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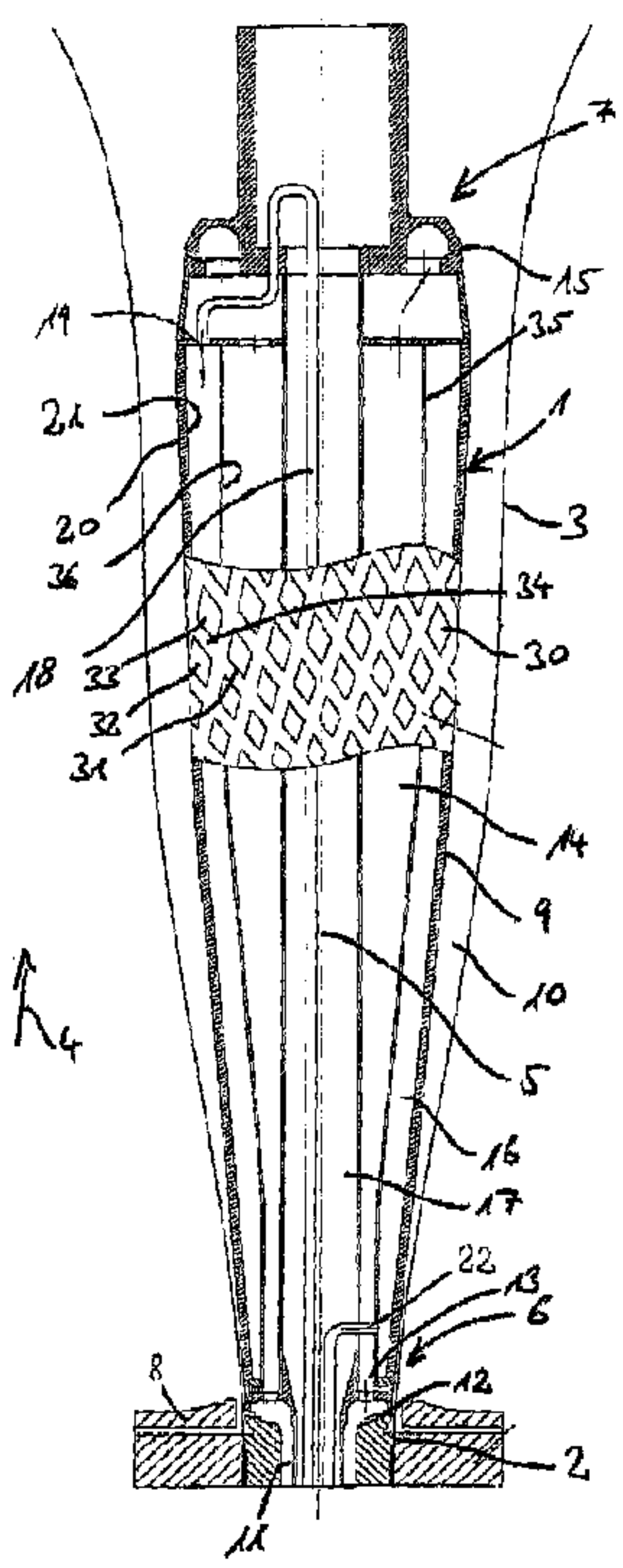
(54) Titre : CORPS DE REFROIDISSEMENT INTERIEUR POUR SYSTEME DE SOUFFLAGE DE FEUILLE MINCE, SYSTEME DE SOUFFLAGE DE FEUILLE MINCE ET PROCESSUS DE PRODUCTION D'UN SYSTEME DE SOUFFLAGE DE FEUILLE MINC

(54) Title: INTERIOR COOLING BODY FOR A BLOWFILM SYSTEM, BLOWFILM SYSTEM, AND PROCESS FOR PRODUCING A BLOWFILM



(57) **Abrégé/Abstract:**
The invention relates to producing large scale films in the form of tubes from thermoplastic synthetic material. An interior cooling body for a blow film system is disclosed. The cooling body has a nappe jacket with stream channels and stream whirling elevations in the shape of rhombi which are inclined in view of a longitudinal extension of the cooling body. A blow film system and a process of producing a blow film tube using the cooling body are also disclosed.

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Abstract

The invention relates to producing large scale films in the form of tubes from thermoplastic synthetic material. An interior cooling body for a blow film system is disclosed. The cooling body has a nappe jacket with stream channels and stream whirling elevations in the shape of rhombi which are inclined in view of a longitudinal extension of the cooling body. A blow film system and a process of producing a blow film tube using the cooling body are also disclosed.

