

Description

Field of the Invention

[0001] The present invention relates to a melt spinning apparatus, and more specifically, to a melt spinning apparatus that can execute spinning so as to obtain notably a very fine multifilament yarn that is uniform and that has an even fineness.

Background of the Invention

[0002] In general, for melt spinning of a thermoplastic polymer, a molten polymer is supplied by an extruder to spinning packs and spun out of a spinneret of the spinning packs as filaments. Cooling winds are then blown against the filaments to solidify them to obtain a multifilament yarn. However, the more filaments are spun out, the more difficult it is to uniformly cool each of the filaments in a longitudinal direction. Then, the cooling may be uneven, the filaments may come into contact with each other below the spinneret, or the fineness may be uneven.

[0003] In particular, for very fine filaments of single filament size at most 0.55 dtex or even at most 0.33 dtex, each filament is likely to have a high internal strain and to be affected by associated air currents or cooling winds, resulting in an uneven fineness. Further, owing to the very fine single filament fineness, the number of filaments constituting the multifilament yarn is twice to five times as large as that of filaments constituting a common yarn. Consequently, the above tendency is more prone to occur.

[0004] A known effective method for uniformly cooling melt spinning filaments comprises arranging cylindrical spin cooling cylinders below respective spinning packs and blowing cooling winds into the spin cooling cylinders from their top portions so that the winds flow parallel with the filaments (for example, International Publication No. WO 99/067450A). It is known that if the spin cooling cylinders are thus used for cooling, a certain method can be very effectively used to make the cooling action more uniform particularly if very fine filaments are subjected to melt spinning. This method comprises using packing to seal the upper end of each of the spin cooling cylinders from the corresponding spinning pack so that cooling winds from the spin cooling cylinder will not flow in the adjacent pack, as described in the International Publication No. WO 01/79594A.

[0005] However, if the seal is formed by abutting the upper end of each spin cooling cylinder directly against the corresponding spinning pack as described in International Publication No. WO 01/79594A, it is disadvantageously difficult to form a perfect seal for the reason below. Thus, external cooling winds may flow into the spin cooling cylinder through the imperfect seal to disturb the original cooling winds. As a result, the filaments are disadvantageously not uniformly cooled.

[0006] Specifically, each spinning pack is constructed by assembling a plurality of parts together, so that when the spinning packs are installed, the positions of their lower ends vary unavoidably because of errors in the manufacture of these parts or a variation in the amount of collapse of seal elements during assembly and mounting, the seal elements belonging to the spinning packs.

[0007] Consequently, it is difficult to make the lower ends of all the spinning packs flush with one another. Thus, the seal portion at the upper end of each spin cooling cylinder may be imperfect. Further, cooling winds from the adjacent spin cooling cylinder may flow in to cause uneven cooling. This effect is likely to be produced particularly if the cooling section is provided with an integral cooling wind supply box that cover the plurality of spinning packs and if the filament spinning cylinders are provided inside the cooling wind supply box in association with the respective spinning packs.

[0008] It is an object of the present invention to provide a melt spinning apparatus that can execute spinning so as to obtain a uniform multifilament yarn having an even fineness.

[0009] It is another object of the present invention to provide a melt spinning apparatus that can execute melt spinning so as to obtain a very fine multifilament yarn which is composed of uniform filaments and which is uniform in a longitudinal direction particularly even if the very fine multifilament yarn has a single filament fineness of at most 0.55 dtex.

Summary of the Invention

[0010] To accomplish these objects, the present invention provides a melt spinning apparatus comprising a plurality of spinning packs installed in a pack housing contained in a spinning beam, the spinning packs being arranged in a line, an integral Quenching stack provided below the plurality of spinning packs so as to be shared by the spinning packs, and filament cooling cylinders each comprising a cylindrical filter and provided inside the Quenching stack in association with the respective spinning packs, the apparatus being characterized in that a first seal mechanism is used to seal a top portion and a bottom portion of each of the filament cooling cylinders from a top plate and a bottom plate, respectively, of the Quenching stack, and a second seal mechanism is used to seal the top portion of the filament cooling cylinder from a bottom surface of the pack housing via a spacer.

[0011] Thus, the first seal mechanism is used to seal the top portion and bottom portion of each of the filament cooling cylinders from the top plate and bottom plate, respectively, of the Quenching stack, and the second seal mechanism is used to seal the top portion of the filament cooling cylinder from the bottom surface of the pack housing via the spacer. Accordingly, it is possible to allow only stable cooling winds having passed

through the filament cooling cylinders to flow into uniformly cool spun-out filaments. Further, since the second seal mechanism is used to seal the top portion of the filament cooling cylinder from the bottom surface of the pack housing, not from the spinning pack, the spun-out filaments can be reliably uniformly cooled without any seal leakage even if the mounting heights of the spinning packs are changed as a result of the replacement of the packs.

