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(54) METHOD AND APPARATUS FOR MAKING PLASTIC FILM

VERFAHREN UND VORRICHTUNG ZUR HERSTELLUNG VON KUNSTSTOFFFOLIE

PROCEDE ET APPAREIL DE FABRICATION D'UN FILM PLASTIQUE

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(73) Proprietor: **CONENOR OY**
33330 Tampere (FI)

(72) Inventor: **KIRJAVAINEN, Kari**
FIN-33230 Tampere (FI)

(74) Representative: **Huhtanen, Ossi Jaakko**
Kolster Oy AB,
Iso Roobertinkatu 23,
P.O. Box 148
00121 Helsinki (FI)

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Description

[0001] The invention relates to a method for making a plastic film, the method comprising extruding a plastic film, mixing material into the plastic of the plastic film before extrusion, the material causing cavitation bubbles in the plastic film to be stretched, and orientating the plastic film by stretching after extrusion.

[0002] The invention also relates to an apparatus for making a plastic film, the apparatus comprising an extruder and at least one orientation device for orientating the extruded film.

[0003] Making a plastic film by extruding it and then orientating it is known e.g. from US patents 3,244,781 and 3,891,374. It is, however, difficult to make thin and in particular thin foamed films using these solutions.

[0004] EP publication no. 0,182,764 discloses a thin polypropylene film which contains wide and flat disc-like bubbles, which are about 80 micrometers in length and about 50 micrometers in width. The film is produced by extruding material which has been foamed chemically or by means of gas and by orientating the extruded material biaxially. The result is a very versatile plastic film. However, the foaming degree of the film is less than 50%, which is why the properties of the film are not good enough for all purposes.

[0005] US patent no. 3,634,564 discloses orientation of a foamed film to obtain a fiberized film. The foamed film is formed by mixing a foam forming substance into the plastic material. The mixture is extruded, which yields a foamed film, which is stretched. The bubbles of the film obtained are, however, rather large.

[0006] US Patent no. 4,814,124 discloses a film made of polyolefin and a filler which is stretched to obtain a gas permeable porous film. However, the foaming degree of such a film is not sufficiently good, nor are the mechanical properties of such a porous film sufficiently good for acoustic applications, for example.

[0007] Furthermore, it is not possible to produce thin films of polymethylpentene or cyclic olefin copolymer using the prior art solutions.

[0008] WO-A1-9951 419 discloses extruding a film from plastic material. The film is orientated after extrusion. Material is mixed into the plastic so that when the plastic film is stretched, cavitation bubbles are formed on the plastic film. During the orientation, gas is arranged to act on the plastic film under high pressure so that the gas diffuses in the cavitation bubbles and causes overpressure in them. US-A-5188777 discloses providing a resin combination comprising a thermoplastic polymer matrix having dispersed therein as distinct phases multiplicity of small spherical solid particles of cross-linked polystyrene. An unoriented film is formed of said resin combination. Said film is biaxially oriented to an extent sufficient to opacity the same and the formation of voids therein.

[0009] The object of this invention is to provide a very good and thin foamed plastic film and a simple, reliable and improved method and apparatus for making said plastic film.

[0010] The method of the invention is characterized in that after orientation the plastic film is subjected to pressurized gas so that the gas diffuses in cavitation bubbles, and thus bubbles containing gas are formed in the plastic film.

[0011] The apparatus of the invention is characterized in that the apparatus comprises gas supply means arranged after at least one orientation device for feeding pressurized gas into the plastic film after orientation by stretching so that the fed gas diffuses in the cavitation bubbles that are formed in the plastic film during stretching, and thus bubbles containing gas are formed in the plastic film.

[0012] The basic idea of the invention is that a film is extruded from plastic material by means of an extruder and material has been mixed into the plastic so that when the plastic is stretched cavitation bubbles are formed in the material particles mixed into the plastic. The film is orientated by stretching and after that gas is fed into the film under high pressure so that the gas diffuses in the cavitation bubbles and causes overpressure in them. The idea of a preferred embodiment is that after the first orientation and feeding of gas the plastic film is orientated by stretching it in the direction substantially perpendicular to the first orientation direction, and thus the overpressure is released in the cavitation bubbles and the bubbles expand.

[0013] An advantage of the invention is that very thin films with a foaming degree of about 70 to 90% can be provided in a relatively simple manner. An advantage of the high foaming degree is that the electric and mechanical properties of the film are very good. Since the film becomes thinner as it is orientated by stretching, gas diffuses in the orientated film substantially faster than in an non-orientated film, i.e. gas can be fed into the film particularly efficiently by not feeding gas which acts on the film until after orientation. A further advantage is that the method and apparatus can be used for making a film for example of polymethylpentene or cyclic olefin copolymer or a combination thereof.

[0014] The invention will be described in greater detail in the following drawings, in which

Figure 1 is a schematic cross-sectional side view of an apparatus of the invention,
Figure 2 is a partially cross-sectional top view of the apparatus illustrated in Figure 1,
Figure 3 is a cross-sectional view of a detail of the apparatus illustrated in Figure 1 along line A-A,
Figure 4 is a cross-sectional view of a detail of the apparatus illustrated in Figure 1 along line B-B,
Figure 5 is a cross-sectional view of a detail of the apparatus illustrated in Figure 1 along line C-C,
Figure 6 is a schematic cross-sectional top view of an extruder used in the apparatus of the invention,
Figure 7a is a cross-sectional side view of a plastic

film extruded by the apparatus of the invention before orientation of the film,

Figure 7b is a cross-sectional side view of the plastic film extruded by the apparatus of the invention after longitudinal orientation,

Figure 7c is a schematic top view of the plastic film illustrated in Figure 7b, and

Figure 7d is a schematic top view of the plastic film made by the apparatus of the invention after longitudinal and cross-direction orientations.