Interior cooling body for a blowfilm system, blowfilm system, and process for producing a blowfilm

[01] The invention concerns an interior cooling body for a blowfilm system, a blowfilm system, and a process for producing a blowfilm.

[02] Blowfilm systems are used for producing large scale films in form of tubes from thermoplastic synthetic material..

[03] DE 1 211 379, DT 26 08 311 A1, DE 39 03 174 A1, DE 29 24 897 A1, and DE 1 504 648 show different systems for cooling film tubes or for stabilizing film tubes.

[04] Further systems are known from US 3,650,644, AT 315 472, DE 26 39 551 A1, and DE 38 15 415 A1.

[05] Some embodiments of the invention may improve the systems and methods known in the art.

[06] According to a first aspect of the invention, there is provided an interior cooling body for a blow film system, wherein the cooling body has a surface nappe, wherein there are stream channels provided in the nappe, the run of which extends at least over a part of a longitudinal extension of the cooling body.

[07] This aspect of the invention bases on the realization that the providing of stream channels in the nappe of the cooling body causes turbulences, which improve a polster effect of the blowair. By this, in at least the major part of the blow film, a contact between the film and the cooling body can be avoided. Even if some contact happens between the film tube and the cooling body nappe, this is not problematic, since the stream channels are not perpendicular to a longitudinal extension of the body, but they rather have a component which can be projected onto the longitudinal axis of the cooling body.

[08] In addition to this, the turbulences between the blow film tube and the cooling body effect a higher transport of heat energy, which enables the tube to cool down more quickly. This provides for a high flow rate.

[09] It may be pointed out that there is not necessarily a need for absolutely avoiding any contact between the blow film tube and the cooling body. However, the blow film gets a higher quality if at least uncontrolled contact is avoided. It may even be desired to establish contact in order to produce a certain surface character of the film, for example a higher surface roughness.

[10] According to a second aspect of the invention, there is provided an interior cooling body for a blow film system with a nappe, with an inwardly neighboured cooling fluid areal guidance, wherein the cooling fluid areal guidance comprises an annular cross section with an air guidance provided in its interior.

[11] In the terminology, it may be explained that a fluid guidance being neighboured "inwardly" to the nappe means that the fluid guidance is positioned closer to a longitudinal axis of the cooling body. Normally, the cooling body will by at least in general rotation-symmetrical and will have a longitudinal symmetry axis. In this case, a position neighboured inwardly means that the fluid guidance is positioned radially inwards of the nappe.

[12] Further to the terminology, it may be explained that a "cooling fluid areal guidance" is a guidance for an arbitrary cooling fluid, especially for water, which enables the fluid to communicate with the surface of the cooling body via an area in order to cool down the blowair passing on the outside of the surface.

[13] This aspect bases on the realization that such an interior structure of a cooling body is of advantage. Within the interior of a film being extruded in a blow film plant, there is often only little room for bringing in cooling media. A structure as described has the advantage that the cooling of the cooling body surface is performed by water, which is very efficient. At the same time, the water is guided through the cooling body in an annular walling, so that a space for an air guidance is provided in the interior of the fluid guidance. The air guidance can cool down the cooling water radially from the interior side, and the interior air guidance, for example in the form of a central air duct, can be used for transporting blowair to the head of the cooling body. There, the blowair can be added to the bolstering blowair stream, e.g. be ducted into same so that there is a higher air stream at

the head of the cooling body. This can be used in order to widen the film tube.

[14] A further effective use of the room provided is reached if in the air guidance, there is a cooling fluid lead is provided, which is connected to the cooling fluid areal guidance. For example, a pipe or a hose for the cooling fluid can run through the central air duct. Such a lead can easily be maintained, since it is located in the air duct and therefore rather freely accessible.

[15] According to a third aspect of the invention, there is provided an interior cooling body for a blow film system with a cooling fluid areal guidance with an annular cross section in a double-walled jacket or nappe.

[16] It has already been explained that the cooling fluid must often be lead inside the cooling body under narrow room conditions, because within the film tube, there is often only little room. If the cooling fluid areal guidance is provided in a double-walled jacket of the cooling body, the construction of same is rather simple, and the cooling fluid is in direct contact with the outer double-wall of the cooling body, i.e. with the surface or nappe wall.

[17] According to a fourth aspect of the invention, there is provided an interior cooling body for a blow film system, having a length of between approx. 0,5 m or approx. 1 m up until approx. 3 m, and having the shape of a cone base, i.e. a frustrum.