Brief Description of the Drawings

[0012]

Figure 1 is a schematic sectional view showing an embodiment of a melt spinning apparatus according to the present invention.

Figure 2 is an enlarged view of a part of Figure 1 shown by an arrow P.

Figure 3 is a partly exploded top view taken along a line III-III in Figure 1.

Figure 4 is a top view corresponding to Figure 3 according to another embodiment of the present invention.

Figure 5 is a schematic perspective view of a filaments cooling cylinder in the melt spinning apparatus according to the present invention.

Figure 6 is a schematic view illustrating a porous plate used for a cooling wind supply path in the melt spinning apparatus according to the present invention.

Figure 7 is a schematic sectional view showing essential parts of another embodiment of the present invention.

Figure 8 is a schematic sectional view showing essential parts of yet another embodiment of the present invention.

Figure 9 is a schematic sectional view showing essential parts of further another embodiment of the present invention.

Detailed Description of the Preferred Embodiments

[0013] A thermoplastic polymer applied to a melt spinning apparatus according to the present invention is not particularly limited. Any thermoplastic polymer is available for the melt spinning apparatus provided that it can be used to form fibers. The thermoplastic polymer includes, for example, polyamide, polyester, or polyolefin.

[0014] The melt spinning apparatus according to the present invention can execute spinning so as to obtain a uniform multifilament yarn regardless of the single filament fineness of spun-out filaments. However, the melt spinning apparatus is particularly effective on the melt spinning of a multifilament yarn of single filament fineness at most 0.55 dtex or even at most 0.33 dtex. Moreover, the melt spinning apparatus is very effective on the melt spinning of a very fine multifilament yarn having

such a small filament yarn fineness and containing at least 90 filaments in total.

[0015] The melt spinning apparatus according to the present invention will be described below in detail with reference to the specific embodiment shown in the drawings.

[0016] In Figures 1 to 3, a pack housing 33 is provided in an upper spinning beam 1. A plurality of spinning packs 2 are housed inside the pack housing 33 so as to be arranged in a direction orthogonal to the sheet of the drawing. A spinneret 3 is incorporated into each of the spinning packs 2 and has an exposed bottom surface. A plurality of pack housings 33 may be formed for the respective spinning packs 2 or an integral pack housing 33 may comprise a plurality of installation holes in which the respective spinning packs can be installed.

[0017] A filament cooling device 6 is provided below the spinning packs 2 installed in the pack housing 33 as described above. The filament cooling device 6 blows cooling winds against filaments Y constituting the multifilament yarn at 20 to 50 mm below a bottom surface of each of the spinnerets 3. The filament cooling device 6 has independent filament cooling cylinders 44 for the respective spinning packs 2 so that each of the cooling cylinders 44 surrounds the filaments Y spun out of the spinning pack 2 through the spinneret 3. The filament cooling cylinders 44 are installed in a cooling wind supply box 15. The cooling wind supply box 15 is integrally formed so as to be shared by the plurality of spinning packs 2. The independent filament cooling cylinders 44 are provided inside the outer cooling wind supply box 15 for the respective spinning packs 2 (see Figure 3). In the illustrated example, each of the filament cooling cylinders 44 has a double structure composed of an inner cylindrical filter 8 and an outer cylindrical filter 9, as shown Figure 5.

[0018] In the filament cooling device 6, a heat insulating member 24 composed of an adiabatic material is provided between a top plate 6b of the cooling wind supply box 15 and a bottom surface of the pack housing 33 so as to surround the installation holes in the spinning packs 2. The heat insulating member 24 maintains a bottom surface of each of the spinnerets 3 at an appropriate temperature for melt spinning. Further, a protective cover 12 for the filament Y is separably connected to a bottom surface of each filament cooling cylinder 44. An oiling device 11 is provided in a lower part of the protective cover 12 so as to apply a lubricant to the filaments Y cooled by cooling winds through the filament cooling cylinder 44. Moreover, a winding device is provided downstream of the oiling device 11 via a godet roller for drawing the filaments Y (not shown in the drawings).

[0019] In the filament cooling device 6, pieces of packing 21, 22 are provided as a first seal mechanism, a piece of packing 21 is provided between a top surface of each filament cooling cylinder 44 and a top plate 6b of the cooling wind supply box 15, and a piece of packing

22 is provided between a bottom surface of each filament cooling cylinder 44 and a bottom plate 6c of the cooling wind supply box 15. The filament cooling cylinder 44 is thus sealed from the top plate 6b and bottom plate 6c of the cooling wind supply box 15. The first seal mechanism forms a seal to prevent the flow, into a filament path 27, of the cooling winds other than those passing through the cylindrical filters 8, 9 of the filament cooling cylinder 44.