[0015] Figure 1 is a side view of an apparatus according to the invention. The apparatus comprises an extruder 1. The extruder may be for example conical, i.e. it comprises a cone-shaped rotor 2, outside of which there is an outer stator 3 whose surface at least on the rotor 2 side is cone-shaped, and inside the rotor there is an inner stator 4 whose surface at least on the rotor 2 side is cone-shaped. When the rotor 2 rotates, it extrudes material which is between the rotor 2 and the stators 3 and 4 from the extruder 1 in a manner known per se. For the sake of clarity the figures do not illustrate e. g. the rotating means of the rotor or the feeding devices for feeding the material to be extruded into the extruder 1. The extruder 1 may comprise more than one rotor 2 and more than two stators 3 and 4. In that case the extruder 1 can be used for extruding multilayer products. The solution with one rotor 2 and two stators 3 and 4 can be used for making two-layer products. The end portion of the inner stator 4 is wide and tapers in the vertical direction so that together with the nozzle 6 it forms a relatively flat and wide gap through which plastic 5a is extruded. After the nozzle 6 there is a calibration piece 7 whose nuts are used for adjusting the height of the gap, which allows to define the thickness of the plastic film 5 to be obtained from the extruder 1.

[0016] After the extruder 1 the plastic film 5 is cooled by a cooling device 8. The cooling device 8 may comprise e.g. a cooling roll 9, which is arranged in a cooling tank 10 containing a cooling medium, e.g. water. The plastic film 5 is arranged to be pressed against the cooling roll 9. The apparatus according to Figure 1 uses auxiliary rolls 11 for guiding the plastic film 5 at several points.

[0017] After cooling the plastic film 5 is guided to a machine direction orientation device 12. The machine direction orientation device 12 comprises orientation rolls 13 whose velocities are adjusted so that they can be used for stretching the plastic film 5 and thus for orientation in the machine direction. If desired, the velocity of each orientation roll 13 can be adjusted separately. The machine direction orientation device 12 may also comprise heating means 14, such as radiation heaters, for heating the plastic film 5 in a manner known per se. The orientation rolls 13 can also be used for heating the plastic film by supplying a heating medium, such as heated oil, to the orientation rolls 13 so that the orientation rolls 13 become warm. If desired, the temperature of each orientation roll 13 can be adjusted separately.

[0018] After the machine direction orientation device 12 the plastic film 5 is supplied to a discharge chamber 15. Pressurized gas, preferably air, is fed into the discharge chamber 15 by a pump 16. Instead of air, nitrogen or another gas or gas mixture, for instance, may be used as the gas to be fed. The gas to be fed may also be selected according to the desired electric properties. For example, in respect of the dielectric strength of the product it would be advisable to use sulphurhexafluoride SF_6 and in respect of chargeability e.g. argon. A sealing chamber 27 is provided at the forward end and at the tail end of the discharge chamber 15. Gas flowing from the sealing chamber 27 can be sucked by the pump 16 and supplied further to the discharge chamber 15 as shown with arrows D. The pump 16 is used for increasing the pressure in the discharge chamber 15 to the desired level. The pressure in the discharge chamber 15 is relatively small compared to the typical foaming methods. The pressure in the discharge chamber 15 is preferably about 10 bars, but it may vary between 3 and 20 bars, for instance. When the pressure in the discharge chamber 15 is increased with the pump 16, the temperature also rises as gas is compressed in the gas chamber 15. This heat can be utilized for heating the plastic film 5. The discharge chamber 15 may also be provided e.g. with heating resistors which are arranged to heat the plastic film 5. Thus the discharge chamber 15 can be used both for feeding gas into the plastic film and for heating the plastic film 5 for orientation in the cross-direction. When gas is used as the pressurized air, additional air can be can be sucked into the system from outside the apparatus through the sealing chambers 27 as shown with arrows E.

[0019] Suitable material, such as calcium carbonate particles, is mixed into the plastic 5a of the plastic film 5, and due to the influence of the particles the joint surfaces of the plastic molecules and the mixed material are torn during orientation, and thus cavitation bubbles are formed. When the plastic film 5 is subjected to the pressure of pressurized gas after orientation, the gas diffuses in the cavitation bubbles and causes overpressure in the bubbles. In the discharge chamber 15 the pressurized gas can act on both sides of the plastic film 5, and thus gas bubbles are formed evenly in the plastic film 5.

[0020] After the machine direction orientation device 12 and the discharge chamber 15 the plastic film 5 is supplied to a cross-direction orientation device 17. In the cross-direction orientation device 17 the plastic film 5 is stretched in the cross-direction, i.e. orientation is performed in the direction substantially perpendicular to the direction of the orientation performed in the machine direction device 12. Due to the overpressure of the gas in the bubbles and cross-direction stretching the bubbles can grow sideways and in the vertical direction in the cross-direction orientation device 17. In that case the foaming degree of the film is for example about 70

to 90%. The foaming degree can be adjusted simply by adjusting the pressure of the gas to be fed into the discharge chamber 15. The cross-direction orientation device 17 comprises two orientation wheels 18, and an orientation band 19 is arranged against both of the wheels. The orientation band 19 is an endless band which is guided by means of band guide rolls 20. The orientation band 19 presses the edges of the plastic film 5 firmly and evenly between the orientation wheel 18 and the orientation band 19 substantially along the whole travel the cross-direction orientation device 17, in which case the film is not subjected to varying pressure stress or tensile strain, and thus the plastic film stretches sideways without tearing. In Figure 1 the plastic film 5, orientation wheel 18 and orientation band 19 are illustrated at a distance from one another for the sake of clarity, but in reality these parts are pressed firmly against one another. The orientation wheels 18 and the orientation bands 19 are arranged so that in the direction of the plastic film they are further away from one another at the end than at the beginning, as is illustrated in Figure 2, and thus the cross-direction orientation device 17 stretches and simultaneously orientates the plastic film 5 in the cross-direction. The deviation of the angle between the orientation wheels 18 and the orientation bands 19 from the machine direction can be adjusted according to the desired degree of cross-direction stretching. One or more band guide rolls 20 can be arranged to be rotated by the rotating means. Since the bands 19 are firmly pressed against the orientation wheels 18, the orientation wheels 18 do not necessarily need rotating means but may rotate freely. For the sake of clarity the enclosed figures do not illustrate rotating means or other actuators of the apparatus. A curved support plate 21, which has substantially the same shape as the circumference of the orientation wheels 18, is arranged between the orientation wheels 18 to support the plastic film 5.

