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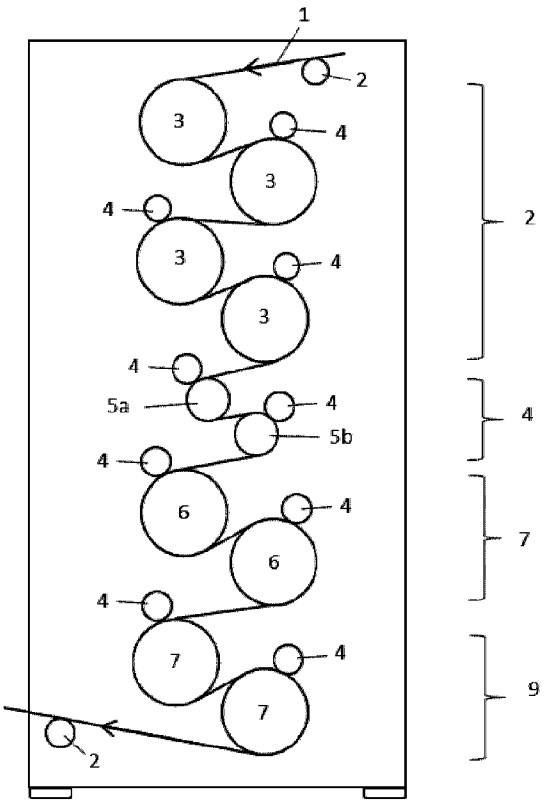
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(54) Titre : DISPOSITIF ET PROCEDE POUR PERMETTRE DES MODIFICATIONS MONOAXIALES DANS LA LONGUEUR DE TOILES DE FILM

(54) Title: DEVICE AND PROCESS TO PERMIT MONOAXIAL CHANGES IN THE LENGTH OF FILM WEBS



(57) Abrégé/Abstract:
In the case of a device to permit the monoaxial length change of film webs in machine direction, which comprises at least one processing gap delimited by two rolls via which a film web is routed in machine direction, whereby the first roll in film transport direction exhibits a first peripheral speed and the second roll in film transport direction exhibits a second peripheral speed, in order to produce film webs with low transverse neck-in as well as reduced edge build-up and to improve the flatness of the film web.

ABSTRACT

In the case of a device to permit the monoaxial length change of film webs in machine direction, which comprises at least one processing gap delimited by two rolls via which a film web is routed in machine direction, whereby the first roll in film transport direction exhibits a first peripheral speed and the second roll in film transport direction exhibits a second peripheral speed, in order to produce film webs with low transverse neck-in as well as reduced edge build-up and to improve the flatness of the film web.

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DEVICE AND PROCESS TO PERMIT MONOAXIAL CHANGES IN THE LENGTH OF FILM WEBS

FIELD OF THE INVENTION

The invention concerns a device and a process to permit monoaxial changes in the length of film webs in machine direction. This comprises at least one processing gap delimited by two rolls via which a film web is routed in machine direction, whereby the first roll in film transport direction exhibits a first peripheral speed and the second roll in film transport direction exhibits a second peripheral speed.

BACKGROUND OF THE INVENTION

In the production of film, orientation lines are used to reduce the thickness of film after its production. The orientation of film is used for both tubular film and for cast film.

An orientation line generally consists of heated rolls in order to prepare the film for orientation followed by orientation rolls between which the film is oriented. Orientation can be followed by so-called annealing or tempering rolls where the film is subjected to heat treatment in order to influence the film properties. As the final step, the film is cooled by means of cooling rolls. By orienting the film webs, it is not only the geometric dimensions of the film that can be altered, but also the properties of the film such as transparency or strength can be influenced in a targeted manner.

Orientation units are operated either offline or in-line within blown film lines. The orientation of tubular film can be performed in-line within blown film lines directly after the pair of take-off rolls or downstream of the turning bar unit which is installed downstream of the two take-off rolls.

