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CA 2927416 C 2022/03/22

(11)(21) 2 927 416

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 2014/10/15
(87) Date publication PCT/PCT Publication Date: 2015/04/23
(45) Date de délivrance/Issue Date: 2022/03/22
(85) Entrée phase nationale/National Entry: 2016/04/14
(86) N° demande PCT/PCT Application No.: DE 2014/000521
(87) N° publication PCT/PCT Publication No.: 2015/055169
(30) Priorité/Priority: 2013/10/15 (DE10 2013 017 072.9)

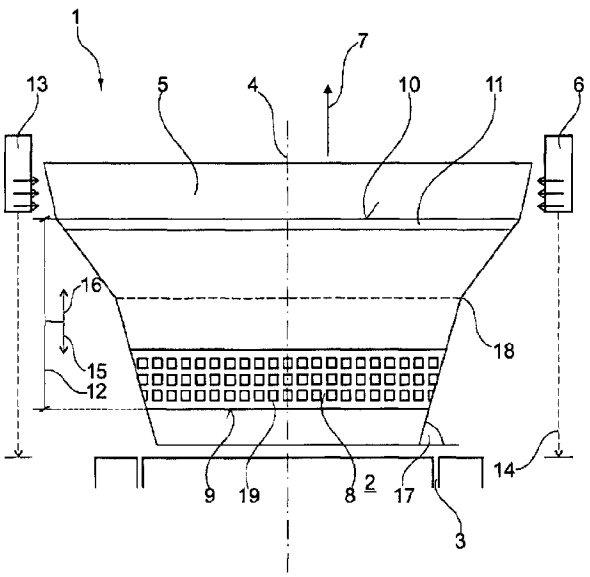
(51) Cl.Int./Int.Cl. *B29C 48/10* (2019.01), *B29C 48/885* (2019.01), *B29C 55/28* (2006.01)

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(54) Titre : LIGNE DE SOUFFLAGE DE FEUILLE MINCE ET METHODE D'EXPLOITATION
(54) Title: BLOW FILM LINE AND METHOD FOR OPERATING A BLOW FILM LINE



(57) Abrégé/Abstract:
The invention relates to a blown film line and to a method for operating a blown film line. The problem addressed by the invention is that of further increasing the throughput of known blown film lines without negatively influencing production quality. According to the invention, the interior cooling element (5) has an air outlet section (12), wherein additionally a cooling ring (6) is designed to be height-adjustable, wherein a controller positions the cooling ring (6) in the lower region of the interior cooling element (5) to start up the line, and positions the cooling ring in the upper region of the air outlet section (12) of the interior cooling element (5) to achieve the steady-state production.

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro

(43) Internationales Veröffentlichungsdatum
23. April 2015 (23.04.2015)

WIPO | PCT

(10) Internationale Veröffentlichungsnummer
WO 2015/055169 A1

(51) Internationale Patentklassifikation:
B29C 47/88 (2006.01) *B29C 47/92* (2006.01)
B29C 47/08 (2006.01) *B29C 55/28* (2006.01)

(21) Internationales Aktenzeichen: PCT/DE2014/000521

(22) Internationales Anmeldedatum:
15. Oktober 2014 (15.10.2014)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
10 2013 017 072.9
15. Oktober 2013 (15.10.2013) DE

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Erklärungen gemäß Regel 4.17:

— *Erfindererklärung (Regel 4.17 Ziffer iv)*

[Fortsetzung auf der nächsten Seite]

(54) **Title**: BLOWN FILM LINE AND METHOD FOR OPERATING A BLOWN FILM LINE

(54) **Bezeichnung** : BLASFOLIENANLAGE UND VERFAHREN ZUM BETREIBEN EINER BLASFOLIENANLAGE

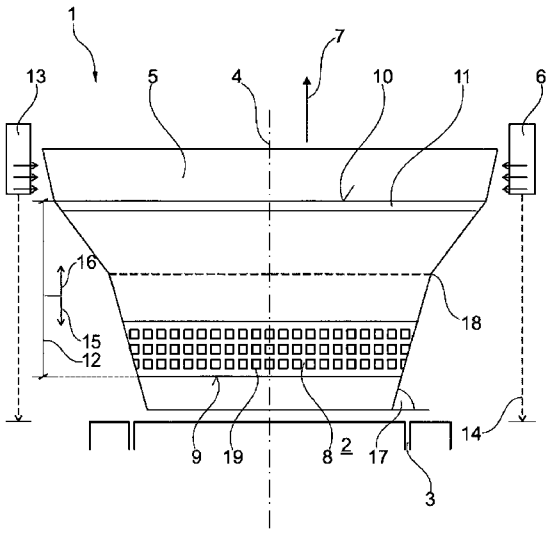


Fig.