[0021] The cross-direction orientation device 17 can be placed in a casing 26 of its own. If desired, the casing 26 can be provided with heaters known per se, such as radiation heaters, to heat the plastic film 5.

[0022] After the cross-direction orientation device 17 the plastic film 5 is led to a relaxation unit 22. In the relaxation unit 22 the plastic film 5 is relaxed, and thus the plastic film shrinks a bit in a manner known per se. Finally, the plastic film 5 is wound on a reel 23.

[0023] Figure 2 is a cross-sectional top view of the apparatus of the invention at the extruder 1. For the sake of clarity Figure 2 does not illustrate the plastic film 5 or the support structures of the apparatus onto which the rolls, reels and plates of the apparatus are attached, for instance.

[0024] Figure 3 is a cross-sectional view of a detail of the extruder 1 along line A-A of Figure 1. Here both the outer stator and the inner stator 4 are round in cross-section. Thus the plastic material 5a is also in an annular feeding channel.

[0025] Figure 4 is a cross-sectional view of a detail of the extruder 1 along line B-B of Figure 1. Here we see the wide tip of the inner stator 4 and the shape of the nozzle 6 which extrude the plastic 5a into the wide and flat gap, and thus a flat plastic film 5 is formed from the plastic 5a.

[0026] Figure 5 is a cross-sectional view of a detail of the cross-direction orientation device 17 along line C-C of Figure 1. It is seen in Figure 5 how the orientation wheel and the orientation band are pushed against each other and press the plastic film 5 between each other. The surface of the support plate 21 against the plastic film 5 may be heated e.g. by providing it with heating resistors, and thus the plastic film 5 slides along the sliding surface in question very easily. Furthermore, propellant, such as air, can be blown from the support plate 21 through the gaps 21a, in which case the propellant flowing through the gaps 21 a provides a sliding bearing between the support plate 21 and the plastic film 5. The gas in question may be heated, if desired, and thus the sliding surface of the support plate 21 and the plastic film 5 are heated with the propellant flowing through the gaps 21a.

[0027] Figure 6 illustrates an extruder 1 used in the apparatus according to the invention. The nozzle 6 of the extruder 1 widens up to the end portion of the extruder, i.e. up to the point where the plastic film 5 exits from the extruder 1. In the nozzle 6 of the extruder 1 the plastic 5a is thus all the time subjected to cross-direction orientation in addition to longitudinal orientation, which makes it considerably easier to orientate the plastic film in the cross-direction at a later processing stage.

[0028] Figure 7a is a side view of the plastic film 5. Before extrusion calcium carbonate particles 24 have been mixed into the plastic 5a. Instead of calcium carbonate particles 24 some other material may also be mixed into the plastic 5a. The material should be such that it causes the joint surface of the plastic molecules and the material mixed into the plastic 5a to tear when the plastic film 5 is stretched so that cavitation bubbles are formed where the joint surfaces are torn. Thus some oily substance, such as silicone oil or paraffin oil, can be mixed into the plastic 5a.The particles mixed into the plastic 5a may cause spot-like asymmetry e.g. in the electric field in the plastic 5a, whereas the oily substance mixed into the plastic does not substantially worsen the electric properties of the plastic. It is also possible to mix a substance having a melting point lower than the orientation temperature of the plastic 5a, such as paraffin, into the plastic, in which case the substance melts when the plastic 5a is orientated. The plastic 5a may be made e.g. from polypropylene PP, polymethylpentene TPX or cyclic olefin copolymer COC. The heat resistance of polymethylpentene and cyclic olefin copolymer is better than that of polypropylene, for example. Electric charges also remain in polymethylpentene and cyclic olefin copolymer better than in polypropylene at high temperatures. Processing of polymethylpentene and cyclic ole-

fin copolymer is very difficult but by the method and apparatus of the invention a very thin and foamed plastic film 5 can be made of them or of their mixtures. In the situation illustrated in Figure 7a the plastic film 5 has not been stretched yet.

[0029] Figures 7b and 7c illustrate the plastic film 5 after it has been stretched in the machine direction orientation device 12 and the pressure of pressurized gas has already acted on the plastic film 5. In that case gas has diffused in the cavitation bubbles and caused overpressure in them, as a result of which bubbles 25 containing gas have formed. In the situation illustrated in Figures 7b and 7c the plastic film 5 has been subjected only to machine direction stretching, and consequently the bubbles 25 are long, flat and narrow.

[0030] Figure 7d illustrates a situation in which the plastic film 5 has also been stretched in the cross-direction by means of the cross-direction orientation device 17. The gas that was overpressurized in the bubbles 25 in the situation illustrated in Figures 7b and 7c has released in the lateral direction in the cross-direction orientation device 17. Thus the bubbles 25 are now also wide. In addition, the bubbles 25 are flat, i.e. they are plate-shaped or disc-like. The bubbles 25 are relatively small, their diameter is at most about 100 micrometers and their height is typically less than one micrometer, at most about 10 micrometers. However, the method and apparatus provide very thin plastic films 5. The thickness of the plastic films 5 may be only 10 micrometers.