[0020] Furthermore, a seal plate 5 as a spacer is placed on the top plate 6b of the cooling wind supply box 15 via packing 39. The seal plate 5 partly overlaps the packing 21 at the top of the filament cooling cylinder 44 and has its top surface sealed from the bottom surface of the pack housing 33 using packing 20 as a second seal mechanism. The second seal mechanism forms a seal to hinder external cooling winds from flowing into the filament path extending from the top portion of the filament cooling cylinder 44 to the bottom surface of the pack housing 33. This prevents the disturbance of the filament Y passing through a downstream side of the filament cooling cylinder 44. Further, the top portion of the filament cooling cylinder 44 is sealed from the bottom surface of the pack housing 33, not from the corresponding spinning pack 2. Accordingly, even if the mounting height of the spinning pack 2 is changed as a result of, for example, the replacement of the spinning pack, it is possible to prevent the seal leakage between the top portion of the filament cooling cylinder 44 and the bottom surface of the pack housing 33.

[0021] The seal plate 5, inserted as a spacer as described above, has its thickness varied to set the appropriate distance from the bottom surface of each spinneret 3 to a cooling wind blowout start position of the filament cooling cylinder 44. The distance from the bottom surface of each spinneret 3 to the cooling wind blowout start position of the filament cooling cylinder 44 is not particularly limited but is preferably selected in accordance with the single filament fineness. This distance is preferably between 20 and 50 mm, more preferably between 30 and 40 mm for the spinning of a very fine filament.

[0022] The illustrated filament cooling device 6 has an elevating and lowering device 13 provided on a rear surface of the protective cover 12 and driven by a hydraulic cylinder. The elevating and lowering device 13 enables the filament cooling device 6 to be elevated and lowered via the protective cover 12. After the filament cooling device 6 has been lowered, the spinning packs 2 can be replaced with new ones or the spinnerets 3 can be cleaned. Further, since the filament cooling device 6 can be elevated and lowered for all of the plurality of spinning packs 2, the airtight sealing characteristic of the yarn cooling device 6 is further enhanced.

[0023] The cooling wind supply box 15 of the filament cooling device 6 is connected to a cooling wind supply duct 26 via a duct 32. A porous piece 7 such as the one shown in Figure 6 is incorporated into the connection

between the cooling wind supply duct 26 and the duct 32. The porous piece 7 serves to make the air flow of cooling winds and their static pressure uniform to allow the cooling winds to be uniformly distributed to the filament cooling cylinders 44 in the cooling wind supply box 15 (see Figure 3). The porous piece 7 preferably has an open area ratio of 30 to 50% and is composed of a material having a transmission resistant characteristic or a combination of the material. For example, the material is a wire mesh, a non-woven cloth, or a porous plate such as a corrosion-resistance metal and plastics.

[0024] An air flow regulating device 14 and an expansion joint 17 are incorporated into the cooling wind supply duct 26. The air flow regulating device 14 properly adjusts the air flow to the filament cooling device 6. The expansion joint 17 allows the elevating and lowering device 13 to smoothly perform operations of elevating and lowering the filament cooling device 6.

[0025] In the integral cooling wind supply box 15 of the filament cooling device 6, which covers the plurality of spinning packs 2, the plurality of filament cooling cylinders 44 may be arranged in a line as shown in Figure 3. Alternatively, the filament cooling cylinders 44 may be staggered as shown in Figure 4 in association with the staggered arrangement of the spinning packs 2 (spinnerets 3) with respect to the spinning beam 1. The staggered arrangement makes the melt spinning apparatus compact.

[0026] The number of filament cooling cylinders 44 in the integral cooling wind supply box 15 can be arbitrarily set and may be, for example, 4, 6, 8, 10, 12, 14, 16. For the inner cylindrical filter 8 and the outer cylindrical filter 9, constituting the filament cooling cylinder 44, the outer cylindrical filter 9 may be formed of a porous plate of open area ratio 5 to 8%, while the inner cylindrical filter 8 may be formed of a porous filter having a lower open area ratio than the outer cylindrical filter 9. The cylindrical filters 8, 9, constituting the filament cooling cylinder 44, are preferably set to have a cooling wind blowout length of 80 to 100 mm when incorporated into the cooling wind supply box 15.