(57) Abstract: The invention relates to a blown film line and to a method for operating a blown film line. The problem addressed by the invention is that of further increasing the throughput of known blown film lines without negatively influencing production quality. According to the invention, the interior cooling element (5) has an air outlet section (12), wherein additionally a cooling ring (6) is designed to be height-adjustable, wherein a controller positions the cooling ring (6) in the lower region of the interior cooling element (5) to start up the line, and positions the cooling ring in the upper region of the air outlet section (12) of the interior cooling element (5) to achieve the steady-state production.

(57) Zusammenfassung: Die Erfindung betrifft eine Blasfolienanlage und ein Verfahren zum Betreiben einer Blasfolienanlage. Es stellt sich die Aufgabe, den Durchsatz bei bekannten Blasfolienanlagen weiter zu steigern, ohne jedoch die Produktionsqualität zu vernachlässigen. Die Erfindung schlägt vor, dass der Innenkühlkörper (5) eine Luftaustrittsstrecke (12) aufweist, wobei außerdem ein Kühlring (6) höhenverstellbar gestaltet ist, wobei ein Controller den Kühlring (6) zum Anfahren der Anlage im unteren Bereich des Innenkühlkörpers (5) positioniert, zum Erreichen der steady-state-Produktion hingegen im oberen Bereich der Luftaustrittsstrecke (12) des Innenkühlkörpers (5).

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Veröffentlicht:

— *mit internationalem Recherchenbericht (Artikel 21 Absatz 3)*

— *vor Ablauf der für Änderungen der Ansprüche geltenden Frist; Veröffentlichung wird wiederholt, falls Änderungen eingehen (Regel 48 Absatz 2 Buchstabe h)*

Blow film line and method for operating a blow film line

[1] The invention relates to a blow film line and a method for operating a blow film line.

[2] Blow film lines are widely known in prior art. They are used to produce large-format films from a molten thermoplastic synthetic material in the form of hoses.

[3] One or more extruders melt the source material in the form of thermoplastic synthetic material and homogenize it. The resulting plasticized melt is pressurized and is introduced via channels into a blow head. Here, single or multi-layered films are generated, exiting the blow head through an annular nozzle. Therefore, a still molten film hose exits the annular nozzle upwards. The inside of the film hose is pressurized. This causes the film hose to radially expand, due to the still molten state in the direction of extrusion, usually upwards in practice, until the solidity of the film hose is of such strength that the film hose no longer experiences any expansion under the internal pressure. In practice, this is frequently called the "frost line". Simultaneously, a pair of draw rolls pulls the film hose along the direction of extrusion and this way causes a longitudinal extrusion in addition to the lateral extrusion by the inflation.

[4] In most applications it is advantageous to adjust the frost line as low as possible, thus as closely as possible near the exit of the melt from the annular nozzle. In practice, accordingly cooling means are used both inside as well as outside the film hose: For this purpose, a so-called "internal cooling body" is provided at the inside as appropriate. Usually "air cooling rings" or in any case one air cooling ring is provided at the outside.

[5] DE 1 211 379 presents an arrangement in which a hose is produced from an annular-shaped die. The hose is expanded by the introduction of blowing air, with the blowing

air being introduced into the hose between the nozzle and a cooling body cooled by water. The blowing air to expand the blow film is cooled by a double-wall cooling body, with water flowing through it. This cooled air can extract heat from the blow film.

[6] DE 26 08 311 A1 shows an arrangement in which the film at its interior is cooled with a cooling body, cooled with water, and at its exterior by direct contact with water.

[7] DE 39 03 174 A1 shows a blow film arrangement in which for interior cooling of the film hose a cooling cylinder is provided, in which at four discrete points, distributed over the height of the cylinder, cooling air grooves are provided around the perimeter of the cylinder.