[0031] The plastic film 5 can be used for several purposes in a manner known per se. At least one surface of the plastic film 5 can be provided with an electrically conductive coating, for instance, in which case the solution can be used e.g. as a microphone or loudspeaker in several acoustic applications, including sound attenuation. The plastic film 5 may also be provided with a permanent electric charge using e.g. the corona charge method.

[0032] The drawings and the related description are only intended to illustrate the inventive concept. The details of the invention may vary within the scope of the claims. Thus the orientation directions of the plastic film 5 and the order of orientations in different directions may vary. According to the invention, the simplest way to make a plastic film is to orientate the plastic film in the machine direction first and thereafter in the direction transverse to the machine direction.

Claims

1. A method for making a plastic film, the method comprising extruding a plastic film (5), mixing before extrusion a material into the plastic (5a) of the plastic film (5), which material causes bubbles in the plastic film (5) to be stretched and orientating the plastic film (5) by stretching after extrusion, wherein after orientation the plastic film (5) is subjected to pressurized gas so that the gas diffuses in the cavitation bubbles, and thus bubbles (25) containing gas are formed in the plastic film (5).

2. A method according to claim 1, wherein gas is arranged to act on the plastic film (5) after the first orientation stage and thereafter the plastic film (5) is subjected to a second orientation which is substantially perpendicular to the first orientation so that the bubbles (25) containing gas expand due to the influence of the second orientation and the gas.

3. A method according to claim 2, wherein at the first orientation stage the plastic film (5) is orientated in the machine direction and at the second orientation stage the plastic film (5) is orientated in the direction substantially transverse to the machine direction.

4. A method according to any one of the preceding claims, wherein the pressure of the gas acting on the plastic film (5) is between 3 and 20 bars.

5. A method according to any one of the preceding claims, wherein before extrusion an oily substance or a substance having a melting point lower than the orientation temperature of the plastic (5a) is mixed into the plastic (5a).

6. A method according to any one of the preceding claims, wherein the plastic film (5) is heated at the same time as gas is fed.

7. A method according to claim 6, wherein the pressure of the pressurized gas is increased so that the temperature of the gas rises, and thus the pressurized gas is used for heating the plastic film (5).

8. A method according to any one of the preceding claims, wherein pressurized gas is fed by a discharge chamber (15), a sealing chamber (27) is provided at least at one end of the discharge chamber, and gas flowing into the sealing chamber (27) is sucked and supplied back to the discharge chamber (15).

9. An apparatus for making a plastic film, the apparatus comprising an extruder (1) and at least one orientation device (12, 17) for orientating the extruded film (5), wherein the apparatus comprises gas supply means (15, 16) arranged after the at least one orientation device (12, 17) for feeding pressurized gas into the plastic film (5) after orientation by stretching so that the fed gas diffuses in the cavitation bubbles that are formed in the plastic film (5) during stretching, and thus bubbles (25) containing gas are formed in the plastic film.

10. An apparatus according to claim 9, wherein the gas

supply means (15, 16) are arranged after the first orientation device (12) and that the apparatus comprises a second orientation device (17) after the first orientation device (12) in the direction of the plastic film (5), the second orientation device (17) being arranged to orientate the plastic film (5) in the direction substantially transverse to the orientation direction of the first orientation device (12) so that the bubbles (25) containing gas expand due to the influence of the second orientation device (17) and the gas.

11. An apparatus according to claim 10, wherein the first orientation device (12) is arranged to orientate the plastic film (5) in the machine direction and the second orientation device (17) is arranged to orientate the plastic film (5) in the direction substantially transverse to the machine direction.

12. An apparatus according to any one of claims 9 to 11, wherein the gas supply means comprise a discharge chamber (15), which is provided with means for heating the plastic film (5).

13. An apparatus according to claim 12, wherein the apparatus comprises means for increasing the pressure of pressurized gas so that the gas temperature rises so high that the gas heats the plastic film (5).

14. An apparatus according to any one of claims 9 to 13, wherein the gas supply means comprise a discharge chamber (15), and a sealing chamber (27) is provided at least at one end of the discharge chamber (15).

15. An apparatus according to claim 14, wherein the gas supply means comprise a pump (16) which is arranged to suck gas from the sealing chamber (27) and means for supplying the gas sucked from the sealing chamber (27) into the discharge chamber (15).

16. An apparatus according to claim 15, wherein the pump (16) is arranged to such additional air through the sealing chamber (27).

Patentansprüche

1. Verfahren zur Herstellung einer Kunstofffolie, wobei das Verfahren die folgenden Schritte aufweist: das Extrudieren einer Kunststofffolie (5), das Mischen eines Werkstoffs in den Kunststoff (5a) der Kunststofffolie (5) vor der Extrusion, wobei der Werkstoff Blasen in der zu streckenden Kunststofffolie (5) verursacht, und das Recken der Kunststofffolie (5) durch Strecken nach der Extrusion, **dadurch gekennzeichnet, dass** die Kunststofffolie (5) nach dem Recken Druckgas ausgesetzt wird, so dass das Gas in die Hohlblasen diffundiert, und somit Blasen (25) in der Kunststofffolie (5) gebildet werden, die Gas enthalten.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** Gas zum Einwirken auf die Kunststofffolie (5) nach der ersten Reckstufe vorgesehen ist, und die Kunststofffolie (5) anschließend einem zweiten Reckvorgang ausgesetzt wird, der im Wesentlichen senkrecht zum ersten Reckvorgang erfolgt, so dass sich die gashaltigen Blasen (25) aufgrund des Einflusses des zweiten Reckvorgangs und des Gases ausdehnen.

3. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass** bei der ersten Reckstufe die Kunststofffolie (5) in Maschinenrichtung gereckt wird, und die Kunststofffolie (5) bei der zweiten Reckstufe in die Richtung im Wesentlichen quer zur Maschinenrichtung gereckt wird.

4. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Druck des Gases, das auf die Kunststofffolie (5) wirkt, zwischen 3 und 20 Bar liegt.

5. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** vor der Extrusion eine ölige Substanz oder eine Substanz mit einem niedrigeren Schmelzpunkt als die Recktemperatur des Kunststoffs (5a) in den Kunststoff (5a) gemischt wird.

6. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Kunststofffolie (5) gleichzeitig mit der Gaszufuhr erwärmt wird.

7. Verfahren nach Anspruch 6, **dadurch gekennzeichnet, dass** der Druck des Druckgases erhöht wird, so dass die Temperatur des Gases steigt, und daher das Druckgas zum Erwärmen der Kunststofffolie (5) verwendet wird.

8. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** Druckgas von einer Ausströmkammer (15) geliefert wird, eine Abdichtungskammer (27) an mindestens einem Ende der Ausströmkammer vorgesehen ist, und in die Dichtungskammer (27) strömendes Gas angesaugt und zurück in die Ausströmkammer (15) geleitet wird.

9. Vorrichtung zur Herstellung einer Kunststofffolie, wobei die Vorrichtung einen Extruder (1) und mindestens eine Reckvorrichtung (12, 17) zum Recken der extrudierten Folie (5) aufweist, **dadurch ge-**

kennzeichnet, dass die Vorrichtung eine Gaszufuhrvorrichtung (15, 16) aufweist, die nach der mindestens einen Reckvorrichtung (12, 17) für die Zufuhr von Druckgas in die Kunststofffolie (5) nach dem Recken durch den Streckvorgang angeordnet ist, so dass das zugeführte Gas in die Hohlblasen diffundiert, die in der Kunststofffolie (5) während des Streckvorgangs gebildet werden, und so gashaltige Blasen (25) in der Kunststofffolie gebildet werden.

10. Vorrichtung nach Anspruch 9, **dadurch gekennzeichnet, dass** die Gaszufuhrvorrichtungen (15, 16) nach der ersten Reckvorrichtung (12) angeordnet sind, und die Vorrichtung eine zweite Reckvorrichtung (17) nach der ersten Reckvorrichtung (12) in die Richtung der Kunststofffolie (5) aufweist, wobei die zweite Reckvorrichtung (17) zum Recken der Kunststofffolie (5) in die im Wesentlichen quer zur Reckrichtung der ersten Reckvorrichtung (12) liegende Richtung angeordnet ist, so dass sich die gashaltigen Blasen (25) aufgrund der Einwirkung der zweiten Reckvorrichtung (17) und des Gases ausdehnen.

11. Vorrichtung nach Anspruch 10, **dadurch gekennzeichnet, dass** die erste Reckvorrichtung (12) so angeordnet ist, dass sie die Kunststofffolie (5) in die Maschinenrichtung reckt, und die zweite Reckvorrichtung (17) so angeordnet ist, dass sie die Kunststofffolie (5) in die im Wesentlichen quer zur Maschinenrichtung liegende Richtung reckt.

12. Vorrichtung nach einem der Ansprüche 9 bis 11, **dadurch gekennzeichnet, dass** die Gaszufuhreinrichtung eine Ausströmkammer (15) aufweist, die mit Einrichtungen zum Erwärmen der Kunststofffolie (5) versehen ist.

13. Vorrichtung nach Anspruch 12, **dadurch gekennzeichnet, dass** die Vorrichtung Einrichtungen zum Erhöhen des Drucks des Druckgases aufweist, so dass die Gastemperatur derart ansteigt, dass das Gas die Kunststofffolie (5) erwärmt.

14. Vorrichtung nach einem der Ansprüche 9 bis 13, **dadurch gekennzeichnet, dass** die Gaszufuhreinrichtung eine Ausströmkammer (15) aufweist, und eine Abdichtungskammer (27) an mindestens einem Ende der Ausströmkammer (15) vorgesehen ist.

15. Vorrichtung nach Anspruch 14, **dadurch gekennzeichnet, dass** die Gaszufuhreinrichtung eine Pumpe (16) aufweist, die so angeordnet ist, dass sie Gas aus der Abdichtungskammer (27) ansaugt, und weiter Einrichtungen zum Weiterleiten des aus der Abdichtungskammer (27) angesaugten Gases in die Ausströmkammer (15).

16. Vorrichtung nach Anspruch 15, **dadurch gekennzeichnet, dass** die Pumpe (16) so angeordnet ist, dass sie zusätzliche Luft durch die Abdichtungskammer (27) ansaugt.

Revendications

1. Procédé de fabrication d'un film plastique, le procédé comprenant extrusion d'un film plastique (5), mélangeage, avant l'extrusion, d'une matière dans le plastique (5a) du film plastique (5), cette matière produisant des bulles dans le film plastique (5) à étendre, et orientation, après l'extrusion, du film plastique (5) par extension, dans quel procédé le film plastique (5) est, après l'orientation, soumis au gaz sous pression de sorte que le gaz pénètre dans les bulles de cavitation et, par conséquent, des bulles (25) contenant du gaz se forment dans le film plastique (5).

2. Procédé selon la revendication 1, suivant lequel le gaz est disposé à agir sur le film plastique (5) après le premier stade d'orientation et, après cela, le film plastique (5) est soumis à une deuxième orientation qui est essentiellement perpendiculaire à la première orientation de sorte que les bulles (25) contentant du gaz gonflent à cause de l'influence de la deuxième orientation et du gaz.

3. Procédé selon la revendication 2, suivant lequel le film plastique (5) est orienté, dans le premier stade d'orientation, dans le sens machine et dans le deuxième stade d'orientation le film plastique (5) est orienté dans le sens essentiellement transversal au sens machine.

4. Procédé selon l'une quelconque des revendications précédentes, suivant lequel la pression du gaz agissant sur le film plastique (5) est entre 3 et 20 bar.