In the case of the monoaxial orientation of film webs in machine direction, also known as longitudinal orientation, a transverse necking, the so-called neck-in, occurs with simultaneous thickening of the edges, the so-called edge build-up. This effect is extremely unfavourable for the downstream processing of the film. The neck-in is disadvantageous in that it exacerbates the film production process with respect to the flatness of the film demanded for the downstream film processing. The greater the neck-in is, the more difficult it is to achieve the demanded film quality of monoaxially

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oriented film in an efficient and economic manner. Disadvantages such as hanging film edges and other flatness faults then occur when unwinding the finished reels. This leads to a poor reel quality and thus to a poorer suitability of the film for downstream processing, for example for printing or laminating.

Patent DE 10 2009 046 585 A1 reveals an orientation line designed for the longitudinal orientation of film webs as well as a dedicated process. The orientation system comprises mainly a heating unit, an orientation unit and a cooling unit. In order to lessen the neck-in and the edge build-up when longitudinally orienting the film web, a pressure mechanism in the form of a lay-on roll is used which presses the film web against the orientation roll.

Patent DE 10 2009 046 593 A1 also reveals an orientation line designed for the longitudinal orientation of film webs as well as a dedicated process. In order to lessen the neck-in and the edge build-up, a deflection roll is installed in the orientation gap between the two orientation rolls of the orientation unit. This serves to reduce the necking of the film.

The transverse shrinkage or necking of the monoaxially oriented film can be counteracted during orientation also by the temperature setting of the orientation rolls, as is disclosed in patent DE 10 2011 085 735 A1. In addition, the orientation gap adjustment unit can also be used to counteract the necking. Decreasing the roll gap leads to a reduction of the film neck-in.

In order to improve the flatness of the films produced with blown film lines which are then oriented downstream in orientation systems, film thickness regulation methods such as are known from DE 10 2009 033 171 A1 are employed. The edge build-up during monoaxial orientation in machine direction is thereby reduced. To this end, those areas which later form the edge zones of the laid-flat film are provided with thin spots during manufacture of the film tubes so that after orientation, an end product with as uniform a thickness as possible across the film web width is achieved. This process also has a positive effect on the reduction of the transverse shrinkage.

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BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described, by way of example only, with reference to the attached Figures, wherein:

Figure 1 shows an orientation line with the invention-design device to permit monoaxial changes to the length of a film web in machine direction.

Figure 2 shows a device to permit monoaxial changes to the length of a film web in machine direction

DETAILED DESCRIPTION

It is desirable to make it possible in units designed for the monoaxial length change of film webs in a machine direction to manufacture film webs of improved flatness in that the transverse neck-in and thus the edge build-up are reduced. This increases the quality of the finished film reel.

In the case of a device designed for the monoaxial length change of film webs in machine direction of the generic kind, the invention provides in one aspect, a device to permit monoaxial length change of film webs in a machine direction, comprising at least one processing gap delimited by a first roll and a second roll via which a film web is routed in the machine direction, whereby the first roll in a film transport direction exhibits a first peripheral speed and the second roll in the film transport direction exhibits a second peripheral speed wherein at least one of the first roll and the second roll is an air-flow roll through which air flows from the outside in.
In one aspect, the present invention provides a device where in comparison with the state of the art, at least one of the rolls which delimit the processing gap in which the film web experiences a length alteration is replaced by a roll through which air can be routed. The design of this roll is such that the flow pattern of the air is from the outside in.

As the film web is transported over the rolls, a boundary layer of air is drawn in onto the film web between the film web and the roll. These air cushions have a negative effect on the flatness of the film web during orientation of the film in the processing gap.

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By using the air-flow rolls through which the air flow pattern is from the outside in, the air which is drawn in can continuously pass through the air-flow roll to the inside into the roll and the film lays across its entire width direct on the rolls. The flatness of the film web is improved. These air cushions develop especially at high machine speeds. A transverse neck-in caused by orientation of the film web with simultaneous edge build-up is also counteracted and reduced by the film laying direct on the roll.
If this effect is insufficient, the air-flow roll where the air can be routed from the outside in can be fitted with a negative pressure connection; the negative pressure causes the film web to be sucked onto the roll and it adheres more strongly to the roll and reduces the neck-in and the edge build-up.

