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BLOWING A TUBULAR RESIN FILM UNDER THE INFLUENCE OF A BUBBLE STABILISER

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(57) Claim

1. A blown-film extrusion method for thermoplastic synthetic resin, wherein:
a tubular film extruded from an extrusion die is transferred while brought into contact with a bubble stabilizer constructed of a plurality of filament elements which extend axially in an adequate portion between said extrusion die and a frost line of said film and are arranged into a substantially cylindrical shape.

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COMPLETE SPECIFICATION

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Complete Specification for the invention entitled:

~~"An improved method and apparatus"~~

Method and apparatus for producing blown film.

The following statement is a full description of this invention, including the best method of performing it known to me:-

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Field of the Invention:

The present invention relates to a method and apparatus for producing a blown film, and more particularly to those in which an improved bubble stabilizer is employed.

Description of the Prior Art:

In a blown-film extrusion for producing a tubular resin film, it is important to prevent molecular orientation and thickness deviation from occurring in the film in order to produce a uniform film, which molecular orientation and thickness deviation result from material deformations occurring in flow or extension of the resin material which is extruded from a die in molten state and solidified. As shown in Fig. 11, one of such preventive measure is disclosed in a blown-film extrusion described in Japanese Patent Publication No. 55-2180 in which a bubble is extruded from a die while brought into contact with a small-diameter bubble stabilizer which projects from a surface of the die.

However, in such conventional blown-film extrusion, since a tubular bubble stabilizer employing a bubble stabilizer lacks cushioning properties in

its portion contacting a tubular molten material, such stabilizer can not adapt itself to the changes of the bubble's shape corresponding to the changes in room temperature, cooling effect, resin temperature, an extrusion amount of the reisn, thickness of the bubble and extrusion speed of the film, so that the extruded film is often broken by occurrence of knocking. In addition, in the conventional blown-film extrusion, the molten resin extruded from the die is cooled by a cool air supplied from an air ring while extruded into a tubular molten resin element. However, such cooling action depending only on the cooling through the air ring restricts an extrusion amount of the resin and therefore is not adequate in increasing a production amount of the film per hour.

Further, in the conventional blown-film extrusion, since the bubble stabilizer is fixed in its size and shape, it is necessary to provide various tubular bubble stabilizers having various sizes and various shapes corresponding to various sizes and thickness of the blown films to be produced. Consequently, various types of dies are required to lead to a cumbersome maintenance which is another problem inherent in the conventional blown-film extrusioin.

SUMMARY OF THE INVENTION (non-limiting)

It is an object of the present invention to provide a blown-film extrusion method of thermoplastic synthetic resin, in which a tubular film extruded from the die is transferred while brought into contact with a bubble stabilizer constructed of a plurality of resilient filament elements which axially extend in an adequate portion between the die and a frost line of the film and are arranged into a substantially cylindrical shape.

It is another object of the present invention to provide a blown-film extrusion apparatus in which a pair of supporting members are mounted on a supporting axle so as to be separated from each other by a certain distance, which supporting axle is fixed to a die, between which supporting members are provided a bubble stabilizer constructed of a plurality of filament elements which are mounted on peripheral edge portions of the supporting members at intervals of a predetermined distance in circumferential directions of the supporting members in an expanded condition. Preferments follow.

According to the present invention, the filament elements extend between the supporting members in an expanded condition through engaging means provided in both of the supporting members.

Accroding to the present invention, the filament elements may be substantially parallel to the axis of the supporting axle, or may be oblique to such axis.

The engaging means may be a plurality of holes provided in a peripheral edge portion of each of the supporting members, or may be a plurality of U-shaped holes an opening of each of which is directed outward, which U-shaped holes are provided in the peripheral edge portions of the supporting members, or may be a plurality of hook-like projected tongues provided in the peripheral edge portions of the supporting members.

The plurality of the filament elements may separately extend between the supporting members in an expanded condition.

Further, the filament elements may constitute an elongated endless-ring type single element as a whole, to make it possible that such single element extends between the supporting members through the engaging means in an expanded condition, the number of which endless-ring type element may be more than one.

Preferably, the filament elements are constructed of resilient material, for example such

as wire, filaments of hard synthetic resin materials, coil springs and rubber strings.

The coil springs may be double-coil springs.

The supporting members may be disks or rings.

Of the supporting members such as the disks or the rings, one near the die has a small diameter so that the thus formed bubble stabilizer has preferably a conical shape.

Of the supporting members, one or both of them may be preferably rotatable about the support-axle and/or one or both of them may be preferably movable in a longitudinal direction of the supporting axle.

