station is provided with a recess or a similar space 65', the size of which corresponds approximately to the shape and size of the cross-section of the support arm 60 so that the support arm of another winding station may move in the recess to the area of its body part or even over it. In this embodiment, the winding station is supported from its body part 65 onto a guide 50.2, and every other successive winding station onto the first guide 50.1 and every other onto the third guide 50.3 and further, by means of the support arm, either onto the first 50.1 or onto the third guide 50.3. In other words, the support arm of every other successive winding station is supported onto a different guide.

It is to be noted that only a few most advantageous embodiments of the invention are described in the above. Thus, it is clear that the invention is not limited to the above-described embodiments, but may be applied in many ways within the frame of the appended claims. The features described in conjunction with the various embodiments may be used in conjunction with other embodiments as well and/or various combinations of the described features may be made within the frame of the basic idea of the invention, if so desired and if technical feasibility for this exists.

CLAIMS

1. A winding device (10) for a fibrous web comprising at least two winding stations (30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b) arranged to support a roll (35.1, 35.2, 35.3) to be wound in the winding device by means of centre support from the roll core, and at least one support roll (20) to support the roll (35.1, 35.2, 35.3) to be wound in the winding device by means of circumferential support, **characterised** in that the winding stations (30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b) are shaped so that they may be positioned so as to overlap each other at least partially.

2. A winding device according to claim 1, **characterised** in that in the winding device the winding stations (30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b) are supported movably onto a support beam (25) or the like parallel to said support roll of the winding device, and where each individual winding station has a width parallel to the support beam (25) or the like, and that the winding stations are shaped so that their combined width (n x D) parallel to individual support beams is larger than their total width (D_{Σ}), when the stations are in the vicinity of each other.

3. A winding device according to claim 2, **characterised** in that the width of the winding station parallel to the support beam is the distance between the supporting points of the winding station parallel to the support beam.

4. A winding device according to claim 1 or 2, **characterised** in that the winding station comprises a body part (65) and at least one support arm (60), by means of which the winding station is supported onto the support beam (25).

5. A winding device according to claim 2, **characterised** in that the winding station is supported from its body part (65) to a first (50.1) and second guide (50.2), and that the winding station comprises at least one support arm (60), by

means of which the winding station (30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b) is supported onto said first (50.1) or second guide (50.2).

6. A winding device according to claim 2, **characterised** in that the winding station is supported from its body part (65) to a first (50.1) and second guide (50.2), and that the winding station comprises at least one support arm (60), by means of which the winding station (30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b) is supported onto a third guide (50.3).

7. A winding device according to claim 4, **characterised** in that the support arm (60) extends from the plane passing through the supporting points of the body part (65) of the winding station in the direction of the support beam.

8. A winding device according to claim 4, **characterised** in that the support arm (60) and the body part (65) of an adjacent winding station are arranged so that their areas are, at least partially, non-intersecting in the lateral plane of projection of the winding station.

9. A method of winding partial web rolls in a winding device (10), in which method partial webs (W) are led onto rolls (35, 35.1, 35.2, 35.3) through the nip between a support roll (20) and the rolls at the same time supporting each roll by at least two winding stations (30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b) from the roll core, in which method the rolls are formed alternately on the first and second side of the support roll (20) with respect to the vertical plane passing through the rotation axis of the support roll, and in which method, as soon as the rolls are completed, the rolls (35.1, 35.2, 35.3) formed on the first side of the support roll (20) are removed from the winding device (10) and thereafter the rolls (35) formed on the second side of the support roll are removed via the first side of the support roll, **characterised** in that before the rolls (35) formed on the second side are removed, the winding stations (30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b) on the first side are relocated so that there will space for the removal of the rolls formed on the second side.

10. A method of winding partial web rolls according to claim 9, **characterised** in that the winding stations (30.1a, 30.1b, 30.2a, 30.2b, 30.3a, 30.3b) of the first side are relocated so that at least a part of the winding stations are taken to a position overlapping one another at least partially, away from the path of the rolls (35) formed on the second side of the support roll (20).