The measure for the neck-in and edge build-up is connected among other things with the adhesion of the film on the rolls which delimit the processing gap. The film slips increasingly to the outer zone in transverse direction, i.e. perpendicular to the transport direction of the film web across the roll surface, and attempts in this way to compensate the transverse forces acting upon it. This transverse neck-in takes place essentially in the processing gap and on the rolls themselves.
The aim is to set the negative pressure at the rolls such that the adhesion of the film web on the roll is improved as a result of the increased friction, and the relative speed in transverse and longitudinal direction between the film and the roll is prevented. A uniform contact of the film on the roll across the lay-flat width is achieved. This results in a defined release edge of the film web on the roll in film transport direction at the point where the film runs off the roll just as in a defined lay-on edge of the film web on the roll in film transport direction at the point where the film runs onto the roll.

The magnitude of the negative pressure is also dependent on the desired length change of the film web, the machine speed and the film properties.

The force with which the film is sucked onto the roll is a function of the level of negative pressure. This is usually between about 100 and 300 mbar, in special cases it can also be selected to be higher or lower. The negative pressure is regulated as a function of the characteristics of the film and the desired length change.

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In accordance with the invention, at least one of the rolls which delimits the processing gap of the length change device is designed as an air-flow roll through which the air flows from the outside in.

In an embodiment, the second roll downstream of the processing gap is designed as an air-flow roll.
The air that is drawn in flows through the roll and the film has direct contact on the roll across its entire width.
If the effect is insufficient, in another invention design, the air-flow roll is connected to a negative pressure source.
The negative pressure which is applied to the air-flow roll causes the film web to be sucked onto the roll. As a result, the friction of the film web on the roll of the device is increased, thus reducing the transverse shrinkage downstream of the processing gap. The film is sucked thereby uniformly across its entire width including the film edges onto the roll.

In another invention design, the first roll in the unit upstream of the processing gap is designed as an air-flow roll. The contact between the film web and the roll is increased and prevents the formation of air cushions in between the two. The film web thus lays uniformly on the roll. The film web reaches the processing gap with a reduced level of transverse neck-in. The flatness is positively influenced. This roll can also be connected up to a negative pressure source in another invention design. The higher forces serve to increase the effects.

In another invention design, the roll upstream and the roll downstream of the processing gap is designed as an air-flow roll in each case. This serves to improve the adhesion of the film web between the film web and the rolls with no air entrapped in between, and the neck-in and edge build-up on the film is reduced. In an embodiment, the second roll is additionally connected up to a negative pressure source. This counteracts the transverse neck-in. In rare cases, both rolls can be connected up to a negative pressure source.

In the invention-design equipment, the air-flow rolls can interact with and without lay-on rolls. The lay-on rolls serve to additionally fix the film web on the air-flow rolls.

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They increase the contact of the film to the roll so that the film lays uniformly on the roll.

Dependent on the orientation task, it can be necessary to suck the film across its width onto the air-flow roll to varying degrees, for example more suction at the edges than towards the centre of the film web. In that case, the air-flow roll is designed such that different degrees of negative pressure can be applied over its axial length.

Dependent on the problem specification, a combination of air-flow roll and tempering roll can also be employed. On the one hand, this tempers the film web so that it has the right temperature for the length change and on the other hand, the air drawn in between the film web and the roll can flow to the inside via the air-flow roll. Thanks to the direct contact of the film web on the roll, the heat transfer from roll to film web is also better. If in addition, negative pressure is applied to the rolls in order to suck the film web onto the roll more strongly, the friction between film and roll increases and the neck-in reduces even further.

The tempering can involve heating or cooling. On one side of the combined rolls, the fluid such as gas, steam, water or oil for tempering the roll is supplied and removed via a rotary union. On the opposite side to where the fluid is supplied and removed, a negative pressure source is connected via a rotary union and the air is drawn in. If no negative pressure is applied, the air escapes through these openings. If the roll is a pure air-flow roll, the fluid supply and removal for tempering is omitted.

The combined tempering and air-flow roll consists, just as the state-of-the-art rolls, also of a fluid-tempered double-jacket roll, it is equipped with additional channels for air routing and can be connected up to a negative pressure source. The channels can also be in the form of small drilled holes.
Ideally, an air-permeable layer is applied, similar to a sintered structure. It is also possible to manufacture the rolls from an open-pore material with pores in the micrometre range. The rolls are made of materials such as steel, stainless steel or plastic. In an embodiment, the sintered layer, for example, is made of non-corrosive stainless steel which can also be polished to a glossy finish. In addition, the friction

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and/or adhesion between the film web and the roll can be influenced as a function of the surface roughness or the surface structure of the rolls.
If tempering is not necessary, rolls of the same type and without double jacket are employed.