[18] It has been found out that a frustrum shape is of advantage for an interior cooling body especially if same has a greater length. By this, a continuous widening of the film tube can be reached already in the area of the lower cooling, which is where the blowair makes a bolstering stream for the film tube around the cooling body. In spite of the girth being widened rather much in its rather hot and soft condition, good quality of the film surface can be achieved. By using the long, frustrum-shaped cooling body, the film tube seems to be widen very homogeneously.

[19] Good results have been found especially for a length of at least 0,5 m, or at least 1 m, also around approx. 1,5 m.

[20] It may be pointed out that a "frustrum" shape is not to be understood in ist mathematically precise sense. Rather, preferred embodiments can be reached already if the cooling body has at least over the biggest part of its length a surface gradient which enlarges the girth, so that the cooling body has the greater part of its length extension being formed as to widen the body, and the smaller part being formed as to reduce the girth. Especially, a shape may be considered in which the girth widens over at least 70 %, 80 % or 90 % of the length between cooling body foot and head. In an experiment, also a slight barrel shape proved to be good, i.e. a shape in which the girth widening is quicker in the area of the foot and/or at demi-height than at the head of the cooling body.

[21] According to a fifth aspect of the invention, there is provided interior cooling body for a blow film system with an air guidance parallel

to a bolstering stream streaming around the cooling body in use of the system, wherein there is an air outlet at the head of the cooling body which leads the parallel air guidance into the bolstering stream.

[22] It has already been explained that the room inside of the film tube is often rather little. However, a bolstering stream is to be established wherein beyond the cooling body, i.e. at upwardly extruding plants higher than the cooling body, a widening of the film tube is reached, if possible already at the cooling body.

[23] It has proved to be of advantage to lead a part of the blowair through the cooling body from its foot to its head, and to lead it into the bolstering stream there. As a result, very much air can be pumped through a solid duct inside of the body from its foot to its head. This stream can be controlled almost arbitrarily due to the solid walling. It can especially be controlled up to a very high level. In contrast, the bolstering stream around the cooling body should not be driven too high, because otherwise a risk is taken of widening the film tube in an uncontrolled way.

[24] In order to reach a uniform air output at the head of the cooling body, it is proposed to provide for an air outlet for the parallel air guidance which spreads around the circumference of the cooling body.

[25] According to a sixth aspect of the invention, there is provided an interior cooling body for a blow film system with a multitude of stream whirling elevations with sides which define channels.

[26] As far as the terminology is concerned, it may be explained that a "stream whirling elevation" is to be understood as a macroscopic elevation of at least 3 mm, especially of at least 5 mm, especially of at least 10 mm, which therefore protrudes rather clearly outwardly, especially radially, from the surface of the cooling body. Such an elevation leads to whirling the bolstering stream which runs there in use of the plant. Especially, the stream can be whirled from a laminar status to a turbulent status, or the turbulence can be raised.

[27] By arranging the plurality of elevations in a smart way, a stable air bolster can be produced around the cooling body, so that by regulation of temperature, throughput and extruding material, it can be controlled very well if and where the film tube gets in contact with the cooling body.

[28] Due to the fact that to the sides of the elevations, there are channels, a too high counterpressure for the bolstering stream is avoided. Rather, in providing a network of communicating channels the bolstering stream can be kept strong without much stream resistance, but with high turbulence.

[29] According to a seventh aspect of the invention, there is provided an interior cooling body for a blow film system with a plurality of stream whirling elevations in the shape of rhombi which are inclined versus a longitudinal extension axis of the cooling body.

[30] It has been explained already that the elevations can strengthen the bolstering stream around the surface of the cooling body. Independent of

the presence and shape of the channels, the inventor has found out that the elevations are preferably provided as rhombus-shaped protrusions. A rhombus has four corners, wherein it is to be understood a being "inclined" if a connection between two opposite corners cannot be projected parallel onto the longitudinal axis of the cooling body.

[31] In prototype result, it has been shown that also elevations which are coaxial to the longitudinal axis can lead to a good bolstering stream, especially in the shape of quadrangles, especially in the shape of rhombi. However, also an inclination of the geometrical bodies can lead to a good bolstering effect.

[32] It may be underlined that the advantageous effect is not only present with rhombi. Instead, most polyhedrons proved to give good results, especially areas with triangles, quadrangles, pentagons or with hexagons. The edges between the vortices or corners may be straight, concave and/or convex-shaped.