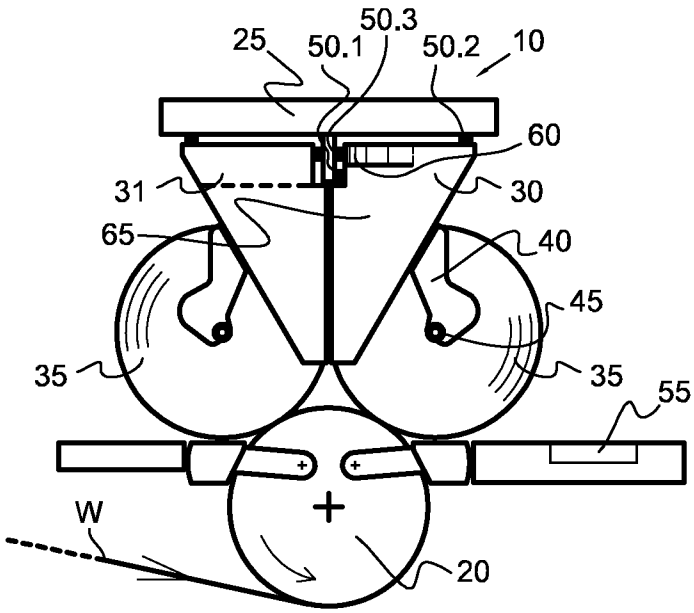
25
50.1
50.3
50.2
10
60
31
30
65
40
45
35
35
55
W
20

FIG. 1

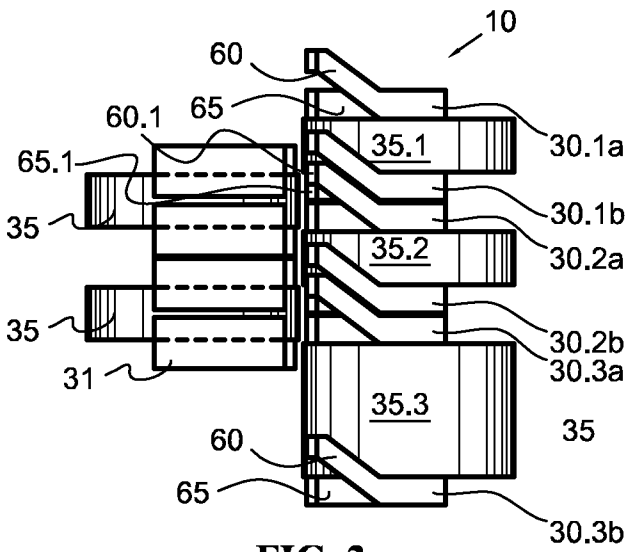
10
60
60.1
65
65.1
35
35
31
35.1
35.2
35.3
35
60
65
30.1a
30.1b
30.2a
30.2b
30.3a
30.3b