The reduction of the transverse neck-in of the film web results in new physical film properties which in turn lead to superior downstream processes in printing devices and lamination units thanks to the improved flatness. This leads furthermore to less edge trimming waste.

The device for length change includes processing gaps which are delimited in each case by two rolls. The first roll in film web transport direction exhibits a first peripheral speed and the second roll in film web transport direction exhibits a second peripheral speed so that the film web in between experiences a length change in the processing gap.

In the event that the second roll exhibits a higher peripheral speed than the first roll, this results in a positive length change of the film. Dependent on the length change ratio, one speaks of orientation, stretching or annealing. There is no clear dividing line in the length change of film between annealing, stretching and orientation.

Length change ratios of between approx. 1:1 and 1:10 can be achieved.

In the case of annealing, not only elongation but also shrinkage of the film web can be permissible, because the second roll rotates at a lower peripheral speed than the first roll and this results in a negative length change.
The shrinkage ratio is usually between approx. 0.5:1 and 1:1.

It can also be that both rolls which delimit the processing gap exhibit the same peripheral speed.

In one design, the invention-design unit for changing the length of a film web is an integral component of an orientation unit.

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In orientation units, which usually comprise an arrangement of heated rolls, orientation rolls, annealing rolls and cooling rolls, the orientation roll downstream of the orientation gap or processing gap is replaced by an air-flow roll because this is where the greatest improvement for the orientation process results.

Such orientation units can either be operated in-line or offline within a film production line.
It is also possible within an orientation system to install several invention-design units which have at least one processing gap delimited by two rolls.
It is, however, also possible in orientation lines with the invention-design unit to have more orientation rolls or more rolls such as the annealing rolls downstream of the orientation rolls and cooling rolls as well as the upstream heated rolls in air-flow design in order to improve the film quality even more.

In the production of tubular film, the invention-design unit for the length change of a film web can be integrated in-line within a blown film line.

Seen in film transport direction, blown film lines include a resin dosing unit, an extruder, followed by a film die head and a cooling unit as well as a calibration basket. Downstream of these components are a lay-flat unit, a take-off unit and a turning device. The tubular film is then wound using a winder.

When producing tubular film with blown film lines, the invention-design device to change the length with at least one processing gap delimited by two rolls, whereby at least one of these rolls is an air-flow roll, can be located direct in film transport direction above the pair of take-off rolls of the take-off unit either upstream or downstream of the turning bars. Possible is also several invention-design units which include at least one processing gap delimited by the two rolls within a blown film line. In addition, they can also be combined with more air-flow rolls.
In this context, the take-off unit can be stationary, rotating or designed as an oscillating take-off unit. It can also be operated without turning bars.

The invention-design device to permit monoaxial changes in length can be arranged as an integral component of an orientation line within a blown film line in film

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transport direction above the pair of take-off rolls either upstream or downstream of the turning bars above the tubular film bubble.
Alternatively, the device can be located within an orientation line also in-line on the floor next to the blown film line or offline on the floor next to the blown film line. In each case, the blown film line can be designed with or without an oscillating take-off unit.

Also possible is to have two of the invention-design devices to permit monoaxial changes in length arranged as components of an orientation line, a so-called MDO system, in-line downstream of a blown film line. In this case, the tubular film is then cut on both sides at opposite points into two film webs, each of which is further processed with an orientation line.

In order to further optimise the quality of the film web, use of the invention-design device can be combined with the application of film thickness regulation systems. With the combined use of film thickness regulation systems in the production of tubular film, e.g. as defined in patent DE 10 2009 033 171 A1, and air-flow rolls in the device for length change, a further positive effect occurs, because if the neck-in in the film web is lower, then less energy needs to be introduced into the regulation system in order to optimise the flatness, a fine-tuned regulation is possible and thus the process is simplified.

The device for length change can also be employed within an orientation or annealing line for handling cast film.