5. Procédé selon l'une quelconque des revendications précédentes, suivant lequel, avant l'extrusion, une substance huileuse ou une substance le point de fusion de laquelle est plus basse que la température d'orientation du plastique (5a) est mélangée avec le plastique (5a).

6. Procédé selon l'une quelconque des revendications précédentes, suivant lequel le film plastique (5) est chauffé simultanément avec l'alimentation en gaz.

7. Procédé selon la revendication 6, suivant lequel la pression du gaz sous pression est augmentée d'une telle manière que la température du gaz augmente, le gaz sous pression étant donc utilisé pour

chauffer le film plastique (5).

8. Procédé selon l'une quelconque des revendications précédentes, suivant lequel du gaz sous pression est alimenté par une chambre de pression (15), une chambre d'étanchéité (27) étant fournie au moins à un bout de la chambre de pression et du gaz écoulant dans la chambre d'étanchéité (27) est aspiré et alimenté de nouveau à la chambre de pression (15).

9. Appareil pour fabriquer un film plastique, l'appareil comprenant une extrudeuse (1) et au moins un dispositif d'orientation (12, 17) pour orienter le film extrudé (5), lequel appareil comprend des moyens d'alimentation en gaz (15, 16) disposés après l'au moins un dispositif d'orientation (12, 17) pour alimenter en gaz sous pression le film plastique (5) après l'orientation par extension de sorte que le gaz alimenté pénètre dans les bulles de cavitation formées dans le film plastique (5) pendant l'expansion et, par conséquent, des bulles (25) contenant du gaz sont formées dans le film plastique (5).

10. Appareil selon la revendication 9, dans lequel les moyens d'alimentation en gaz (15,16) sont disposés après le premier dispositif d'orientation (12), et l'appareil comprenant un deuxième dispositif d'orientation (17) après le premier dispositif d'orientation (12), dans le sens du film plastique (5), le deuxième dispositif d'orientation (17) étant disposé à orienter le film plastique (5) dans le sens essentiellement transversal à la direction d'orientation du premier dispositif d'orientation (12) de sorte que les bulles (25) contenant du gaz gonflent à cause de l'influence du deuxième dispositif d'orientation (17) et du gaz.

11. Appareil selon la revendication 10, dans lequel le premier dispositif d'orientation (12) est disposé à orienter le film plastique (5) dans le sens machine et le deuxième dispositif d'orientation (17) est disposé à orienter le film plastique (5) dans le sens essentiellement transversal au sens machine.

12. Appareil selon l'une quelconque des revendications 9 à 11, dans lequel les moyens d'alimentation en gaz comprennent une chambre de pression (15), ce qui est munie de moyens de chauffage du film plastique (5).

13. Appareil selon la revendication 12, l'appareil comprenant des moyens pour augmenter la pression du gaz sous pression de sorte que la température du gaz augmente tellement haut que le gaz chauffe le film plastique (5).

14. Appareil selon l'une quelconque des revendications 9 à 13, dans lequel les moyens d'alimentation en gaz comprennent une chambre de pression (15), une chambre d'étanchéité (27) étant fournie au moins à un bout de la chambre de pression (15).

15. Appareil selon la revendication 14, dans lequel les moyens d'alimentation en gaz comprennent une pompe (16) disposée à aspirer du gaz depuis la chambre d'étanchéité (27) et des moyens pour alimenter la chambre de pression (15) en gaz aspiré depuis la chambre d'étanchéité (27).

16. Appareil selon la revendication 15, dans lequel la pompe (16) est disposée à aspirer l'air additionnel à travers de la chambre d'étanchéité (27).