[8] DE 29 24 897 A1 shows a cylindrical stabilizer for blowing resin, which heats the film hose from the inside, however expands its diameter. In return, a cooling ring is provided at the outside around the film hose. The inner stabilizer comprises engraved or cut patterns, particularly in the form of grooves.

[9] EP 1 800 832 A2 shows an inner cooling body for a blow film line. The inner cooling body comprises flow channels at its jacket area, with their progression at least partially extending over a section of a longitudinal extension of the inner cooling body. Eddies develop through this macroscopically structured surface at the inner cooling body, which ensure for a cushioned guide of the rising flow film hose.

[10] Blow film lines are frequently equipped with cooling rings or even with double cooling rings, in order to increase the flow rate of these devices. The melt between the first and the second cooling ring is already extended to a certain ratio. This leads to the melt being more easily cooled at the upper cooling ring, due to the lower thickness. Here, more than two cooling rings may also easily be used.

[11] DE 32 41 192 C2 describes a blow film line with a first cooling ring, which is arranged downstream directly following a nozzle, a second cooling ring, which is

arranged closely upstream in reference to calibration, and an iris diaphragm, optionally arranged there between, which shall prevent any vibration of the film hose.

[12] Other blow film lines and cooling rings are known from DE 44 05 463 A1, DE 34 36 881 A1, US 4,601,649 B, US 3,555,604 B, US 4,606,879 B, US 6,273,699 B, US 5,126,096 B, US 4,842,803 B, US 5,576,029 B, the lecture "IKV-Fachtagung Folienextrusion - Rohstoffe, Verarbeitung, Anwendungen; Steigerung des Durchsatzes durch innovative Ansätze zur Schlauchkühlung bei der Blasfolienextrusion" [IKV-special meeting Film extrusion - raw materials, processing, applications; increase of flow rate by innovative approaches for cooling hoses in blow film extrusion] dated September 22/23, 2008 in Aachen, presented by Dr. Christoph Lettowsky, at said time Extrusion GmbH, Worms, as well as from the article "Wasser mit Luft kombiniert" [water combined with air] by Dr. Christoph Lettowsky, published in Carel Hanser Verlag, Munich, in the journal "Kunststoffe [plastics] 11/2008", as well as known from DE 1 504 648, US 3,650,644, AT 315 472, DE 26 39 551 A1, and DE 38 15 415 A1.

[13] The present invention is based on the objective to further increase the flow rate while maintaining secure production.

[14] According to a first aspect of the present invention this objective is attained in a blow film line with an inner cooling body comprising an air outlet path, with the inner cooling body being embodied at least over an overwhelming portion of the air outlet path in a monotonously or strictly monotonously expanding fashion, and with a cooling ring, which can be adjusted in its height, being provided for cooling from the outside a blow film hose traveling during the operation of the blow film line, with here the blow film line being implemented to position the cooling ring during the steady-state production in the upper half of the air outlet path, particularly preferred in the upper third.

[15] According to a second aspect of the present invention the objective is attained in a blow film line comprising an inner cooling body with an air outlet path, with the inner

cooling body being embodied at least over an overwhelming portion of the air outlet path in a monotonously or strictly monotonously expanding fashion, and with a cooling ring, which can be adjusted in height, being provided for cooling from the outside a blow film hose traveling during operation of the flow film line, with the blow film line being implemented to position the cooling ring during the steady-state production in the lower half of the air outlet path, particularly preferred in the lower third.

According to another aspect of the invention, there is provided a blow film line comprising an inner cooling body with an air outlet path, the inner cooling body being embodied at least over an overwhelming part of the air outlet path in a monotonously or strictly monotonously expanding fashion, and a height-adjustable cooling ring that cools a blow film hose from outside the inner cooling body, the height-adjustable cooling ring traveling along a displacement path that extends along the entire inner cooling body during the operation of the blow film line, wherein the cooling ring is positioned in an upper half of the air outlet path during a steady-state production, and wherein the cooling ring is positioned in a lower half of the air outlet path during a start- up phase; wherein a controller is provided, which is connected to a height adjusting means of the cooling ring, wherein the controller is embodied to position the cooling ring during the start -up phase of the blow film line underneath the upper area and/or in a lower area, and to move it for the steady-state production into the upper area and/or to move it upwards within the lower area.