[0027] When the pressure loss in the filament cooling cylinder 44, having such a double structure, is defined as ΔP (kPa) and the flow rate of cooling winds per unit area is defined as Q (litter/min/cm²), the filament cooling cylinder 44 is preferably set to have a passing resistance $\Delta P/Q$ of 0.02 to 0.06. To accomplish this passing resistance, a wire mesh or a non-woven cloth may be incorporated between the inner cylindrical filter 8 and the outer cylindrical filter 9. When the passing resistance $\Delta P/Q$ is lower than 0.02, the static pressure and the air flow of cooling winds may not be uniform among the filament cooling cylinders 44 and within each filament cooling cylinder 44. Then, it is difficult to uniformly cool the filaments. On the other hand, if the passing resistance $\Delta P/Q$ is higher than 0.06, the pressure loss in the filament cooling cylinder 44 increases. Consequently, an insufficient air flow is blown into the filament cooling cylinder

44, thus hindering uniform cooling. If an attempt is made to blow a sufficient air flow of cooling winds into the filament cooling cylinder 44 while the pressure loss remains heavy, running costs may increase. This is economically disadvantageous.

[0028] Figure 7 shows essential parts of another embodiment of a melt spinning apparatus according to the present invention.

[0029] As in the case of the embodiment shown in Figures 1 and 2, previously described, the seal plate 5 is placed on the packing 21 at the top of the filament cooling cylinder 44, with the packing 20 placed on the top surface of the seal plate 5. The present embodiment differs from the above embodiment in that the packing 20 is not allowed to adhere directly to the bottom surface of the pack housing 33 but in that a firm seal is formed by using a seal ring 35 having an annular projecting portion 35a which projects downward and which cuts into the surface of the packing 20. The seal ring 35 also acts as a spacer. The seal ring 35 is formed on the bottom surface of the pack housing 33 so as to surround the installation hole in the spinning pack 2. The seal ring 35 is removably screwed into the bottom surface of the pack housing 33. The projecting portion 35a can be allowed to cut into the surface of the packing 20 by using the elevating and lowering device 13 to raise the protective cover 12.

[0030] Figure 8 shows essential parts of another embodiment of a melt spinning apparatus according to the present invention.

[0031] In the embodiment shown in Figure 8, the seal ring 35, having the annular projecting portion 35a projecting downward, is removably screwed into the bottom surface of the pack housing 33 as in the case of Figure 7. The seal ring 35 acts as a spacer. Further, the seal plate 5, placed on the packing 21 at the top of the filament cooling cylinder 44 in Figure 7, is replaced with an annular pot 37 in the embodiment shown in Figure 8. The pot 37 is filled with a fluid metal 43 acting as a seal material. Then, a seal is formed by immersing the annular projecting portion 35a of the seal ring 35 into the liquid metal 43.

[0032] The applicable liquid metal include a low-temperature solder, a fuse, or a low-melting-point material used in a fire hydrant, a high pressure reservoir safety plug, a dental material, a physical or chemical model, or the like.

[0033] Also in the present embodiment, the annular projecting portion 35a of the seal ring 35 can be immersed into the liquid metal 43 by using the elevating and lowering apparatus 13 to raise the protective cover 12.

[0034] Figure 9 shows essential parts of another embodiment of a melt spinning apparatus according to the present invention.

[0035] In the embodiment shown in Figure 9, the spinning pack 2 is installed so that its bottom portion projects below the bottom surface of the pack housing 33. Since

the bottom portion of the spinning pack 2 thus projects downward, a heater 4 is set around the projecting portion so as to maintain the surface temperature of the spinneret 3 at a predetermined value (spinning temperature $\geq$ the predetermined value $\geq$ spinning temperature - 10°C). The heater 4 is fixed to the bottom surface of the pack housing 33 via adiabatic packing 19. The packing 20 and seal ring 5, which are similar to those in the embodiment shown in Figures 1 and 2, are abutted against the bottom surface of the heater 4.

[Example]

[0036] The melt spinning apparatus shown in Figures 1 and 2 was used to subject polyethylene terephthalate to melt spinning while taking it off at a drawing speed of 2,800 m/min. Thus, a partly oriented non-drawn multifilament yarn of 82 dtex was obtained which was composed of 177 very thin filaments.

[0037] An Uster yarn unevenness measuring instrument manufactured by Zellweger Uster AG was used to measure the non-drawn multifilament yarn obtained for Uster unevenness U (%) under normal conditions. The measured value was 0.7%. Under a half inert condition, the Uster unevenness U was 0.3%. Both measured values were very small, indicating that the multifilament yarn obtained was uniform.