Other elements of the bubble stabilizer and the blown-film extrusiion apparatus may be conventional ones.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a longitudinal sectional view of the blown-film extrusion apparatus of the present invention;

Fig. 2 is a view similar to Fig. 1, in which the bubble stabilizer is different in construction from one shown in Fig. 1;

Fig. 3 is a cross-sectional view taken

along the line B-B of Fig.1;

Fig. 4 is an enlarged view of a portion encircled with the lines A-A and A'-A' of Fig. 1;

Figs. 5 and 6 are longitudinal sectional views of another embodiment of the bubble stabilizer of the blown-film extrusiion apparatus of the present invention, which embodiment is different from that shown in Fig. 1; in which Fig. 5 is a view for explaining the longitudinal section of the bubble stabilizer; and Fig. 6 is a view showing in section the essential parts of the blown-film extrusion apparatus of the present invention;

Fig. 7 is a perspective view of the bubble stabilizer, showing one embodiment of the engaging means for the filament elements of the supporting disks, and showing the extending condition of the elongated endless ring of the bubble stabilizer of the present invention;

Fig. 8 is a partially sectional view of the elongated coil spring, showing its end connection;

Figs. 9 and 10 are perspective views of other engaging means of the supporting disks, which are different from that shown in Fig. 7, respectively; and

Fig. 11 is a longitudinal sectional view

of the conventional blown-film extrusion apparatus provided with the bubble stabilizer.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be hereinbelow described in detail with reference to the drawings showing the embodiments of the present invention, which have no intention to limit the present invention.

In Fig. 1, the reference numeral 1 denotes a die; 2 a tubular resin film; 3 an air ring; and 4 a bubble stabilizer provided between the die 1 and a frost line 5 of the film 2.

In the bubble stabilizer 4, a supporting axle 6 is fixed to the die 1, to which supporting axle 6 are respectively fixed through screws 9 a pair of supporting disks 7 and 8 one of which is a small-diameter supporting disk 7 disposed in a position near the die 1 and the other of which is a large-diameter supporting disk 8, each of which 7 and 8 is provided with a boss.

As shown in Fig. 3 in the clearest manner, a coil spring 10 which is made of stainless steel and acting as a filament element extends between the supporting disks 7 and 8 in parallel to an axis of the supporting axle 6.

These supporting disks 7 and 8 may be rotat-

able about the supporting axle 6 and longitudinally slidable along the same 6 by slightly releasing the screws 9.

Since the filament element 10 is constructed of the coil spring, it is expandable to make it possible to rotate one of the supporting disks 7, 8 relative to the other thereof about the axis of the supporting axle 6, so that, as shown in Fig. 2, the filament element 10 may be tilted relative to the axis of the supporting axle 6, i.e., a cylindrical wall surface of the bubble stabilizer 4 constructed of at least one of the filament element 10 is put into a twisted condition.

Although it is not shown in the drawings, it is possible to adjust the distance between the supporting disks 7 and 8 so as to change a frusto-conical shape of the bubble stabilizer 4.

Thus, it is possible to provide various sizes and shapes by the use of a single bubble stabilizer 10, to make it possible to adequately select the optimum conditions of the blown-film extrusion in tilting angle in circumferential direction, radius of conic section, and in resilient force of the filament element 10.

As shown in Fig. 1, the filament element 10

contacts the tubular resin film 2 through a tiny contact area. In addition, since the film 2 curves naturally to contact the filament element 10 and is separated from the latter 10 while expanded, the expansion of the film 2 does not suffer from resistance to make it possible that such expansion is smoothly conducted. In such expansion of the film 2 or bubble, the bubble is put under the influences of the room temperature, cooling action, resin temperature, extrusion amount of the resin, thickness of the bubble, extrusion speed of the film 2 and the like factors to be deformed in a complex manner so that the bubble changes in its outer diameter and its position contacting the filament element 10 in a bubble's portion 12 immediately before a funnel-shaped enlarged portion 11 of the tubular resin film 2. However, such changes of the bubble can be immediately absorbed by the filament element 10 through its resiliency to make it possible to resolve the breakage problem of the film 2 through the knocking thereof. In addition, as shown in the drawings, the air supplied into the tubular resin film 2 through an air blowing port 13 prevents the tubular resin film 2 from being heated to a high temperature when the air passes through the funnel-shaped enlarged

portion 11 so as to support the cooling action of the air ring 3 inside the tubular resin film 2, to make it possible to increase the extrusion amount of molten resin to be extruded, whereby the production of the film 2 per hour is increased.

In addition, since the contacting area is tiny, the tubular resin film can substantially keep its thickness uniform even when there is an uneven thermal conductivity in the film 2 during its extrusion, so that there is no fear to produce a defective part of the film or defective product.

In case that the blown film 2 is produced by the use of the blown-film extrusion apparatus of the present invention, the tubular resin film 2 extruded through the die 1 is brought into contact with the filament element 10 of the bubble stabilizer 4 slightly at an inner surface of its portion 12 immediately before the funnel-shaped enlarged portion 11 of the film 2. Consequently, particularly in case that the filament element 10 is tilted relative to the axis of the supporting axle 6, the inner surface portion of the tubular resin film 2 reaching the above portion 12 is kneaded obliquely by the filament element 10 to give uniformity to the film 2 in its polymer orientation in lateral and longitudinal direc-

tions. At this time, the film 2 is simultaneously evened in its thickness through such oblique kneading action of the filament element 10 while transferred to the funnel-shaped enlarged portion 11, so that the film 2 is extended in lateral and longitudinal directions, whereby the film 2 is evened in its mechanical properties, for example such as tensile strength, tear propagation strength, thickness and the like.