According to another aspect of the invention, there is provided a blow film line comprising an inner cooling body with an air outlet path, whereby the inner cooling body is embodied at least over an overwhelming part of the air outlet path in a monotonously or strictly monotonously expanding fashion, and whereby a height-adjustable cooling ring is provided for cooling a blow film hose from the outside during the operation of the blow film line, wherein the height-adjustable cooling ring traveling along a displacement path that extends along the entire inner cooling body during the operation of the blow film line, whereby the blow film line is embodied to position the cooling ring in the lower half of the air outlet path during the steady-state production, particularly preferred in the lower third; and a controller is provided, which is connected to a height adjusting means of the cooling ring, wherein the controller is embodied to position the cooling ring during the start-up phase of the blow film line underneath the upper area and/or in a lower area, and to move it for the steady-state production into the upper area and/or to move it upwards within the lower area.

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[16] With regards to terminology, the following is explained:

[17] Within the scope of the present patent application, indefinite articles and numeric statements, such as "one ...", "two ..." etc. shall regularly be understood as minimum statements, thus representing 'at least one ...", "at least two ..." etc., except when it is discernible from the respective context that here for example, only "precisely one ...", "precisely two ..." etc. shall be understood.

[18] The wording of the present patent application is selected such that it describes a blow film line, which allows for a film hose to rise from the bottom towards the top, thus being blown out of the annular nozzle opposite the forces of gravity and pulled upwards. However, it shall be explicitly emphasized that the invention can also be applied to a device blowing downwards along with the forces of gravity. All explanations given here shall then be appropriately adjusted, thus in most cases simply inverted.

[19] The "inner cooling body" represents a body provided inside the limits designated by the film hose, which is connected to the air driving means, primarily to a pump such that the air can be blown via an "air outlet path" in a pressurized fashion out of the inner cooling body and this way impinges the blow film surrounding the inner cooling body during the operation of the blow film line.

[20] The dimension of the "air outlet path" shall be sized in a projection of the open area provided at the inner cooling body towards the air outlet along the extrusion axis,

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thus along a central axis of the film hose traveling from the annular nozzle towards the pulling unit.

[21] The air outlet path will in most cases represent the entire height at which the air is blown out at the inner cooling body.

[22] However, constructive embodiments are also possible in which initially the inner cooling body blows out the very overwhelming portion of the air, with another air outlet being located there above at a vertical distance, either in the form of a punctual air outlet in reference to the height or an air outlet with a vertical extension. In such a constellation, only the lower part of the air outlets is understood as the "air outlet path", when less than 10% of the air is blown out above the first air outlet path. In most cases, the air outlet path will maximally be approx. 1 m high, or for example also up to 2 m high.

[23] A simplifying constellation can abut the upper end of the air outlet path, where, beginning at the lower end of the compressed air outlet, over the rising height at the inner cooling body in the mathematical sense integrated 90% or 95% of the pressurized air flow has added from the inner cooling body. In a simple inner cooling body with a one-piece air outlet path this definition will in general deviate slightly by a few cm from the purely geometrical air outlet path, but presumably particularly in multi-part air outlet paths it will frequently lead to a definition that can be applied with confidence.

[24] Any "expanding" of the inner cooling body represents that the inner cooling body at least essentially shows at every cross-section normally a circular shape with a diameter along the direction of extrusion, with said diameter monotonously or strictly monotonously increasing along the direction of extrusion. The diameter shall represent the smallest circular perimeter of each cross-section, with the air outlet slots being negligible, here.

[25] The "height adjustable" cooling ring must be effectively connected to a height adjusting means, for example a conventional motor, a stepper motor, a torque-motor, a hydraulic or pneumatic, or any other drive. It is important that the drive is implemented to adjust the cooling ring in its height also during operation of the blow film line, thus in its distance from the annular shaped die in the blow head. The blowing can occur upwards or downwards.

[26] When starting the production at a blow film line, no complete film hose is provided from the blow head to the pull-off device. Rather, initially the film hose coming from the blow head is manually grasped and guided to the pull-off device. When the pull-off begins to pull, the equipment can slowly approach a continuous production stage, thus the status "steady-state production".

[27] The "positioning" of the cooling ring in the upper half of the air outlet path shall represent that either the air outlet slots or air outlet holes at the cooling ring show in the vertical projection to the axis of extrusion an appropriate height above the blow head in the air outlet path, or that the air impingement line of the air blown by the cooling ring on the film hose shows a respective height, or preferably both.