[0038] The partly oriented non-drawn multifilament yarn was textured by simultaneously drawing and false twisting. The yarn obtained was free from dyeing unevenness and was favorable in texturing.

[0039] As described above in detail, according to the melt spinning apparatus according to the present invention, the first seal mechanism is used to seal the top portion and bottom portion of each of the filament cooling cylinders from the top plate and bottom plate, respectively, of the integral cooling wind supply box, and the second seal mechanism is used to seal the top portion of the filament cooling cylinder from the bottom surface of the pack housing. Consequently, it is possible to allow only stable cooling winds having passed through the filament cooling cylinders to flow in to uniformly cool spun-out multifilaments. Further, since the second seal mechanism is used to seal the top portion of each filament cooling cylinder from the bottom surface of the pack housing, not from the spinning pack, the spun-out multifilaments can be reliably uniformly cooled without any seal leakage even if the mounting heights of the spinning packs are changed as a result of the replacement of the packs.

Claims

1. A melt spinning apparatus comprising a plurality of spinning packs installed in a pack housing contained in a spinning beam, the spinning packs being arranged in a line, an integral cooling wind supply

box provided below said plurality of spinning packs so as to be shared by the spinning packs, and filament cooling cylinders each comprising a cylindrical filter and provided inside the cooling wind supply box in association with said respective spinning packs, the apparatus being **characterized in that:**

a first seal mechanism is used to seal a top portion and a bottom portion of each of said filament cooling cylinders from a top plate and a bottom plate, respectively, of said cooling wind supply box, and a second seal mechanism is used to seal the top portion of the filament cooling cylinder from a bottom surface of said pack housing via a spacer.

2. A melt spinning apparatus according to Claim 1, **characterized in that** said spinning packs are arranged in a line in a staggered manner.
3. A melt spinning apparatus according to Claim 1, **characterized in that** said cylindrical filter comprises at least one of a porous plate, a wire mesh, a non-woven cloth, and a porous material.
4. A melt spinning apparatus according to Claim 3, **characterized in that** when a pressure loss of said filament cooling cylinder is defined as ΔP (kPa) and the flow rate of cooling winds per unit area is defined as Q (litter/min/cm²), a passing resistance $\Delta P/Q$ is set to be between 0.02 and 0.06.
5. A melt spinning apparatus according to any one of claims 1 to 4, **characterized in that** said second seal mechanism comprises a seal ring formed with an annular projecting portion projecting downward, and a ring-like packing, and the annular projecting portion of said seal ring is pressed against said packing.
6. A melt spinning apparatus according to any one of Claims 1 to 4, **characterized in that** said second seal mechanism comprises a seal ring formed with an annular projecting portion projecting downward, and a ring-like pot filled with a liquid metal, and the annular projecting portion of said seal ring is immersed into said liquid metal.
7. A melt spinning apparatus according to any one of Claims 1 to 6, **characterized in that** an annular heat insulating member is placed between said pack housing and said cooling spinning cylinders.
8. A melt spinning apparatus according to any one of Claims 1 to 7, **characterized in that** the apparatus is used for melt spinning of a very thin multifilament yarn of single filament size at most 0.55 dtex.