In Figs. 5 and 6, there is shown another embodiment of the present invention, which is different from that shown in Figs. 1 and 2.

In such embodiment, in order to adjust the distance between the upper 7 and lower 8 supporting disks, a telescopic cylinder element 14 is mounted on the supporting axle 6 between these supporting disks 7, 8. The telescopic cylinder element 14 is constructed of an inner cylinder 15 abutting against the lower supporting disk 8 and an outer cylinder 16 abutting against the upper supporting disk 7 to keep these supporting disks 7, 8 in their adjusted positions. The cylinder element 14 is fixed to the supporting disk 7 through screw 17. The upper supporting disk 7 is provided with a rib 18 which is inserted into the outer cylinder 16 of the cylinder

element 14 one side of which is fixed to the upper supporting disk 7 at the rib 18 through the screw 17.

In Fig. 7, there is shown another embodiment of the filament element 10, i.e., an elongated endless ring 19. In this embodiment, a plurality of circular holes 20 acting as the engaging means for the endless ring 19 are provided in a peripheral edge of each of the upper 7 and lower 8 supporting disks at intervals of a certain distance. The elongated endless ring 19 passes through one circular hole 20 from the outside of the supporting disks 7, 8 to the inside of the sames, and then passes through another circular hole 20 adjacent to the first one from the inside of the supporting disks 7, 8 to the outside of the sames. The elongated endless ring 19 thus passed through the circular holes 20 of one of the supporting disks 7, 8 is then extended toward the other of the supporting disks 7, 8 so as to be passed through the circular holes 20 of the other of the supporting disks 7, 8 in the same manner as in the case of the circular holes 20 of the first one of the supporting disks 7, 8, whereby such passing operation of the elongated endless ring 19 is repeated with respect to the circular holes 20 to make it possible to extend

the elongated endless ring 19 between the supporting disks 7 and 8 in an expanded condition so as to form a cylindrical wall surface of the bubble stabilizer 4.

The engaging means provided in the upper 7 and lower 8 supporting disks, which are the circular holes 20, may be replaced with another embodiment of the engaging means as shown in Fig. 9 in which the circular holes 20 is replaced with U-shaped holes 21 an opening of each of which is directed outward to form a tongue portion 22 which engages with the filament element 10, i.e., the elongated endless ring 19.

In addition, as shown in Fig. 10, the circular holes 20 may be replaced with further another embodiment of the engaging means, which takes a hook-like tongue 23 provided in outer surfaces of the supporting disks 7, 8 and directed radially inward of the sames 7, 8.

These embodiments make it possible that the upper 7 and lower 8 supporting disks are rotated about the supporting axle 6 relative to each other to twist the cylindrical wall surface formed by the filament element 10, or that the upper 7 and lower 8 supporting disks are axially moved relative to

each other to change the form of the bubble stabilizer 4 as is in the former embodiments of the present invention.

Further, as shown in Figs. 7 and 8, in case that the elongated endless ring 19 is extended between the upper 7 and lower 8 supporting disks in an expanded condition, it is possible to form such endless ring 19 by press-fitting a short coil spring 24 to the opposite ends of the ring 19 in an insertion manner, which short coil spring 24 is slightly larger in its outer diameter than the inner diameter of the coil spring constituting such endless ring 19, to make it possible to provide such endless ring 19 acting as the filament element 10 without causing any deterioration in resiliency and flexibility of the ring 19.

In the bubble stabilizer 4 provided with the above-mentioned engaging means, it is possible to easily mount and replace the filament element 10 according to the present invention.

The Claims defining the invention are as follows:-

1. A blown-film extrusion method for thermoplastic synthetic resin, wherein:
a tubular film extruded from an extrusion die is transferred while brought into contact with a bubble stabilizer constructed of a plurality of filament elements which extend axially in an adequate portion between said extrusion die and a frost line of said film and are arranged into a substantially cylindrical shape.

2. The blown-film extrusion method as set forth in claim 1, wherein: said filament element is made of resilient material.

3. A blown-film extrusion apparatus in which a pair of supporting members are mounted on a supporting axle so as to be separated from each other by a certain distance, said supporting axle being fixed to an extrusion die, between which supporting members are provided a bubble stabilizer constructed of a plurality of filament elements which are mounted on peripheral edge portions of said supporting members at intervals of a predetermined distance in circumferential directions of said supporting members in an expanded condition.

4. The blown-film extrusion apparatus as set

forth in claim 3, wherein: said filament elements extend substantially parallel to an axis of said supporting axle.