[33] According to an eighth aspect of the invention, there is provided an interior cooling body for a blow film system with a plurality of stream whirling elevations, which are provided in rows around the nappe of the cooling body, namely in more than 20 rows, more than 30 rows, especially in more than 40 rows.

[34] It has been found out with prototypes that by providing a minimum number of rows, the bolstering stream gets extremely strong. If the blowair

only passes a lower number of elevation rows when streaming along the cooling body, e.g. only fifteen or sixteen rows, it proved that the bolstering effect may not be stable enough. As soon as more rows are installed, the stability of the bolstering stream is highly strengthened.

[35] In a preferred embodiment, the cooling body has an areal ratio of stream whirling elevations versus recesses (the recesses being defined in view of the nappe around the elevations) of maximum 5:1, especially of maximum 2:1, especially of maximum 1:1.

[36] As far as the terminology is concerned, especially the ratio of knolls versus the area between the knolls shall have these values. In a preferred embodiment, the knolls of the elevations comprise surfaces which are at least generally identical with the nappe, i.e. which are part of a circular encircling. However, even a surface shape at the elevation which deviates a little from the encircling can be understood as knoll. Especially, the knoll surface can deviate from the encircling by for example only maximum 5 mm towards the longitudinal axis. Alternatively and additionally, also those areas of the knolls can be understood as knoll which deviate from the encircling only by the fourth part, especially by the tenth part, of the radius difference between highest elevation and deepest channel.

[37] According to this thought, the nappe is portioned into knoll areas and into channels defined among those. The given ratio values are to be kept between these to area sums.

[38] It has proved that these ratio values lead to a very stable bolstering effect, where at the same time, the stream does not habe too much of a flow resistance. The surface of the cooling body is rather to be seen as a surface from which stream whirling elevations protrude radially outward, rather than as a surface in which grooves are installed.

[39] The cooling body may widen its girth from a foot area towards a head area, especially in the shape of a frustrum.

[40] Again, it may be pointed out that a "frustrum" is the mathematical definition of a threedimensional body. However, it is not necessary to build the cooling body exactly or nearly exactly in the preciseness of the mathematical idea or of the physical possibilities. Rather, an advantage is already reached if a widening from the foot towards the head shows, especially in the shape of a barrel.

[41] In a preferred embodiment, the cooling body comprises a nappe which has an at least partially macroscopically structured surface with stream whirling elevations. The advantages of such a structure have been explained above, especially with a difference of at least 5 mm or at least 10 mm between knolls and valley bottoms. The edge between knoll and valley can be designed almost arbitrarily, e.g. with angled or square-cut edges, with flutings, with a curvature or continuous. However, it is desired that the stream channels result radially inwards of the nappe around the knolls, so that the blowair stream can flow rather freely, but at the same time in high turbulence.

[42] It is preferred if the knolls of the elevations are designed rather clear. Especially, the elevations can define a nappe around the cooling body, wherein the elevations comprise edges with a curvature radius of maximum 3 mm from the knolls towards the channels lying between them. In this design, a rather sharp edge leads from the knoll surfaces to the side walls of the elevations which are the defining walls of the channels.

[43] The bottom of a stream channel can be designed almost arbitrarily. Especially, it can be U-, or V-shaped, or with a rectangular shape.

[44] It is obvious that an interior cooling body according to at least one of the aspects described above is of advantage to the whole blow film system and plant. A high performance with good production quality can be reached.

[45] If in addition to the interior cooling body, an exterior cooling is provided, especially with a cold air fan, the performance can be driven even higher. The cooling body introduced here enables even a cooling air stream on the outside of the film tube, because a strong bolstering effect can be reached inside of the tube.

[46] A cooling body as described above can ideally be used in a process wherein a blow film tube is produced from a thermoplastic synthetic material, wherein the tube is widened by blowair and wherein an interior cooling body is provided inside of the tube, together with a bolstering stream

between the tube and the cooling body which avoids a contact between the film and the cooling body at least at the greatest part.

[47] A cooling body with a structured surface can preferably be used for the generation of a turbulent cooling stream.

[48] It is preferred if the bolstering force of the blowair between the cooling body and the blow film is varied in at least one part of the cooling body. By this, a contact between the film and the surface can be reaches at a certain point or distance from the foot, preferably in a uniform way around the circumference of the body.

[49] The amount of blowair, the temperature and/or the moisture may be controlled in order to adapt the cooling of the film tube to the desired perfomance.