[28] Experiments of the inventor using prototypes have shown that with the object of the first aspect of the present invention considerably increased flow rates can be achieved even in reference to arrangements already showing high flow rates, without here the quality of the production being compromised.

[29] The inner cooling body can preferably show a structured surface. With regards to the various options of a structured surface, reference shall be made to the content

disclosed in EP 1 800 832 A2, with its entire content disclosed being hereby included by way of reference.

[30] The inner cooling body may show annular grooves, which are designed as air outlets. The annular grooves themselves may for example show several discrete bore holes, through which they are provided with pressurized air from the inside.

[31] Alternatively or cumulative it is possible that the inner cooling body shows a perforated sheet at its surface. Such a perforated sheet may be used, due to the plurality of round, square, rectangular, or otherwise designed air outlets, also for blowing cooling air to the film hose.

[32] It is suggested that the inner cooling body shows a functionally modified surface.

[33] The surface of the inner cooling body is generally made from metal. A functional surface modification may represent for example a coating.

[34] For example, modifications are possible for reducing the precipitation of paraffin or for reducing the surface roughness or for influencing the thermal conductivity.

[35] It seems advantageous for the height adjusting means for the cooling ring to be connected effectively to a manual switch, with the switch showing a rising position, a lowering position, and a holding position. This way the cooling can easily and manually be adjusted in height.

[36] When the height adjusting means is effectively connected to a manual switch, with the switch showing a spring-loaded rising position and a spring-loaded lowering position, here the operator can control the switch like a feeler. Either the operator holds the switch in the position against the spring force for raising or lowering, and the cooling ring stops as soon as the operator releases the switch, so that it is reset by the spring force; or the operator pushes the switch briefly against the spring force towards

one of the two spring-loaded end positions, then allows the switch to resiliently return, and the cooling ring moves automatically into an upper and/or a lower end position.

[37] If the height adjusting means is effectively connected to a controller and the controller is in a data transmitting connection to a recipe database, with the controller being implemented to read data from the recipe database for a target height position of the cooling ring, primarily for precisely two target height positions, and to appropriately control or regulate the height adjusting means, then the method of the cooling ring can occur automatically. The automatic control can extend to temporal or local details of the displacement, preferably to both.

[38] It has already been mentioned that preferably a controller is provided which is effectively connected to a height adjusting means of the cooling ring.

[39] The controller may be implemented to keep the cooling ring stationary during the steady-state production, or it may be designed to keep the cooling ring in motion during the steady-state production, due to continuous measurements, with in the latter variant a control being achieved such that the controller shall also be in a data transmitting connection to a measuring means, for example a measuring means for the thickness of the film at the film hose.

[40] In the preferred embodiment the controller is embodied to position the cooling ring during the start-up phase of the blow film line under the area described in the first aspect of the invention, thus in the lower half of the air outlet path, and for the steady-state production to displace the air cooling ring then into the upper area, and here to keep it during the steady-state production, at least over the very overwhelming portion of the time, preferably over at least 90% of the time.

[41] According to a third aspect of the present invention the objective set provides a method for operating a blow film line as described above, with for the start of the blow film line the cooling ring set to a position lower than the upper half of the air cooling

path, and then in order to achieve the steady-state production the cooling ring is displaced upwards.

[42] In the following, the invention is explained in greater detail based on an exemplary embodiment with reference to the drawing. Here, it is shown

in the single figure largely schematic in a longitudinal cross-section the upper edge of a blow head with an annular nozzle, the lower part of an inner cooling body, as well as a height-adjustable cooling ring, each at a blow film line.

[43] The blow film line 1 in the figure (shown only partially) comprises with regards to the extrusion of a plastic melt essentially the blow head 2 with an annular shaped die 3, which is arranged rotationally-symmetrical around an extrusion axis 4, as well as an inner cooling body 5 located upstream thereof, and a cooling ring 6. During operation of the blow film line 1 a plastic melt is extruded through the annular shaped die 3 in a direction of extrusion 7, thus vertically upwards. In its diameter, perpendicular in reference to the axis of extrusion 4, the blow film expands then along the direction of extrusion 7 around the inner cooling body 5, preferably without contacting it.

[44] Air outlet sections are arranged along the height of the inner cooling body 5, for example air outlet grooves or perforated sheets 8 with pressurized air flowing behind them (shown as an example).