5. The blown-film extrusion apparatus as set forth in claim 3, wherein: said filament elements extend obliquely relative to an axis of said supporting axle.

6. The blown-film extrusion apparatus as set forth in claim 3, wherein: said filament elements extend separately between said supporting members.

7. The blown-film extrusion apparatus as set forth in claim 3, wherein: said filament elements are shaped into a single elongated endless ring extended between said supporting members through engaging means.

~~8. The blown-film extrusion apparatus as set forth in claim 3, wherein: said filament elements are made of resilient material.~~

~~9.~~ 8. The blown-film extrusion apparatus as set forth in claim ~~3~~ 3, wherein: ~~said~~ each filament element is constructed of a coil spring.

~~10.~~ 9. The blown-film extrusion apparatus as set forth in claim ~~3~~ 3, wherein: ~~said~~ each filament element is constructed of a rubber string.

~~11.~~ 10. The blown-film extrusion apparatus as set

forth in claim 3, wherein: said supporting members are shaped into supporting disks.

~~12.~~ 11. The blown-film extrusion apparatus as set forth in claim 3, wherein: said supporting members are shaped into supporting rings.

~~13.~~ 12. The blown-film extrusion apparatus as set forth in claim ~~11~~ 10, wherein: of said supporting disks, one near said extrusion die is smaller in diameter than the other.

~~14.~~ 13. The blown-film extrusion apparatus as set forth in claim ~~12~~ 11, wherein: of said supporting rings, one near said extrusion die is smaller in diameter than the other.

~~15.~~ 14. The blown-film extrusion apparatus as set forth in claim 3, wherein: said supporting members are rotatable about the axis of said supporting axle.

~~16.~~ 15. The blown-film extrusion apparatus as set forth in claim 3, wherein: said supporting members are movable in a longitudinal direction of said supporting axle.

~~17.~~ 16. The blown-film extrusion apparatus as set forth in claim 3, wherein: said supporting members are rotatable about said supporting axle while movable in a longitudinal direction of said supporting axle.

~~18.~~ 17. The blown-film extrusion apparatus as set

forth in claim 3, wherein: said filament elements are extended between said supporting members through engaging means provided in said supporting members.

~~19.~~ 18. The blown-film extrusion apparatus as set forth in claim ~~18~~ 17, wherein: said engaging means are constructed of a plurality of circular holes provided in peripheral edge portions of said supporting members.

~~20.~~ 19. The blown-film extrusion apparatus as set forth in claim ~~18~~ 17, wherein: said engaging means are constructed of a plurality of U-shaped holes an opening of each of which is directed outward, said U-shaped holes are provided in peripheral edge portions of said supporting members.

~~21.~~ 20. The blown-film extrusion apparatus as set forth in claim ~~1~~ 17, wherein: said engaging means are constructed of a plurality of hook-like tongues provided in peripheral edge portions of said supporting members.

~~22. Any novel method or method step set forth herein,~~ or any novel apparatus or apparatus component set forth herein, the said method, ~~step,~~ apparatus or component being ~~substantially as herein described.~~

DATED this 6th day of August 1986

SUPER BAG COMPANY, LIMITED

By Its Patent Attorneys

ARTHUR S. CAVE & CO.

PATENT OFFICE

FIG. 1

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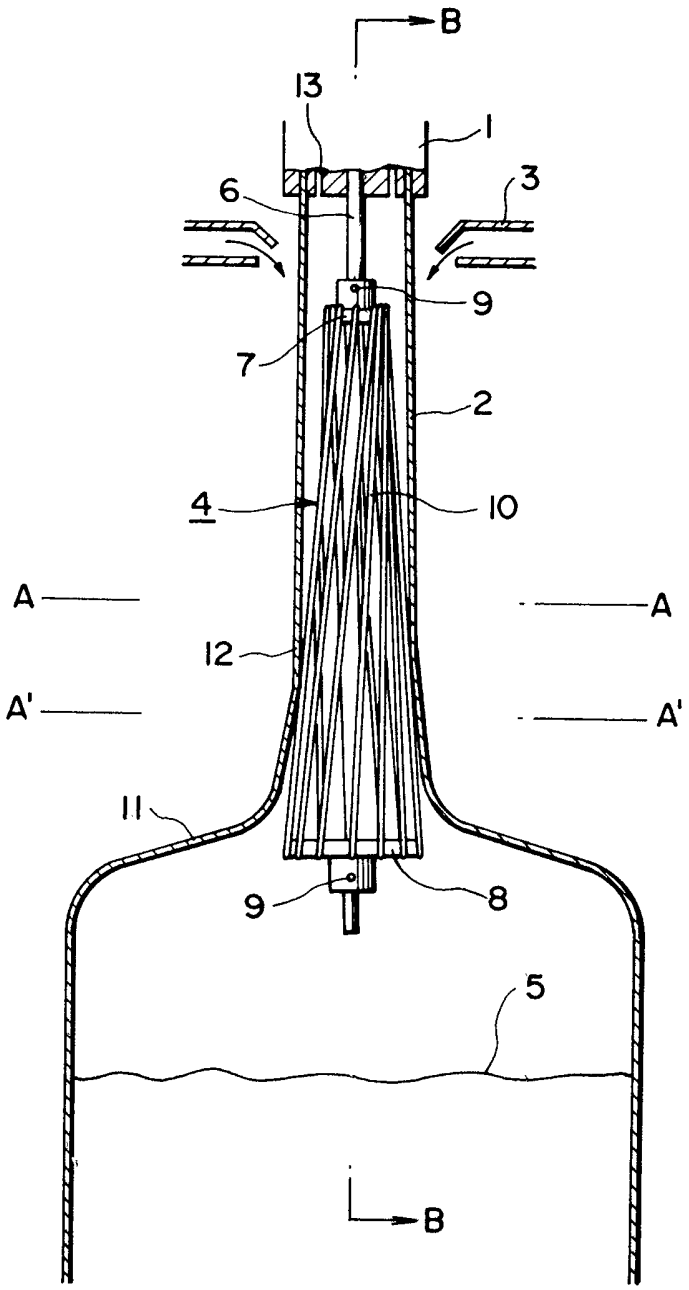