FIG. 1

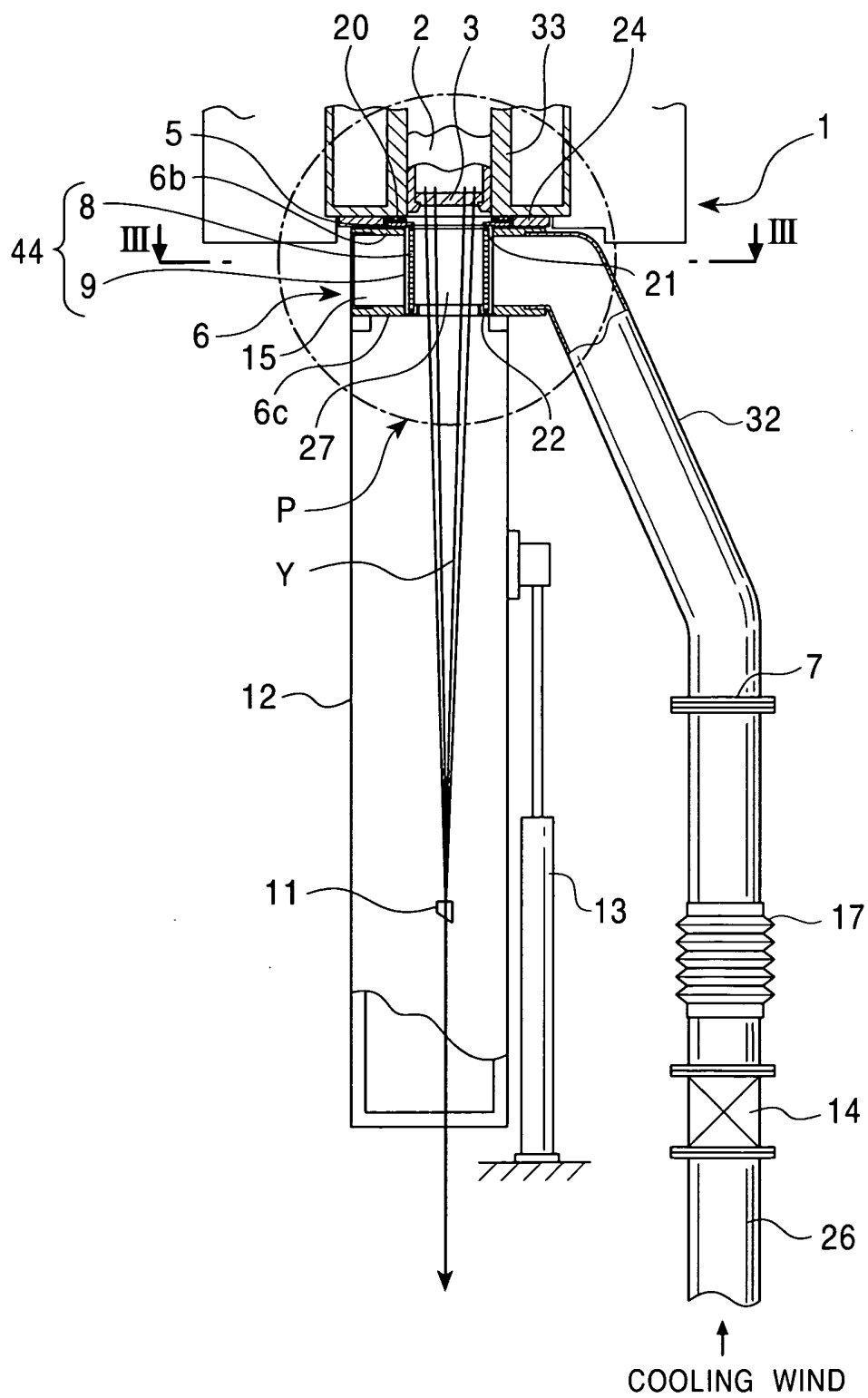


FIG. 2

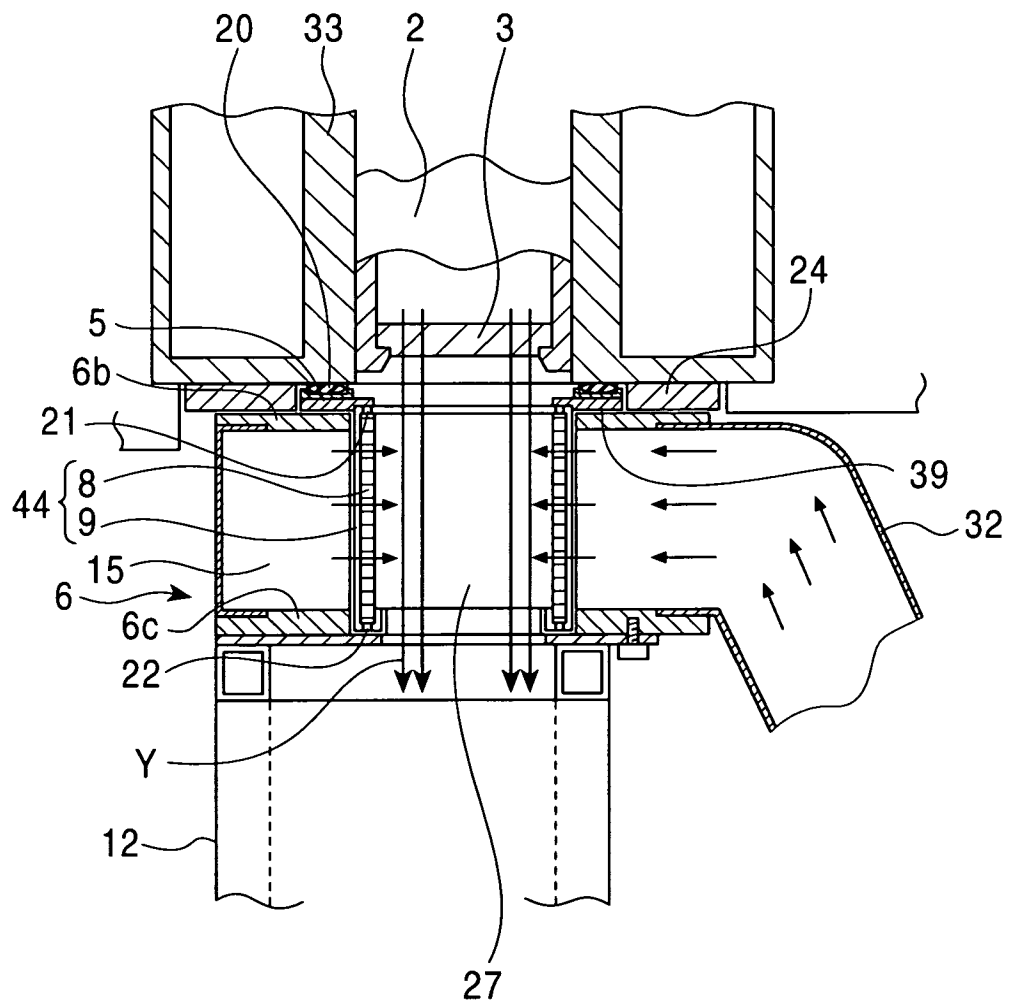