FIG. 2

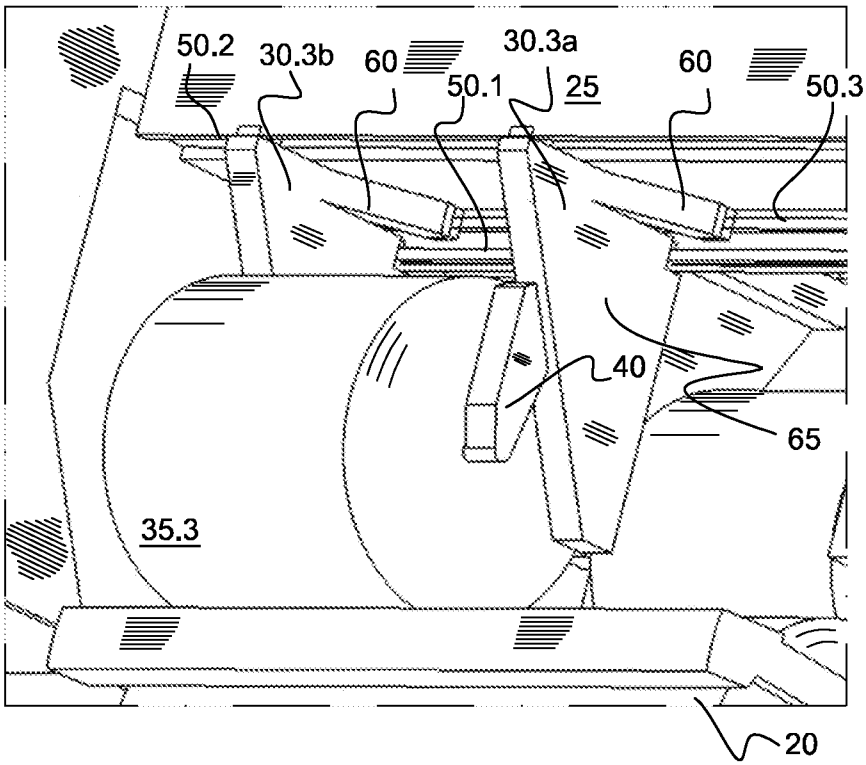

FIG. 3

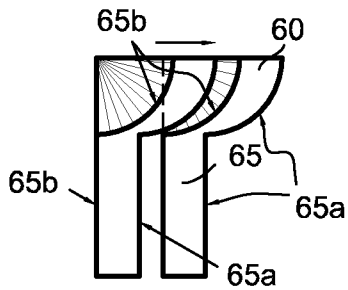

FIG. 13

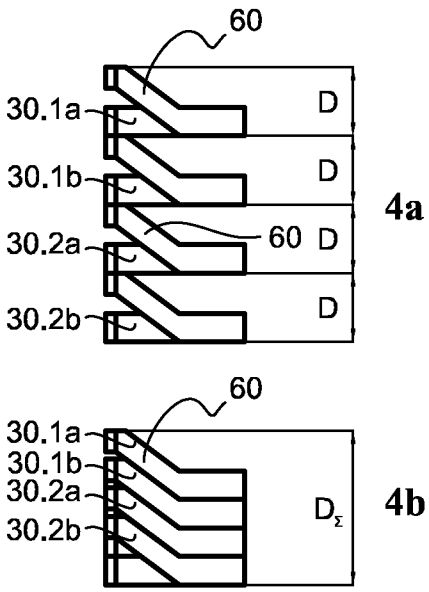

FIG. 4

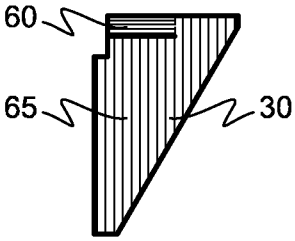

FIG. 5

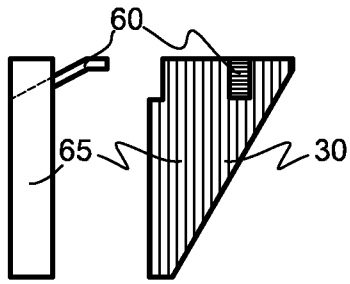

FIG. 6

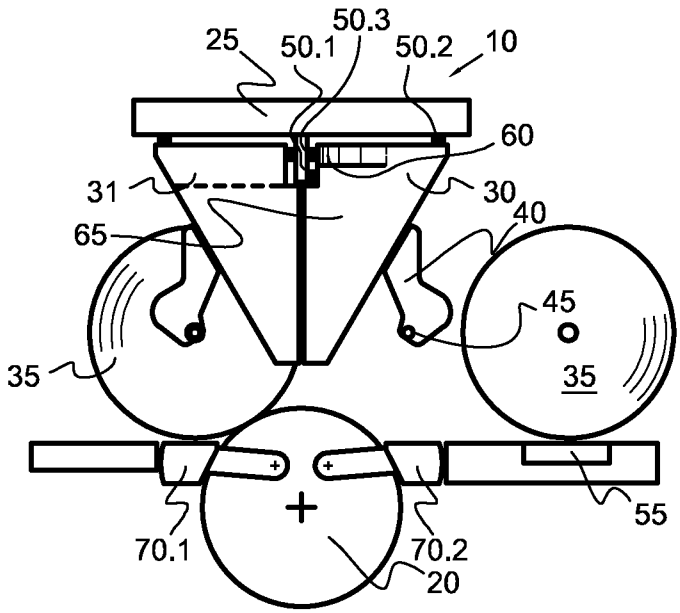
25
50.1
50.3
50.2
10
60
31
30
40
65
45
35
35
55
70.1
70.2
20