In an invention-design process to permit monoaxial changes in the length of film webs, the film web is routed via at least one processing gap delimited by two rolls. Whereby the first roll in film transport direction exhibits a first peripheral speed and the second roll in film transport direction exhibits a second peripheral speed. At least one of these rolls is an air-flow roll which ensures that the film web routed over it lies direct on the roll in order to counteract transverse neck-in and an edge build-up of the film web and to prevent the formation of air cushions between roll and film web. With a combination of air-flow and tempering roll, the heat transfer between the film and roll is furthermore increased because the insulating layer of air in between can flow

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off through the air-flow roll. A stable orientation process is thus achieved and as a result, a homogeneous film with no flatness defects because the film has uniform contact across its entire lay-flat width on the roll.

If negative pressure is applied, the effect is even stronger. The suction generated by the negative pressure results in improved fixing of the release edge of the film on the roll in film transport direction at the point where the film runs off the roll, as well as of the lay-on edge of the film on the roll in film transport direction at the point where the film runs onto the roll, so that a lower relative speed difference in transverse and longitudinal direction across the lay-flat width between the film and roll occurs.

For further optimisation of the film web quality, the process is combined with a film thickness regulation system as described in patent DE 10 2009 033 171 A1. In this case, a tubular film is subjected during its production with a blown film line to a film thickness regulation, whereby the thickness profile of the film tube is regulated such that the film tube displays thin spots at those points which in a downstream orientation line operated in-line represent the peripheral zones of the laid-flat tubular film, so that after orientation of the film in an orientation line, a film with as few deviations as possible from the average film thickness across the film width results. If the film web is now during orientation in the orientation line additionally routed through the device for length change via an air-flow roll with negative pressure source which sucks the film onto it and thus prevents transverse neck-in and edge build-up, film of even better quality is produced. Application of a negative pressure source at the air-flow roll improves the quality even further. The laid-flat tubular film can be a blocked film, a film cut through on one or two sides, a twice-laid-flat tubular film or a film processed on one side in two orientation units.

Use of an air-flow roll with and without connection to a negative pressure source as a roll, especially as an orientation roll, increases the adhesion of the film web on the roll and thus leads to less transverse neck-in as well as to a reduced edge build-up of the film web and thus to an improved flatness of the film. This serves to reduce the previously unavoidable edge trimming waste. Both increase the economic efficiency during the production of oriented film.

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Other details, features and advantages of the subject matter of the invention arise from the following description of the associated drawings in which an embodiment of the invention is shown by way of example.

Figure 1 shows the invention-design device to permit monoaxial changes to the length of a film web in machine direction within an orientation line, also known as an MDO line, as an application possibility of the invention-design device.
The film web (1) is introduced into the orientation line from above. It is then routed via a heating section (2) with heated rolls (3). The film web (1) is then routed to the invention-design device for length change (4), here the orientation unit (4), with the rolls (5), here the orientation rolls with the processing gap in between, here the orientation gap (6), and is oriented. The diameter of the orientation rolls (5) can be smaller than that of the heated rolls. The film web (1) is subsequently routed to an annealing section (7) with annealing rolls (8) for tempering, followed by a cooling section (9) with cooling rolls (10). The film (1) finally exits the MDO system and can be wound with the winder. The film web is held securely on the different rolls by means of lay-on rolls (11).
Figure 2 shows the device for length change (4) of the orientation line in detail. The film web (1) is routed over the first orientation roll (5a) to the second orientation roll (5b). The orientation gap (6) is located between the orientation rolls (5a) and (5b). In this orientation line, the second orientation roll (5b) has a higher peripheral speed than the first orientation roll (5a) so that a positive length alteration results. The lay-on rolls (11) serve to additionally fix the film web (1) on the orientation rolls (5a) and (5b).

The film web (1) then exits the invention-design device (4). The orientation roll (5b) is designed in accordance with the invention as an air-flow roll with the possibility of connecting up a negative pressure source, not shown here. The orientation roll (5a) and the orientation roll (5b) can also be designed in addition as tempering rolls. In that case, the orientation roll (5b) is a combination of air-flow roll and tempering roll. Dependent on the orientation task, individual lay-on rolls (11) or all of them can be omitted.
Orientation lines can also have more than two orientation rolls (5) and thus have more invention-design devices (4).

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The orientation line can have two, three or more heated rolls, orientation rolls, annealing rolls or cooling rolls in each case.