[45] From a lowest height 9, at which cooling air is blown out of the inner cooling body 5, to an uppermost height 10, here for example represented by an air outlet groove 11, an air outlet path 12 extends parallel in reference to the axis of extrusion 4.

[46] The cooling ring 6 shows air outlet nozzles 13 (numbered as examples). The cooling ring 6 is additionally positioned along a displacement path 14 in a manner

adjustable in height along the inner cooling body 5. A height adjusting means (not shown) is effectively connected to a controller (not shown) so that within certain maximal limits the controller can displace the cooling ring 6, more precisely its area at the air outlet nozzles 13 projected to the axis of extrusion 4.

[47] The preferred embodiment of the invention provides that the air outlet nozzles 13 of the cooling ring 6 or in case of several cooling rings of at least one cooling ring, preferably however of all cooling rings, preferably during the start-up phase of the equipment are positioned in a lower area 15 of the air outlet path 12, in any case however during the steady-state production in an upper area 16.

[48] The inner cooling body 5 may, as shown in the present example, be provided with different angles of incline 17 of its jacket, here for example initially showing a strictly monotonously expanding angle of incline 17, then a bend 18, followed again by a stronger, strictly monotonously increasing area in its diameter, and finally a strictly monotonous, less increasing area in the diameter. Prototype tests of the inventor have shown that the diameter of the inner cooling body 5 should expand strictly monotonously or at least monotonously, with preferably at least one section being provided with strictly monotonous expansion, thus a non-cylindrical area with an incline angle 17 of the jacket being $\neq 90°$, with the angle potentially changing rapidly or steadily over the vertical extension. Any small recesses in the surface of the inner cooling body 5 potentially formed by air outlets, such as caused by each recess 19 in the perforated sheet 8, are not considered, here. Rather, the actual surface contour is being discussed.

[49] When the diameter expands in a strictly monotonous fashion along the direction of extrusion, here the blow film hose is subject to tensile stress over the entire distance due to the also strictly monotonous expansion, which can prevent the formation of creases.

[50] It shall be understood that the figure only represents one of many exemplary embodiments. The embodiment shown shall therefore not be understood as the limiting scope of the protection claimed. Rather, the maximum scope of protection claimed includes the overall content of disclosure provided in the present patent application based on the claims, the description, and the figure.

Reference characters

1	Blow film line
2	Blow head
3	Annular shaped die
4	Axis of extrusion
5	Inner cooling body
6	Cooling ring
7	Direction of extrusion
8	Perforated sheet
9	Lowest height
10	Uppermost height
11	Air outlet groove
12	Air outlet path
13	Air outlet nozzle
14	Displacement path
15	Lower area
16	Upper area
17	Angle of incline
18	Bend
19	Recess

CLAIMS

1. A blow film line

comprising an inner cooling body with an air outlet path,

the inner cooling body being embodied at least over an overwhelming part of the air outlet path in a monotonously or strictly monotonously expanding fashion, and

a height-adjustable cooling ring that cools a blow film hose from outside the inner cooling body, the height-adjustable cooling ring traveling along a displacement path that extends along the entire inner cooling body during the operation of the blow film line,

wherein the cooling ring is positioned in an upper half of the air outlet path during a steady-state production, and

wherein the cooling ring is positioned in a lower half of the air outlet path during a start- up phase;

wherein a controller is provided, which is connected to a height adjusting means of the cooling ring, wherein the controller is embodied to position the cooling ring during the start -up phase of the blow film line underneath the upper area and/or in a lower area, and to move it for the steady-state production into the upper area and/or to move it upwards within the lower area.

2. A blow film line

comprising an inner cooling body with an air outlet path,

whereby the inner cooling body is embodied at least over an overwhelming part of the air outlet path in a monotonously or strictly monotonously expanding fashion, and

whereby a height-adjustable cooling ring is provided for cooling a blow film hose from the outside during the operation of the blow film line,

wherein the height-adjustable cooling ring traveling along a displacement path that extends along the entire inner cooling body during the operation of the blow film line,

whereby the blow film line is embodied to position the cooling ring in the lower half of the air outlet path during the steady-state production, particularly preferred in the lower third;

and a controller is provided, which is connected to a height adjusting means of the cooling ring, wherein the controller is embodied to position the cooling ring during the start-up phase of the blow film line underneath the upper area and/or in a lower area, and to move it for the steady-state production into the upper area and/or to move it upwards within the lower area.