FIG. 7

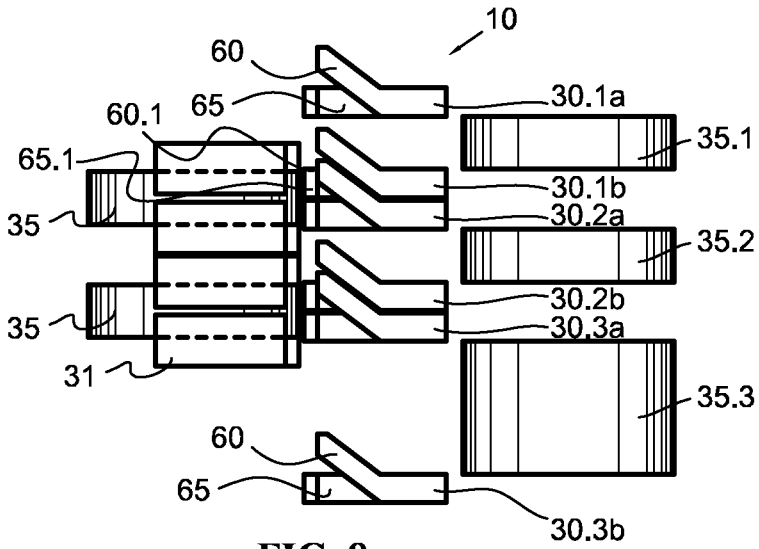
10
60
65
60.1
30.1a
35.1
65.1
30.1b
30.2a
35
35.2
30.2b
35
30.3a
31
35.3
60
65
30.3b

FIG. 8

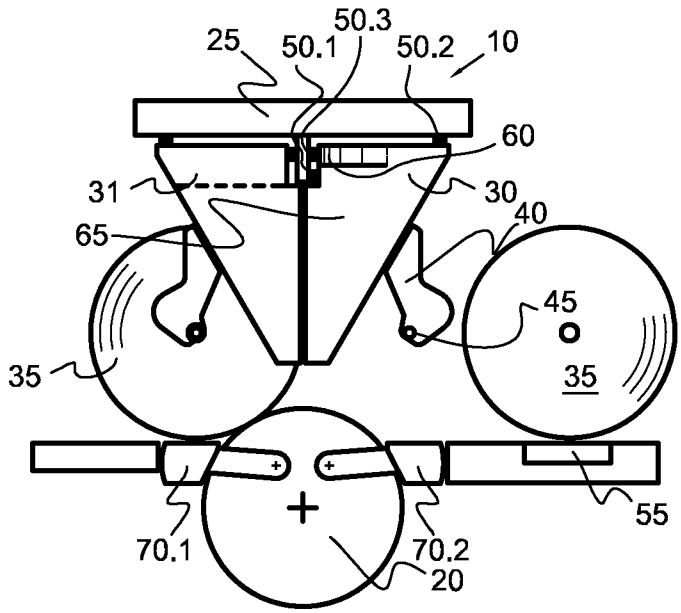
25
50.1
50.3
50.2
10
60
31
30
40
65
45
35
35
55
70.1
70.2
20

FIG. 9

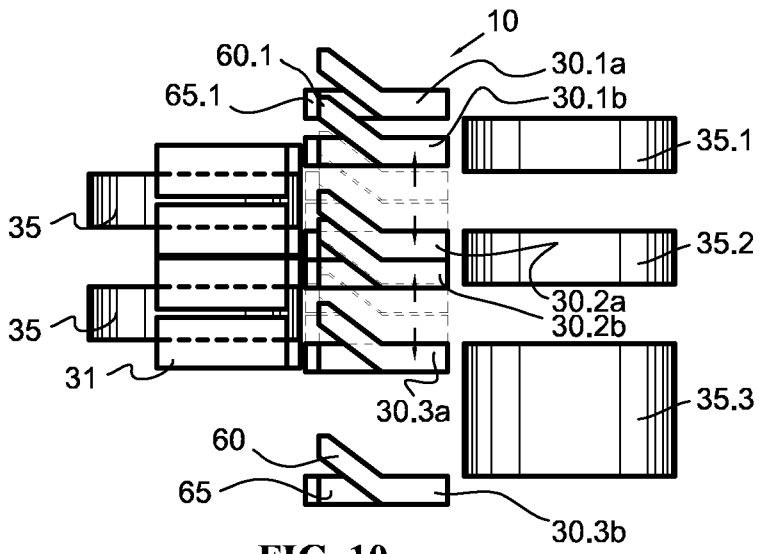
10
60.1
30.1a
65.1
30.1b
35.1
35
35.2
30.2a
30.2b
35
31
30.3a
35.3
60
65
30.3b