[50] A system for producing a blow film from a thermoplastic synthetic material normally comprises a press, an annular slit nozzle, a haul-off with a squeezing roller, a water-worked cooling body and an air deduction from within the film tube above the cooling body. The surface of the cooling body preferably comprises a surface which is provided with communicating stream channels, e.g. with grooves, flutes, recesses, or chamfers. A surface structured in this way can lead to a higher turbulence.

[51] A preferred embodiment has the surface parts remaining amidst the stream channels shaped als rhombi, wherein the longitudinal axis of each rhombus runs essentially parallel to the longitudinal axis of the cooling

body. By this, the streams running along the surface among the rhombi can unite and part, so that high turbulence can be reached in a highly uniform way.

[52] A preferred embodiment of the cooling body has the depth and/or the width of the stream channels over the surface designed in a varying way, wherein the characteristics are the same in view of one distinct circumference strip.

[53] This is of advantage because at one distinct circumference strip there should be uniform stream characteristics. Over the length, a variation can be provided.

[53a] According to one embodiment of the present invention, there is provided an interior cooling body for a blow film system with a nappe jacket, wherein stream channels are provided on an outside surface of the nappe jacket, a run of which extends over at least a part of a longitudinal extension of the cooling body, and with a plurality of stream whirling elevations in the shape of rhombi which are inclined in view of the longitudinal extension of the cooling body.

[53b] According to another embodiment of the present invention, there is provided a blow film system or plant with an interior cooling body as described herein.

[53c] According to still another embodiment of the present invention, there is provided a process of producing a blow film tube from a thermoplastic synthetic material, wherein the film tube is widened by blowair, wherein an interior cooling body as described herein is provided in the interior of the film tube, and wherein a bolstering stream is generated between the cooling body and the film tube, which prevents at least a portion of the film tube from contacting the cooling body.

[54] The invention is further explained below in view of the drawing. It shows the single figure schematically a longitudinal section through an interior cooling body which is connected with its foot to an annular slit valve, and a blow film tube surrounding the cooling body.

[55] The cooling body 1 is part of a blow film plant, in which plastic material is molten and extruded by an annular slit valve 2 to a fluid film tube 3. The tube 3 is transported in a transport direction 4 essentially parallel to a longitudinal axis 5 of the cooling body 1, thus of the whole blow film system. By this, the tube 3 is widened by blowair starting at a foot area 6 of the cooling body 1, along a head area 7 and beyond further.

[56] In the run of the transport direction 4, the tube 3 cools down, so that it turns hard above the blowing head 8, in praxis most of the time above the head area 7, and can be folded flat and later be rolled.

[57] For the cooling of the moving film of the tube 3, especially the cooling body 1 is used, if desired an additional exterior cooling system (not shown). The cooling is reached by the surface design of the cooling body 1, blowair and a water cooling:

[58] The blow film tube 3 runs along a surface 9 of the cooling body 1 with a certain distance. This is reached by blowing into an annular slit 10 between the cooling body 1 and the film tube 3 a bolstering air stream. For this, in a blow head 8, there is a pressure duct 11, from which on the blowair takes two ways in use, namely one through a first outlet 12 to the interior side of the film tube 3, and at the same time through a second outlet 13 into an annular stream channel within the cooling body 1.

[59] The blowair leaving through the first outlet 12 to the blow film 3 streams along the slit 10 from there, thereby generating a bolstering effect between the blow film tube 3 and the surface 9 of the cooling body 1.

[60] This bolstering air stream moves through the annular slit 10 in the transport direction 4 along the whole cooling body 1 until it reaches the head area 7 of the cooling body 1 and leaves the surface 9 there and streams further upwards within the film tube.

[61] Essentially parallel to this stream, there is a second air stream, which runs through the second outlet 13 of the pressure air duct 11 into the annular stream duct 14 within the interior of the cooling body 1. It runs essentially in the transport direction 4 of the film tube 3 and leaves in the head area 7 of the cooling body 1 through an annular slit 15. There, it reunites with the bolstering stream of the air slit 10 and effects a further widening of the film tube 3 above the head 7. The leaving slit 15 in directed rather radial, namely in an angle of approximately 70 ° to the axis 5 of the cooling body 1. This exerts in the area of the head 7 a radially outwardly pointing force onto the film tube 3.

[62] The stream through the interior air guidance 14 can be controlled by the fixed or variable design of the outlets 12, 13 of the pressure air duct 11, especially its ratio to the bolstering stream through the annular slit 10.