FIG. 2

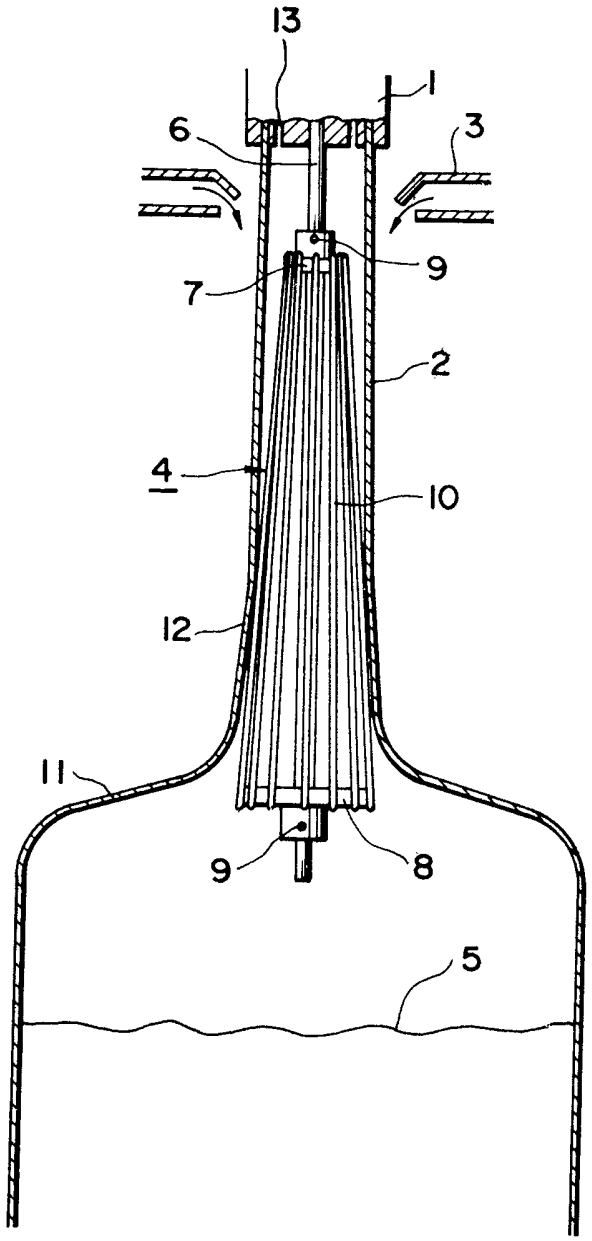

FIG. 3

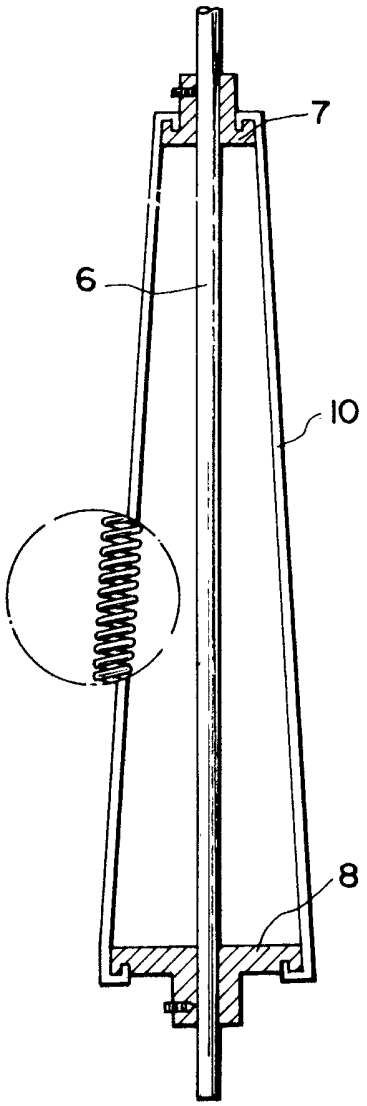

FIG. 4

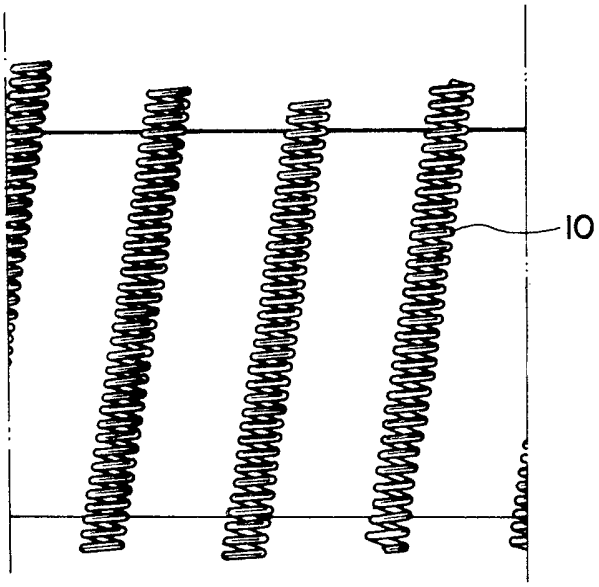