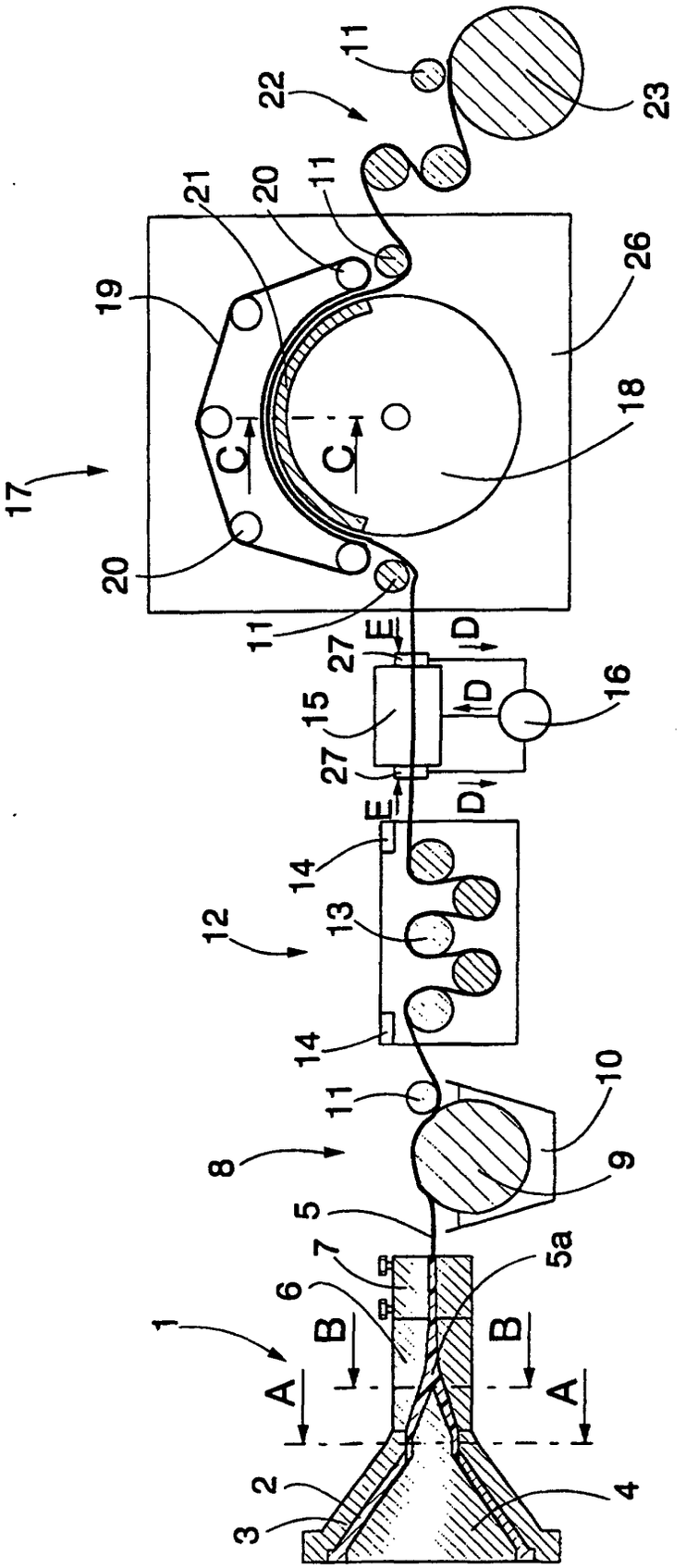

FIG. 1

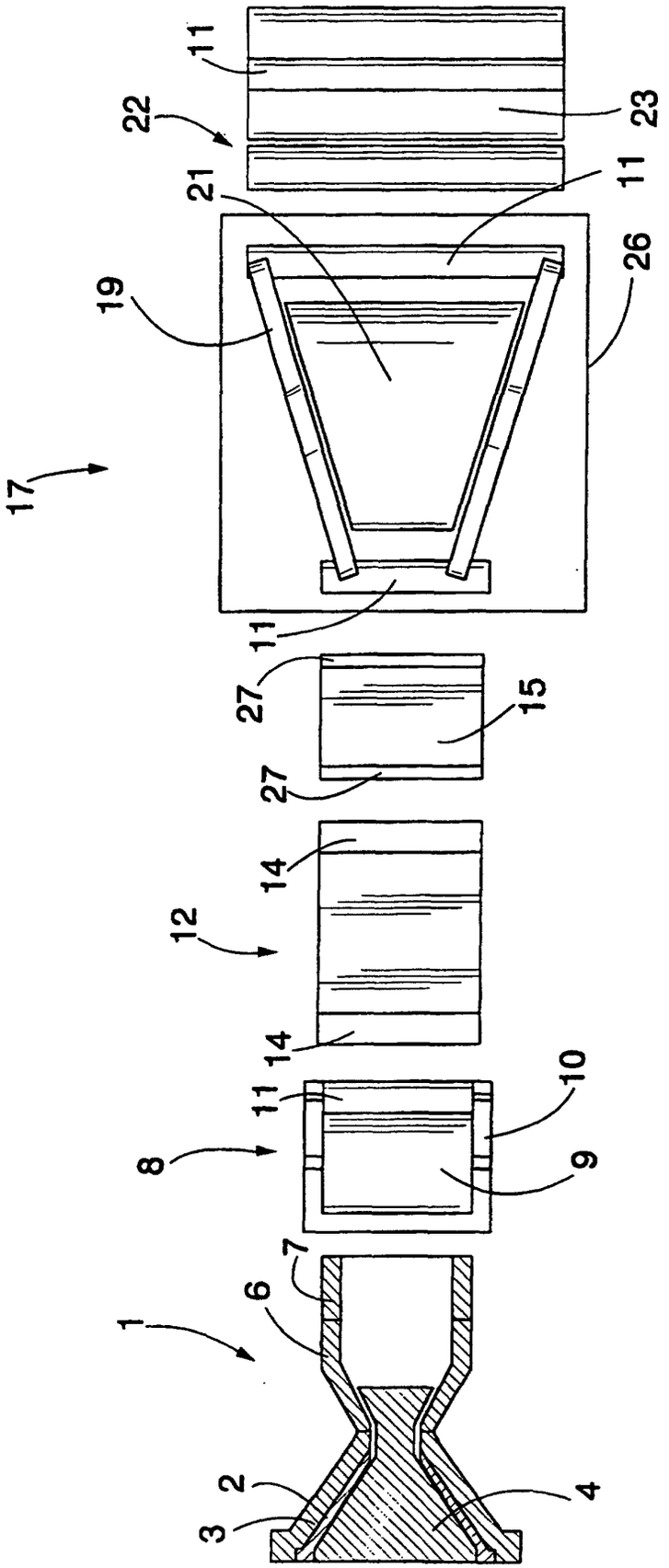

FIG. 2

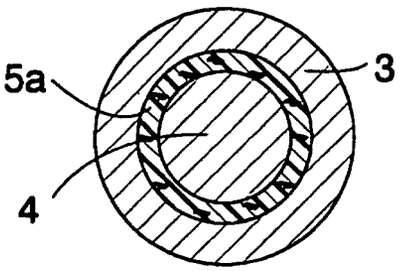

FIG. 3

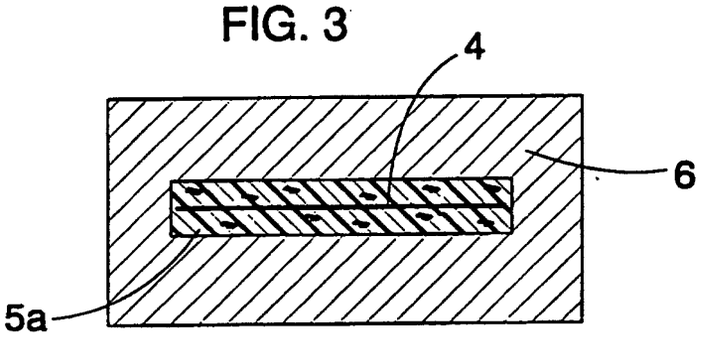

FIG. 4

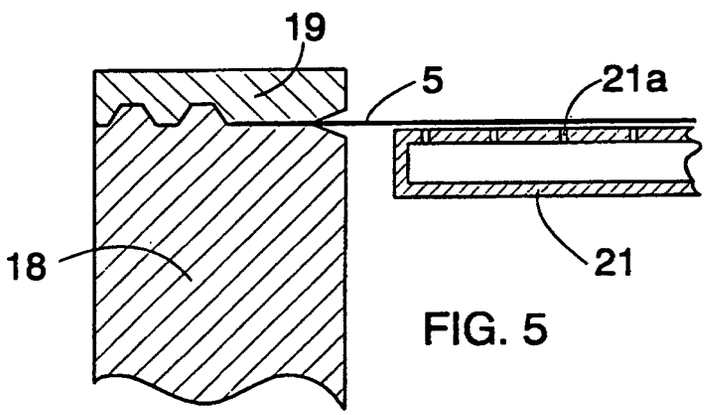

FIG. 5