Legend

1 Film web

2 Heating section

3 Heated rolls

4 Device for length change / orientation unit

5 Rolls / orientation rolls

5a First roll / orientation roll

5b Second orientation roll / roll

6 Processing gap / orientation gap

7 Annealing section

8 Annealing rolls

9 Cooling section

10 Cooling rolls

11 Lay-on rolls

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Claims:

1. A device to permit monoaxial length change of film webs in a machine direction, comprising:
   at least one processing gap delimited by a first roll and a second roll via which a film web is routed in the machine direction,
   whereby the first roll in a film transport direction exhibits a first peripheral speed and the second roll in the film transport direction exhibits a second peripheral speed
   wherein
   at least one of the first roll and the second roll is an air-flow roll through which air flows from the outside in.

2. The device in accordance with Claim 1, **wherein**
   a negative pressure source can be connected up to the air-flow roll for applying a negative pressure.

3. The device in accordance with Claim 2, **wherein**
   different degrees of negative pressure can be applied to the air-flow roll along its length.

4. The device in accordance with any one of Claims 1 to 3, **wherein**
   the air-flow roll can be combined with a temperature control.

5. The device in accordance with any one of Claims 1 to 4, **wherein**
   the first peripheral speed is lower than the second peripheral speed and the monoaxial length of the film web increases.

6. The device in accordance with any one of Claims 1 to 4, **wherein**
   the first peripheral speed is higher than the second peripheral speed and the monoaxial length of the film web decreases.

7. The device in accordance with any one of Claims 1 to 4, **wherein**
   the first peripheral speed is the same as the second peripheral speed.

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8. The device in accordance with any one of Claims 1 to 7, **wherein**
the device is an integral part of an orientation line.

9. The device in accordance with Claim 8, **wherein**
the orientation line comprises a plurality of rolls designed as air-flow rolls with and without applied negative pressure.

10. The device in accordance with Claim 8, **wherein**
the orientation line is located in-line within a blown film line.

11. A blown film line for the production of tubular film, **comprising**
a device in accordance with the device of any one of Claims 1 to 9, wherein the device is located in-line within the blown film line.

12. The blown film line in accordance with Claim 11, **wherein** the device in accordance with any one of Claims 1 to 9 is located in the film transport direction downstream of the first roll and the second roll, and upstream or downstream of turning bars of the blown film line.

13. The blown film line in accordance with Claim 11 or 12, **wherein**
the blown film line includes a plurality of devices in accordance with the device of any one of Claims 1 to 9.

14. A process to permit the monoaxial length alteration of film webs in a machine direction, whereby
a film web is routed through at least one processing gap delimited by a first roll and a second roll,
whereby the first roll, in a film transport direction, exhibits a first peripheral speed, and the second roll, in the film transport direction, exhibits a second peripheral speed
wherein
the film web experiences a change in the monoaxial length in the processing gap and

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at least one of the first roll and the second roll is an air-flow roll through which air flows from outside in and whereby air that accumulates between the air-flow roll and the film web flows out through the first and second rolls, and the film web lays direct on the air-flow roll.

15. The process in accordance with Claim 14, **wherein**
the film is subjected, during its production on a blown film line, to a film thickness regulation wherein the thickness profile of the film tube produced with the blown film line is regulated wherein the thickness profile exhibits deviations from a uniform film thickness, which serves to compensate for film thickness changes across the film width which occur during the downstream monoaxial orientation in machine direction so that a film web is produced as a result of orientation whose transverse thickness profile has as few deviations as possible from the average film thickness across the entire width of the film web.