[63] The bolstering stream in the slit 10, i.e. between the surface 9 and the film tube 3, cools down the tube 3. This is reached by the blowair taking heat energy from the film tube 3 and passing it on to the cooler surface 9 of the cooling body 1. In order to keep the surface 9 of the cooling body 1 rather cool, there is provided cooling water in an annular water duct which is an areal contact to the surface 9. The cooling water is permanently renewed through a central channel 17 and a water lead 18, located in the central channel 17, in a pump direction 19 in use of the plant. The cooling water – or generally: the cooling fluid – is thus kept in a counter stream to the bolstering air stream in the annular slit 10 at the inside of a jacket 20 of the cooling

body 1. It takes from the jacket 20 at the radial inside 21 the heat energy which the jacket 20 hat taken with its surface 9, i.e. the outside, from the bolstering stream in the annular slit 10.

[64] The heat energy of the film tube 3 is thus transported into the cooling stream and from there through a deduction hole 22 out of the cooling body 1.

[65] It may be understood that as well the bolstering effect in the annular slit 10 as well as the heat transport performance from the bolstering stream to the cooling body both depend on the quality and on the quantity of the air stream. At the surface 9 of the cooling body 1, there is thus a special threedimensional geometry. The whole surface 9 is designed with rhombus-shaped elevations. The jacket 20 of the cooling body 1 is cast in this shape, or a channel geometry has been milled from an originally thicker jacket.

[66] The rhombi 30 protrude into the annular slit 10 and cause a whirling of passing blowair. Their rhombus-shaped surfaces lie in the circumference surface of the body 1, therefore defining the surface 9 of the jacket 20.

[67] At side edges 31 of the rhombus-shaped elevations, the outer shape of the jacket 20 of the cooling body 1 turn with a curvature radius of approx. 1 mm to 2 mm away from the surfache to a wall running radially inwards. It may be stressed that the threedimensional form of the elevations is not shown in the drawing, which is to be understood as a sketch.

[68] The side walls of the elevations 30 run over a distance of approx. 1 cm to 2 cm approx. radially to the central axis 5. Between every two neighboured elevations (see 32, 33), the side walls form a valley 34. This can run curved, e.g. in a U-shape.

[69] The macroscopic structure of the surface 9 in form of the elevations 30, 32, 33 generate a strong turbulence in the bolstering stream in the slit 10. This enlargens the force onto the film tube 3. Same can thus be extruded in a high speed without risking uncontrolled contact to the surface 9 of the cooling body 1.

[70] As a result of the cooling water stream along the interior side of the jacket 20 of the cooling body 1, namely in the double-walled guidance between the outer wall 20 and an inner wall 35, the heat is transferred effectively. At the same time, the water cooling ist supported by the blowair passing along its radial inside 36.

[71] With different words the film tube is kept away from the bottle-like cooling body by the bolstering stream.

CLAIMS:

1. Interior cooling body for a blow film system with a nappe jacket, wherein stream channels are provided on an outside surface of the nappe jacket, a run of which extends over at least a part of a longitudinal extension of the cooling body, and with a plurality of stream whirling elevations in the shape of rhombi which are inclined in view of the longitudinal extension of the cooling body.

2. Interior cooling body according to claim 1, with a cooling fluid areal guidance inwardly of the nappe jacket, wherein the cooling fluid areal guidance comprises an annular cross section with an air guidance provided therein.

3. Interior cooling body according to claim 2, wherein in the air guidance, a cooling fluid lead is provided, which is connected to the cooling fluid areal guidance.

4. Interior cooling body according to any one of claims 2 to 3, wherein the cooling fluid areal guidance comprising the annular cross section in a double-walled jacket.

5. Interior cooling body according to any one of claims 2 to 4, with a length of at least approx. 0,5 m up to approx. 3 m, with a frustrum shape.

6. Interior cooling body according to claim 5, wherein the length is approx. 1 m, to approx. 3 m.

7. Interior cooling body according to any one of claims 2 to 6, wherein the air guidance is substantially parallel to a bolstering stream around the cooling body when in use, with an air outlet at a head, which leads the air guidance into the bolstering stream.

8. Interior cooling body according to claim 7, wherein the air outlet is spread over a circumference of the head.

9. Interior cooling body according to any one of claims 1 to 8, wherein the plurality of stream whirling elevations have sides defining the stream channels.

10. Interior cooling body according to any one of claims 1 to 9, wherein the plurality of stream whirling elevations, is provided in at least 20 rows over a nappe girth of the nappe jacket.