FIG. 5

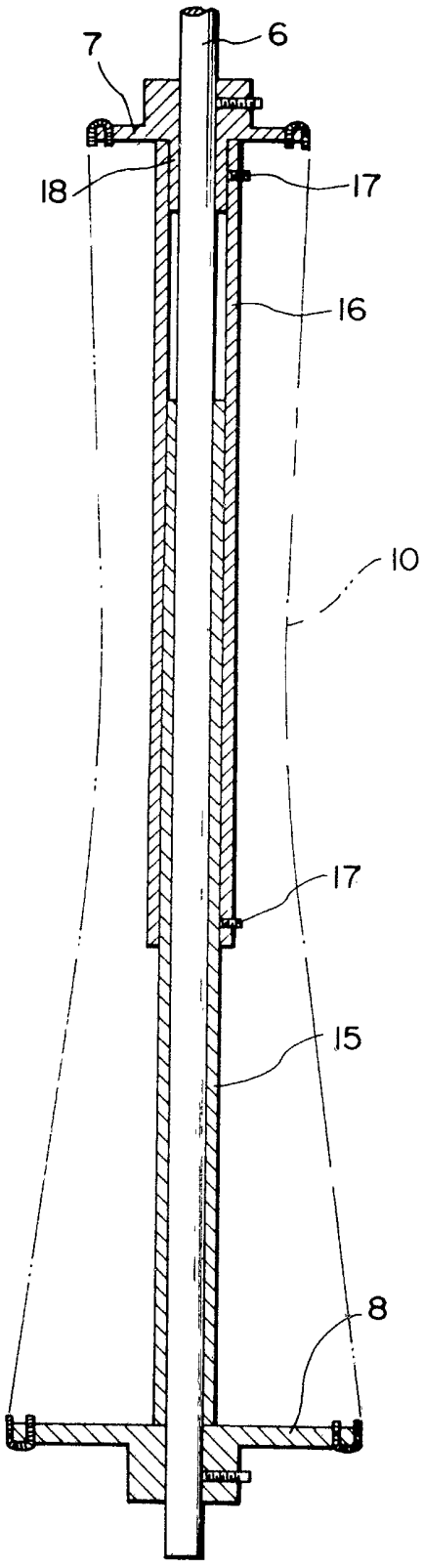

FIG. 6

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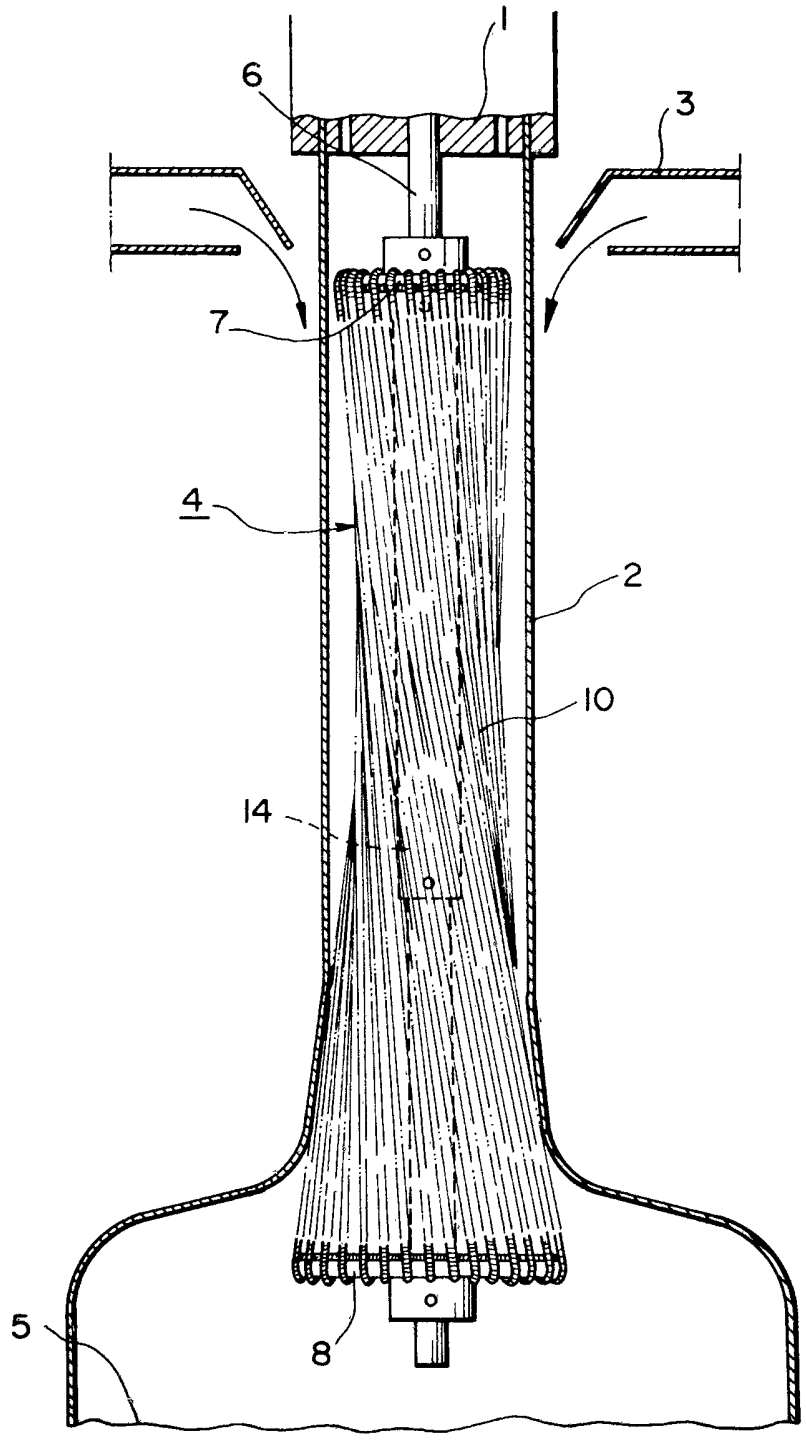