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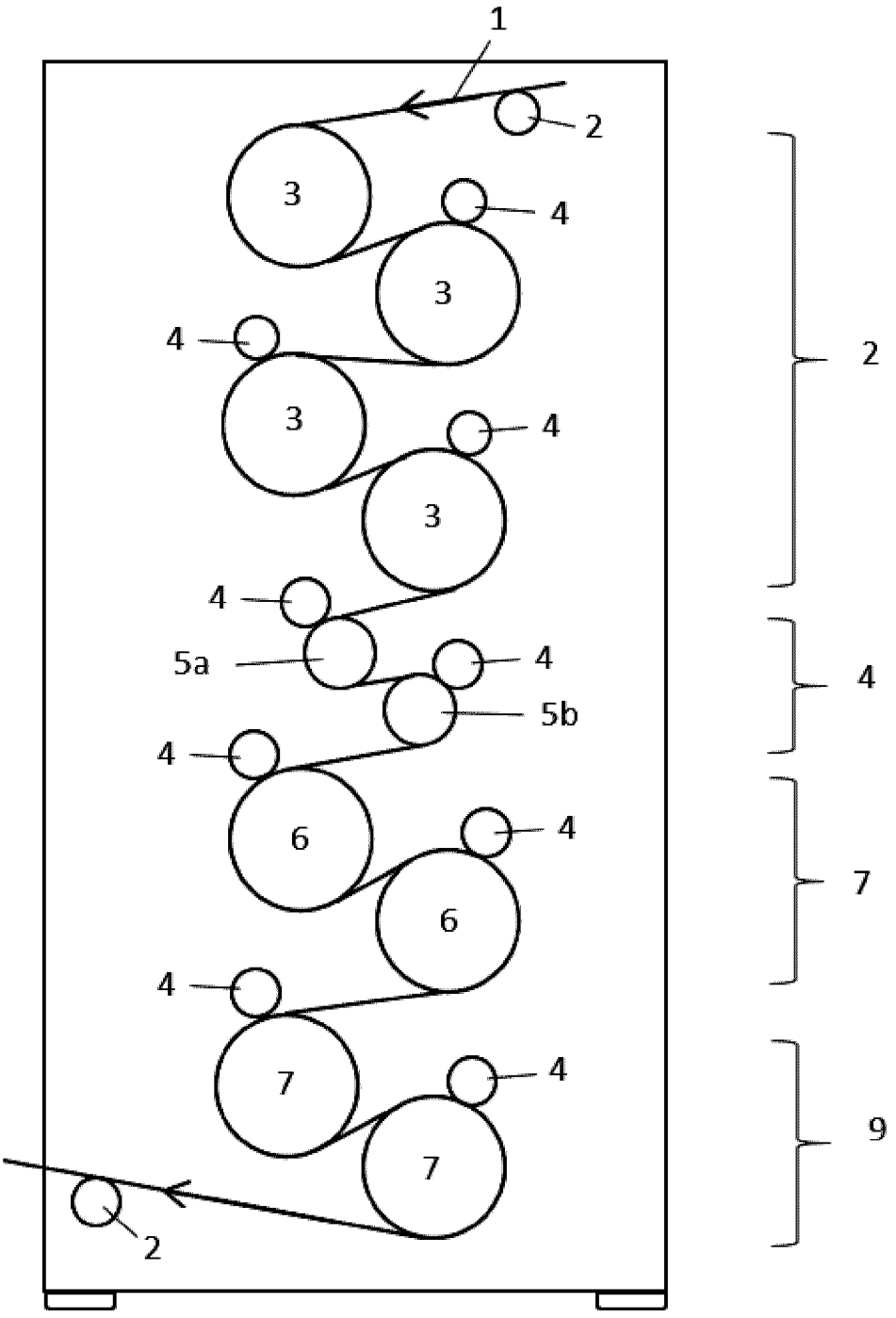