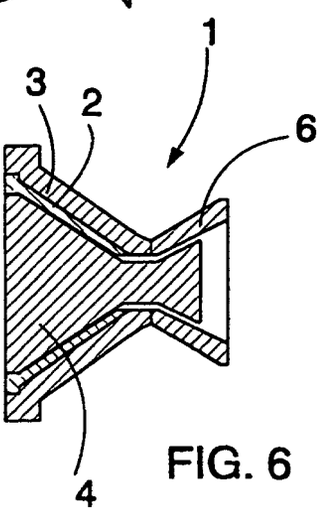

FIG. 6

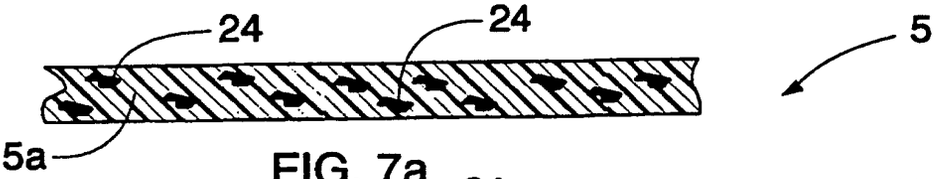

FIG. 7a

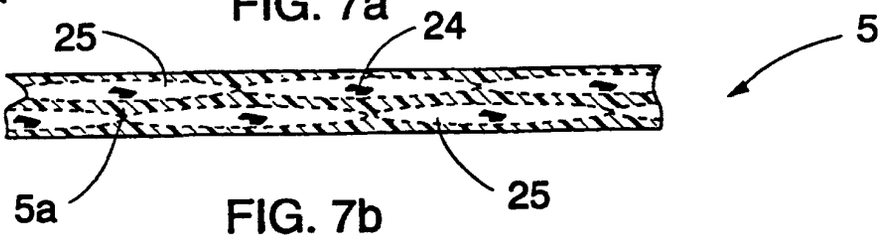

FIG. 7b

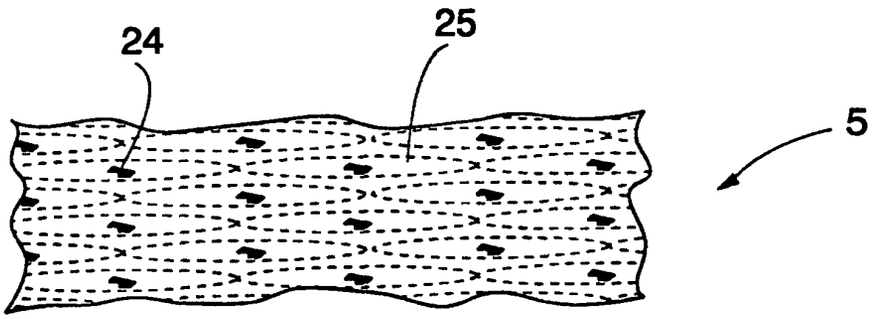

FIG. 7c

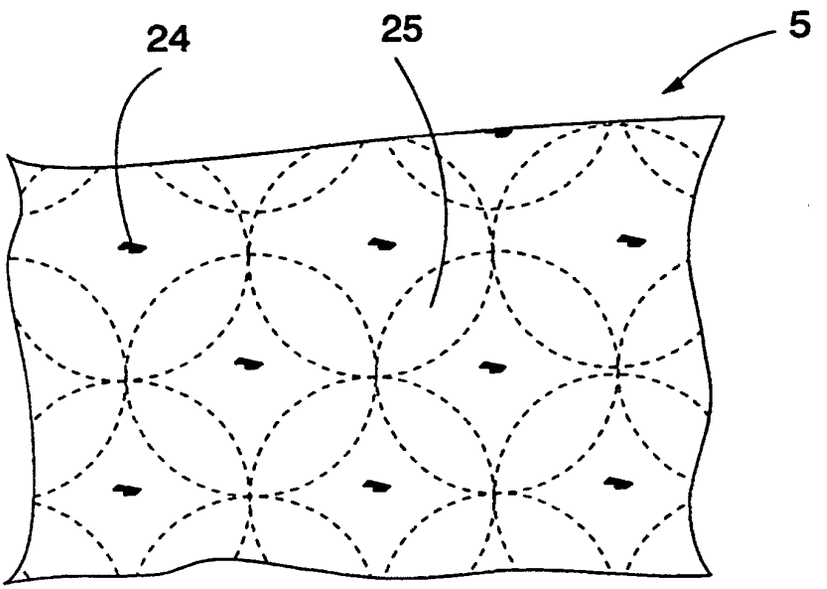

FIG. 7d