FIG. 7

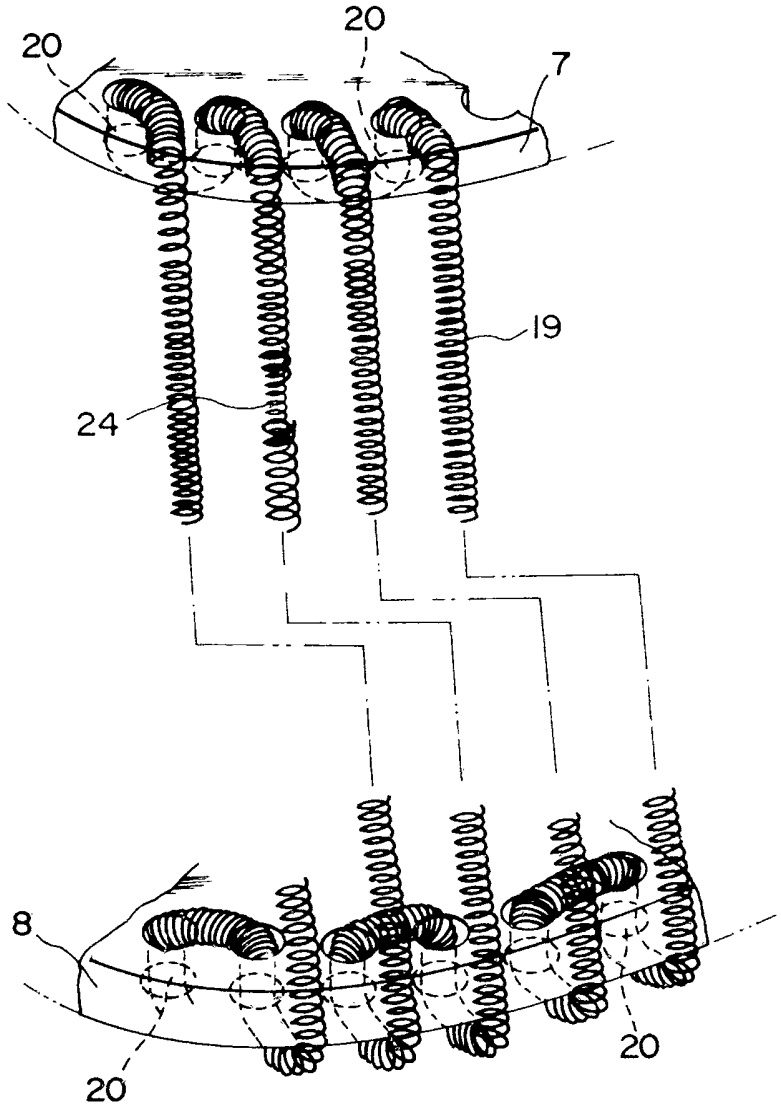

FIG. 8

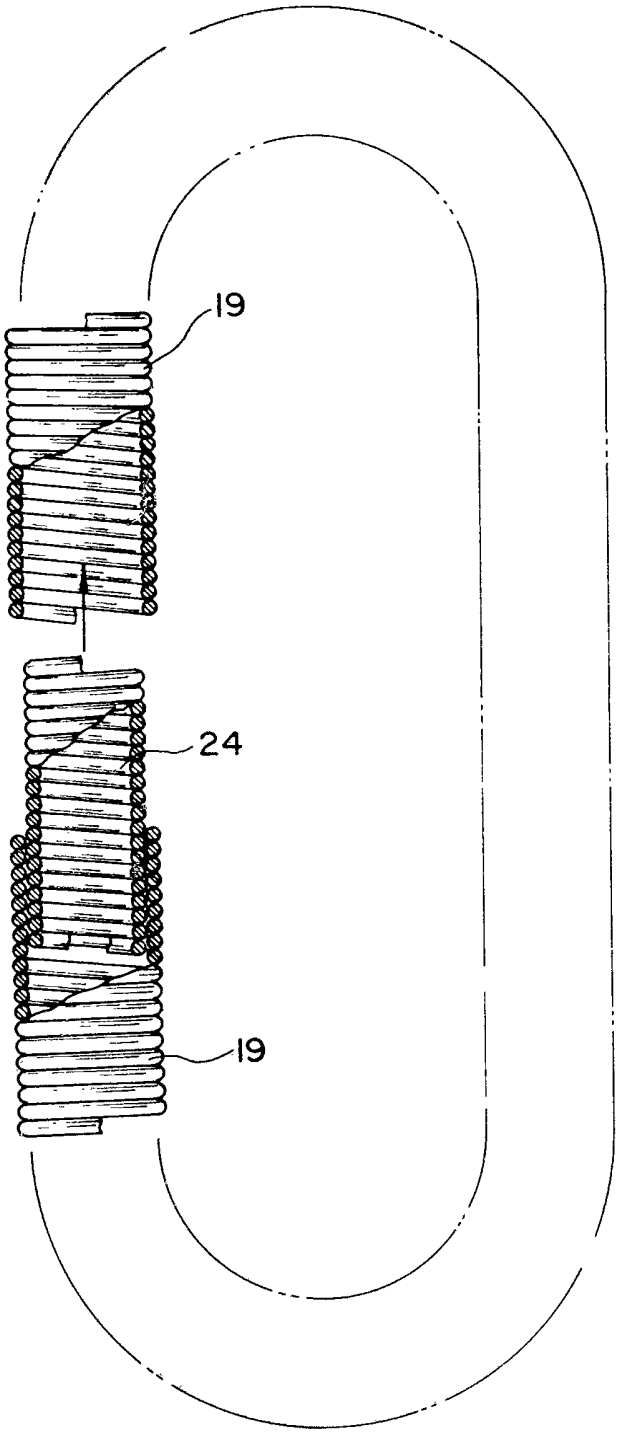