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3. A blow film line according to claim 1, wherein the blow film line is implemented to allow the blow film hose to travel upwards and to pull it off.

4. A blow film line according to claim 1, wherein the inner cooling body shows a structured surface.

5. A blow film line according to claim 1, wherein the inner cooling body further includes a plurality of annular grooves which are embodied as a plurality of air outlets.

6. A blow film line according to claim 1, wherein the inner cooling body comprises a perforated sheet at its surface.

7. A blow film line according to claim 1, wherein the inner cooling body comprises a functionally modified surface.

8. A blow film line according to claim 7, wherein the inner cooling body comprises a coating.

9. A blow film line according to claim 1, wherein the height adjusting means is provided for the cooling ring, which shows a drive.

10. A blow film line according to claim 9, wherein the height adjusting means is connected to a manual switch, with the switch comprising a rising setting, a lowering setting, and a holding setting.

11. A blow film line according to claim 9, wherein the height adjusting means is connected to a manual switch, and the manual switch includes a spring-loaded rising setting and a spring- loaded lowering setting.

12. A blow film line according to claim 9, wherein the height adjusting means is connected to the controller, and the controller is connected to a recipe database in a data transmitting fashion, wherein the controller is embodied to read data from the recipe database

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regarding a target height position of the cooling ring, primarily regarding precisely two target height positions, and the height adjusting means being appropriately addressed or regulated.

13. A blow film line according to claim 1, wherein the controller is provided, which is connected to the height adjusting means of the cooling ring, wherein the controller is embodied to keep the cooling ring locally fixed during the steady-state production.

14. A blow film line according to claim 1, wherein the controller is provided, which is connected to the height adjusting means of the cooling ring, wherein the controller is implemented to keep the cooling ring in motion during the steady-state production based on continuous measurements.