FIG. 3

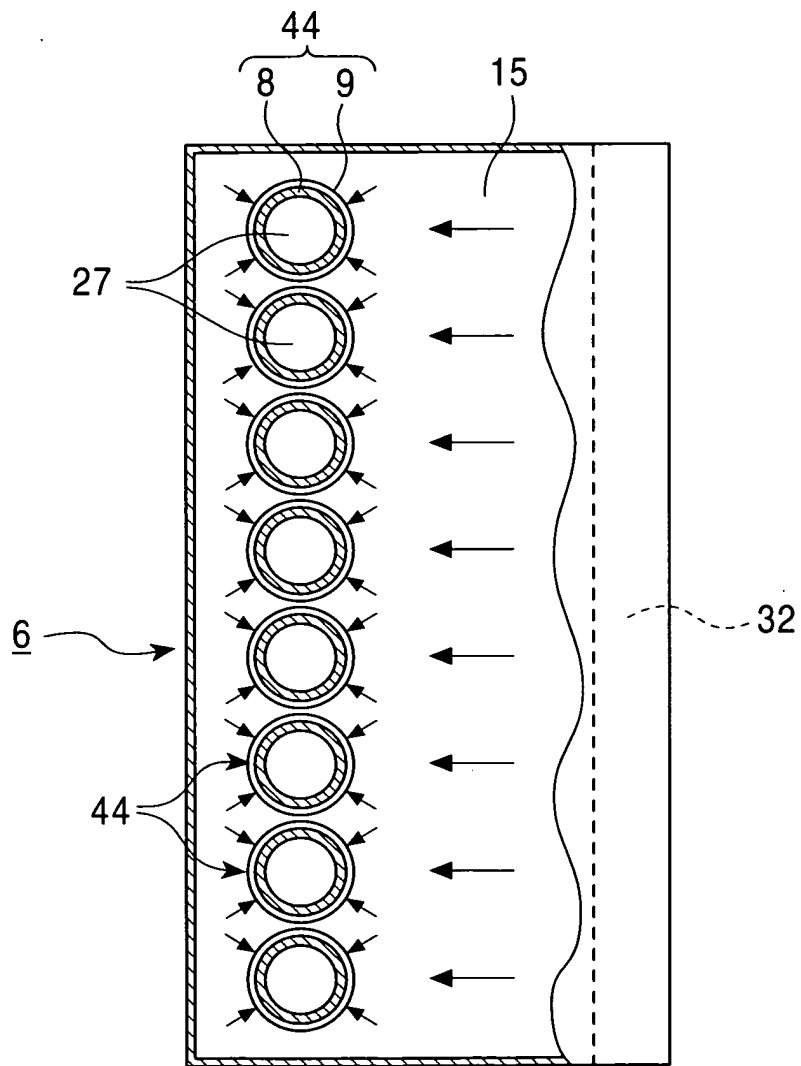


FIG. 4

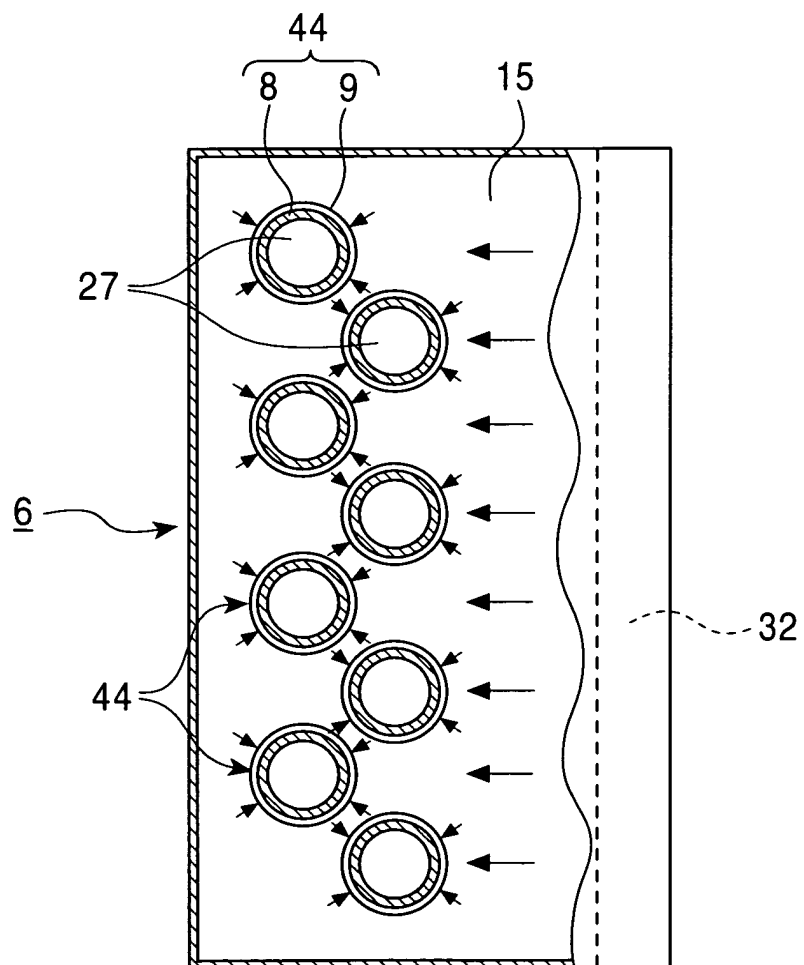


FIG. 5