FIG. 10

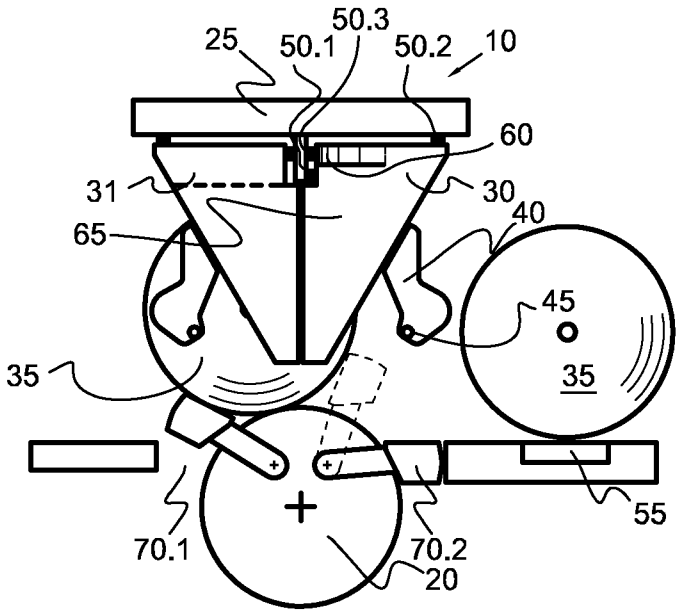
25
50.1
50.3
50.2
10
60
31
30
40
65
45
35
35
55
70.1
70.2
20

FIG. 11

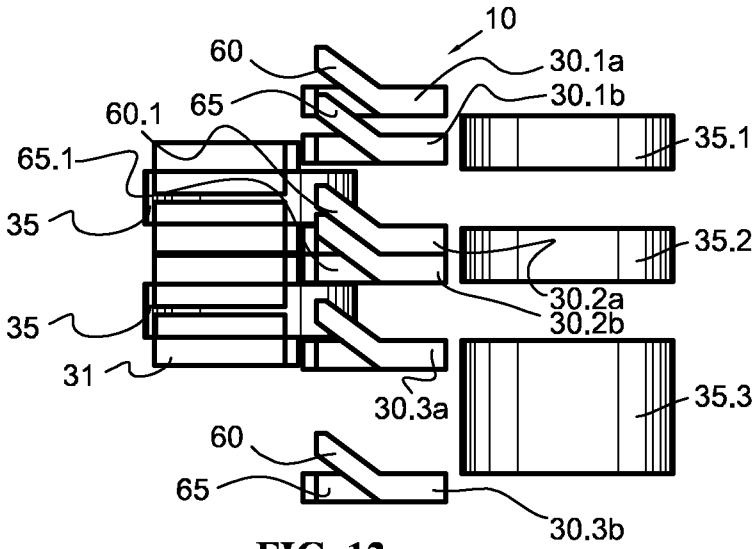
10
60
30.1a
30.1b
60.1
65
35.1
65.1
35
35.2
30.2a
30.2b
35
31
30.3a
35.3
60
65
30.3b

FIG. 12

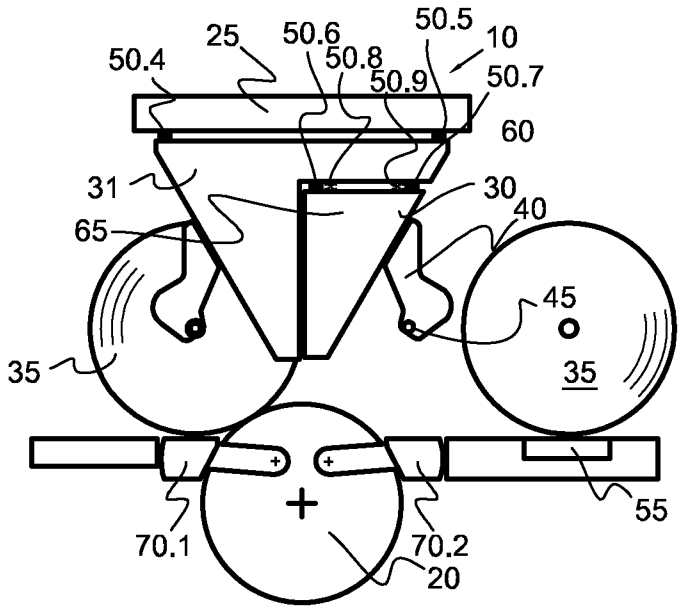
25
50.6
50.5
10
50.4
50.8
50.9
50.7
60
31
30
40
65
45
35
35
55
70.1
70.2
20