FIG. 9

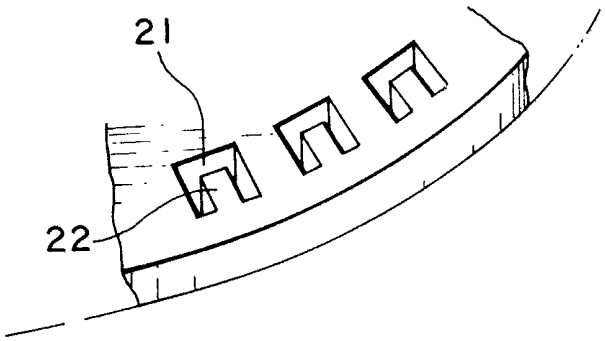

FIG. 10

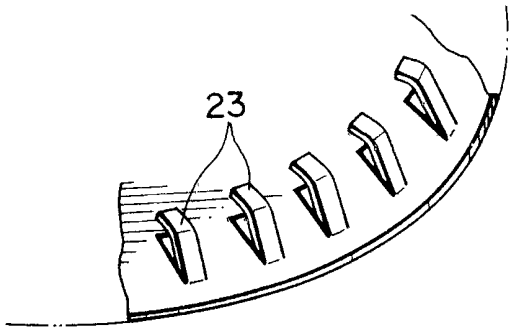

FIG. 11