11. Interior cooling body according to claim 10, wherein the plurality of stream whirling elevations is provided in at least 30 rows over the nappe girth.

12. Interior cooling body according to claim 10, wherein the plurality of stream whirling elevations is provided in at least 40 rows over the nappe girth.

13. Interior cooling body according to any one of claims 1 to 12 with an areal ratio of a maximum of 5:1 between the plurality of stream whirling elevations and recesses provided with respect to the nappe jacket around the plurality of stream whirling elevations.

14. Interior cooling body according to claim 13, wherein the areal ratio is a maximum of 2:1.

15. Interior cooling body according to claim 13, wherein the areal ratio is a maximum of 1:1.

16. Interior cooling body according to claim 1, wherein a girth of the cooling body widens from a foot area towards a head area.

17. Interior cooling body according to claim 16, wherein the girth of the cooling body widens in the shape of a frustrum.

18. Interior cooling body according to any one of claims 1 to 17, wherein the plurality of stream whirling elevations provides the nappe jacket with an at least partially macroscopically structured surface.

19. Interior cooling body according to claim 18, wherein the plurality of stream whirling elevations comprise edges with a radius of curvature of maximum 3 mm at an edge to the stream channels.

20. Blow film system or plant with an interior cooling body according to any one of claims 1 to 19.

21. Blow film system or plant according to claim 20, wherein an exterior cooling is provided.

22. Blow film system or plant according to claim 21, wherein the exterior cooling comprises a cool air fan.

23. Process of producing a blow film tube from a thermoplastic synthetic material, wherein the film tube is widened by blowair, wherein an interior cooling body according to any one of claims 1 to 19 is provided in the interior of the film tube, and wherein a bolstering stream is generated between the cooling body and the film tube, which prevents at least a portion of the film tube from contacting the cooling body.