FIG. 14

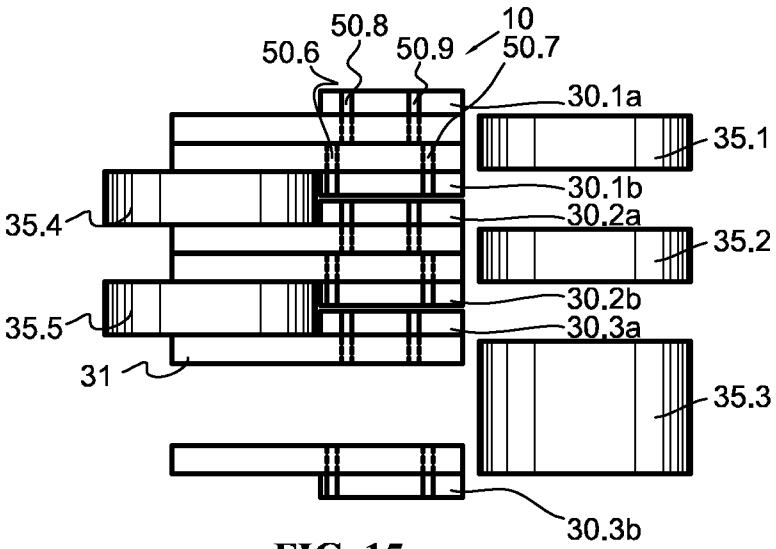
50.8
10
50.6
50.9
50.7
30.1a
35.1
30.1b
35.4
30.2a
35.2
30.2b
35.5
30.3a
31
35.3
30.3b

FIG. 15

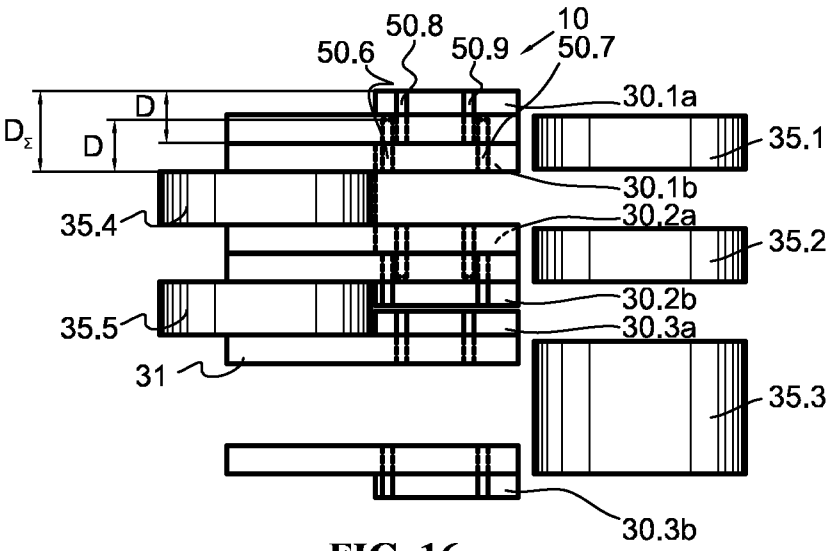
50.8
10
50.6
50.9
50.7
30.1a
D
D_Σ
D
35.1
30.1b
35.4
30.2a
35.2
30.2b
35.5
30.3a
31
35.3
30.3b

FIG. 16

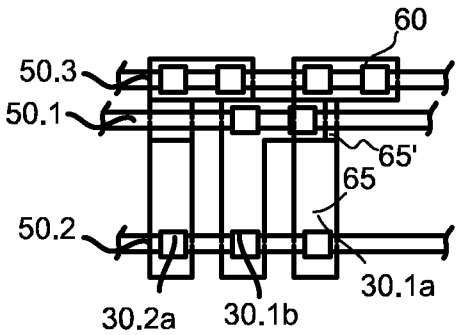
60
50.3
50.1
65'
65
50.2
30.1a
30.2a
30.1b

FIG. 17