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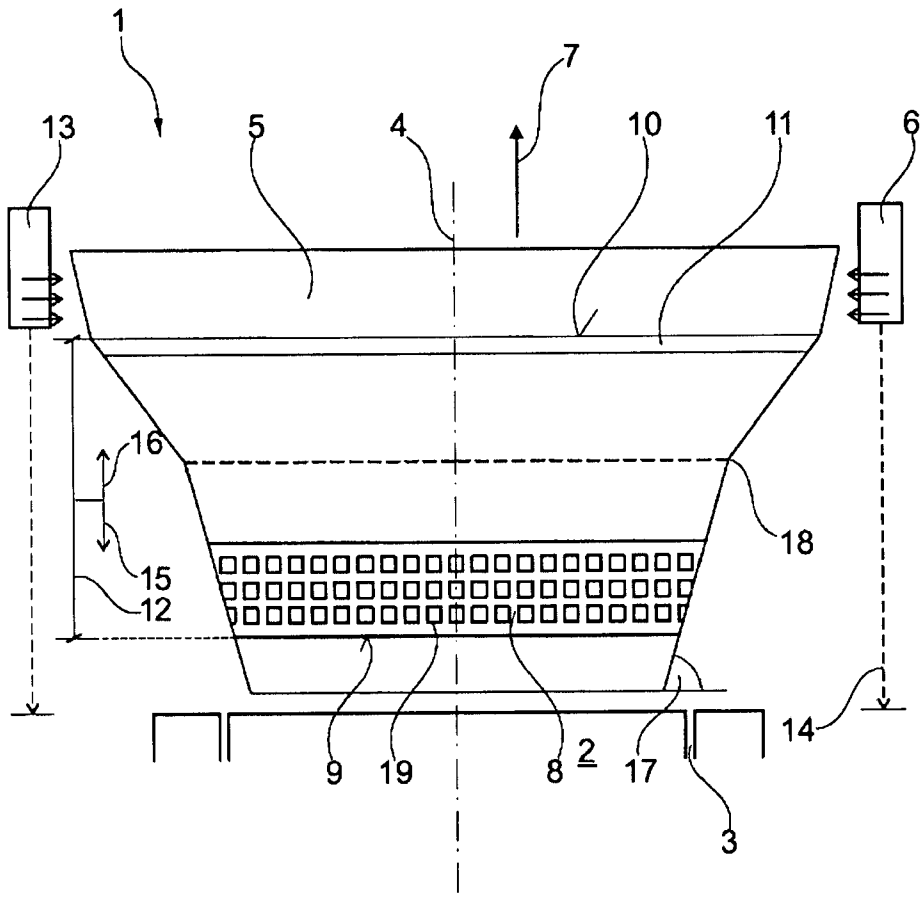
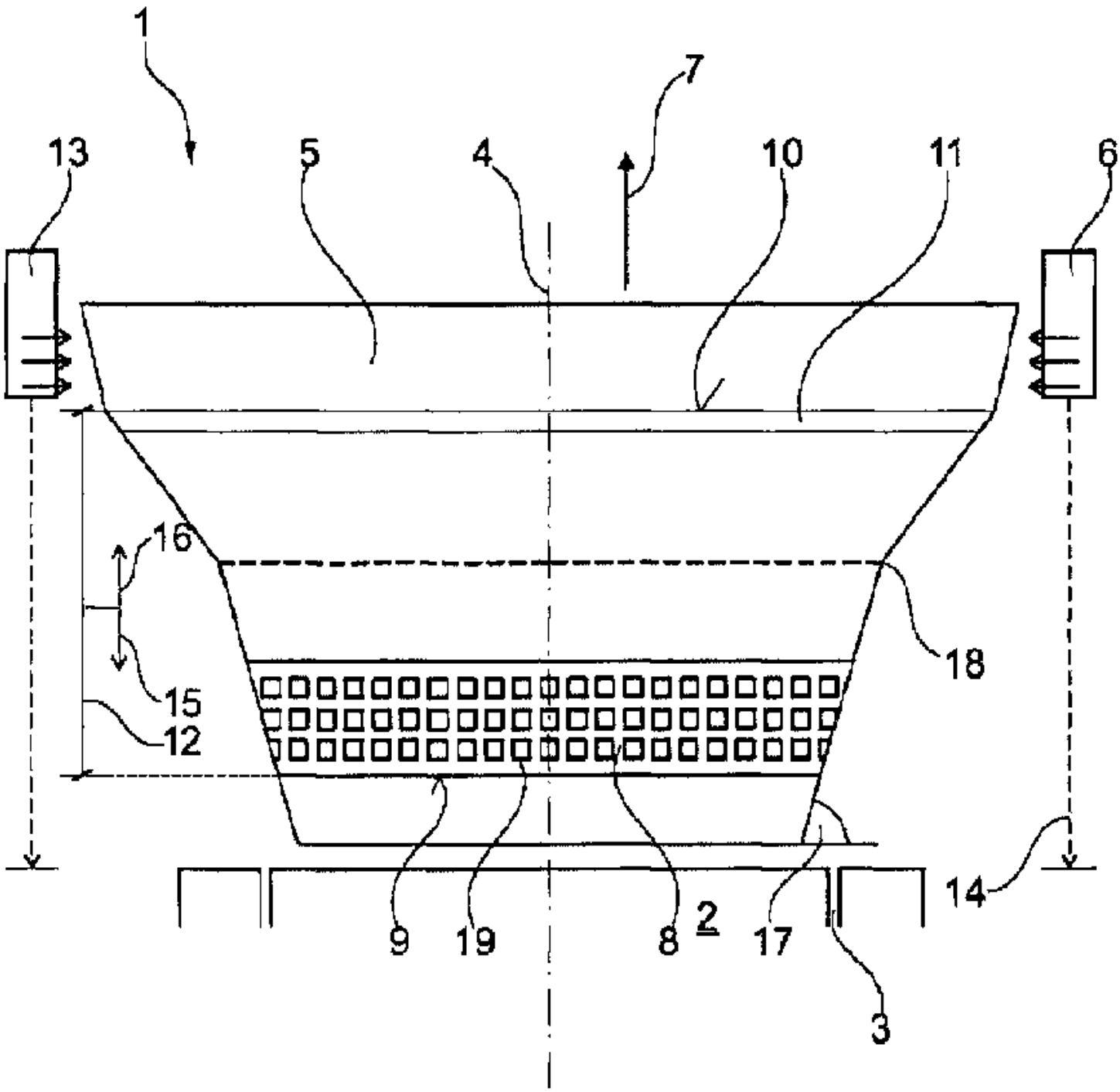


Fig.


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