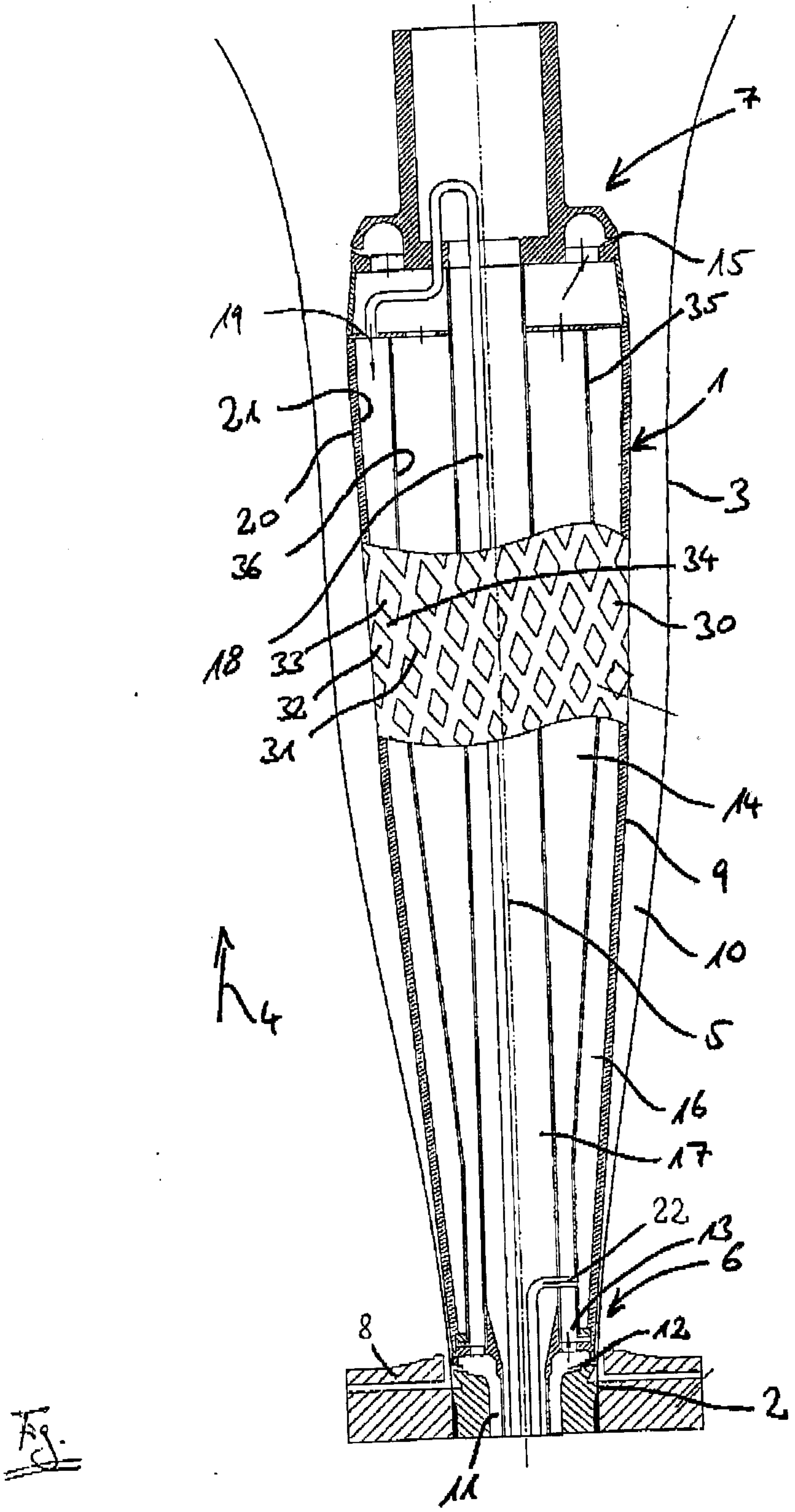
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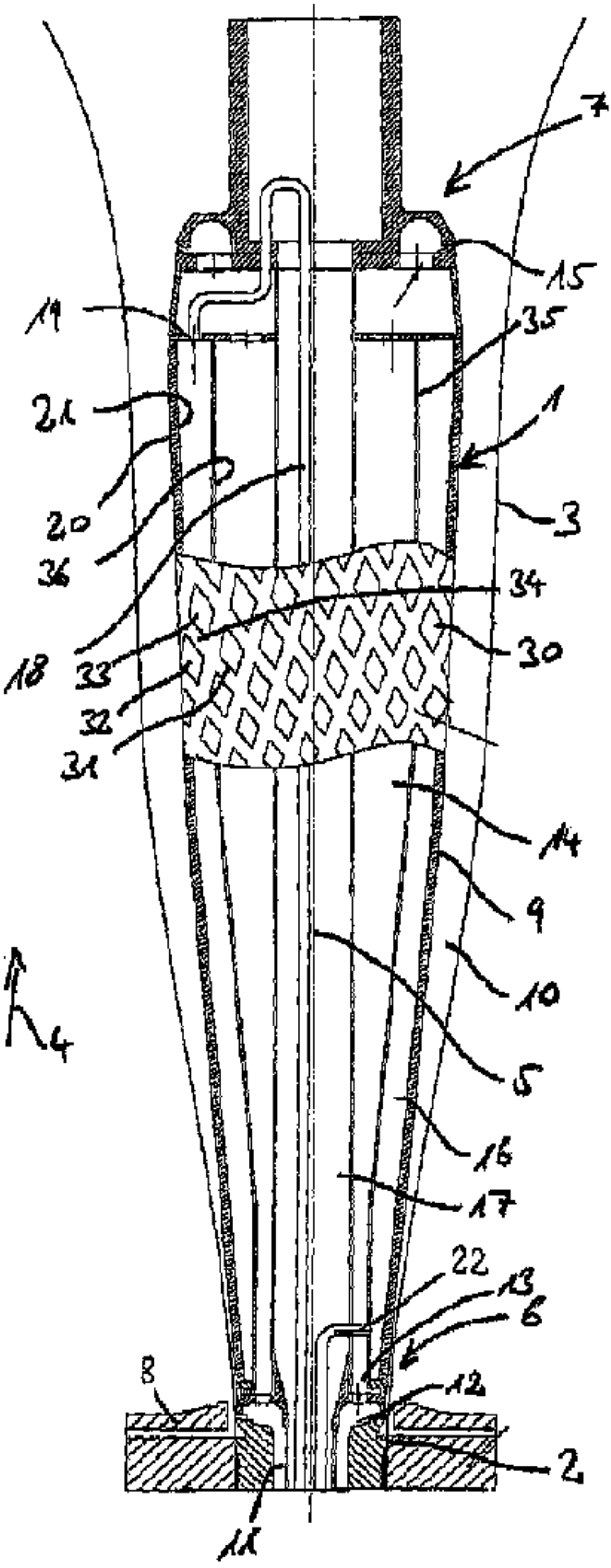
Fig.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