Figure 1

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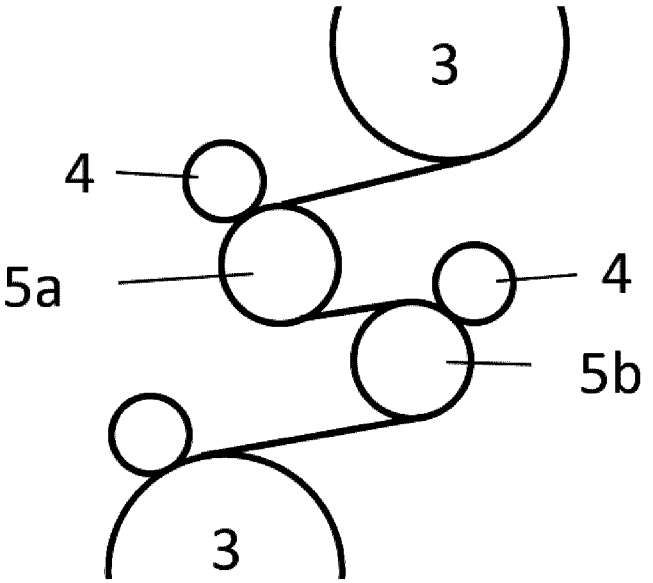
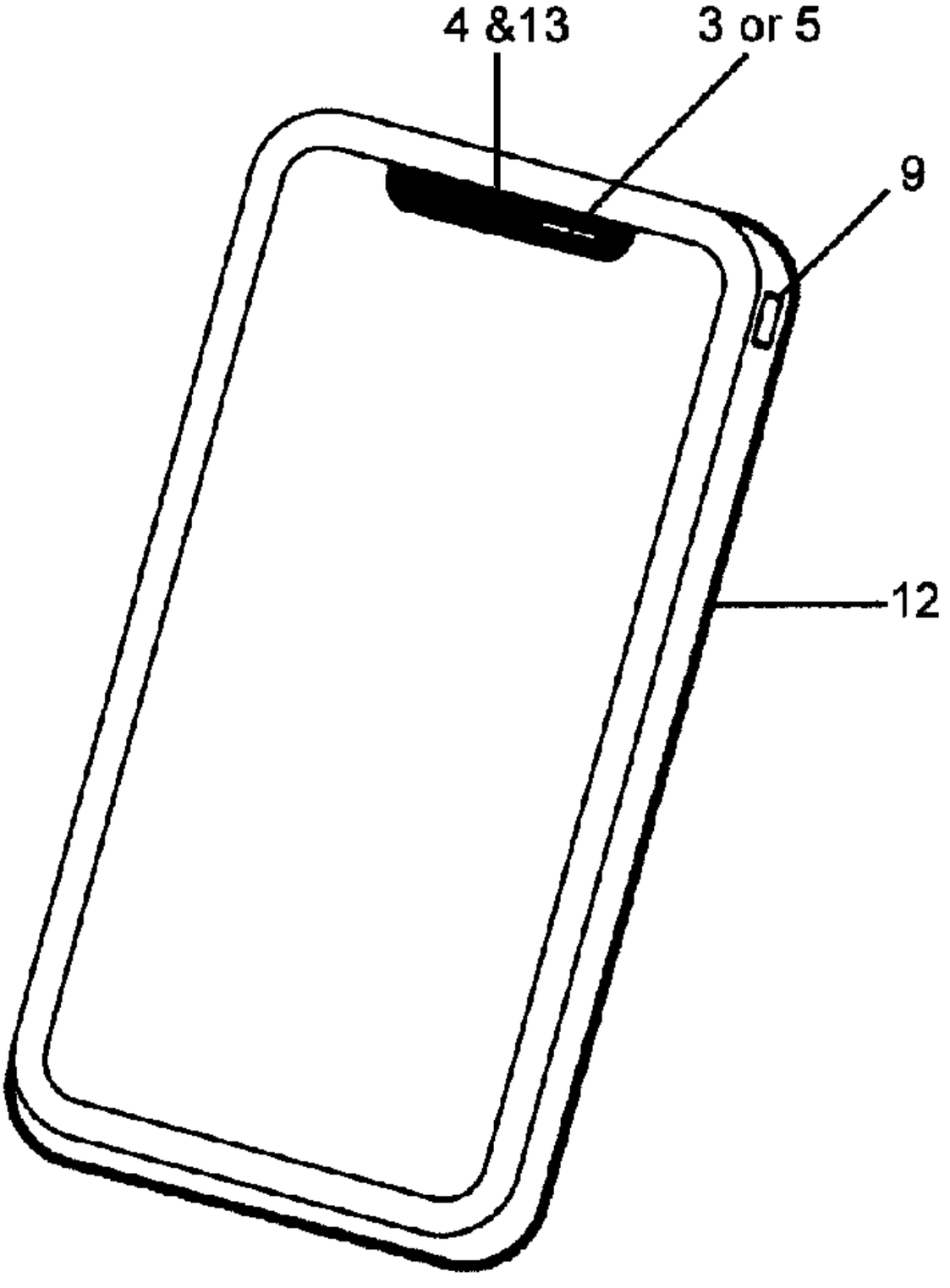


Figure 2

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4 &13
3 or 5
9
12