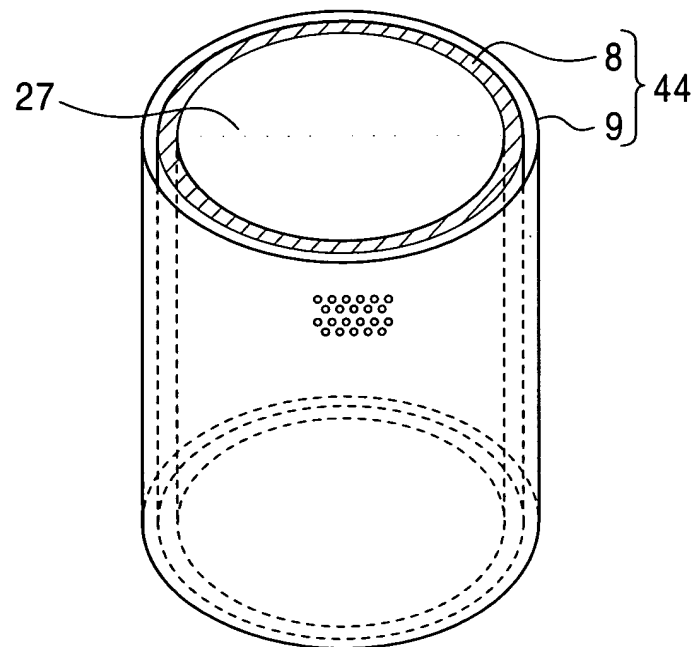


FIG. 6

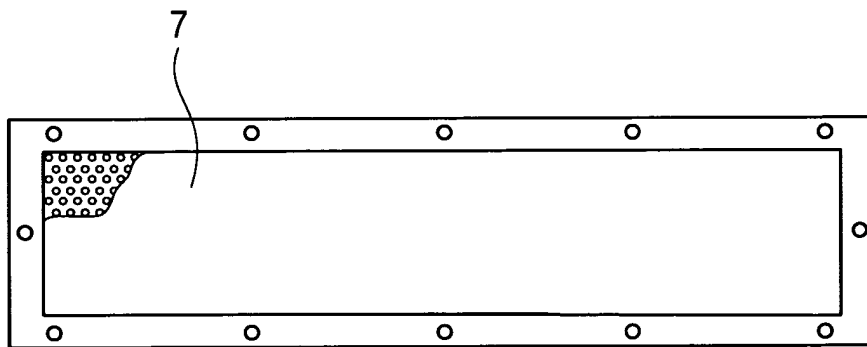


FIG. 7

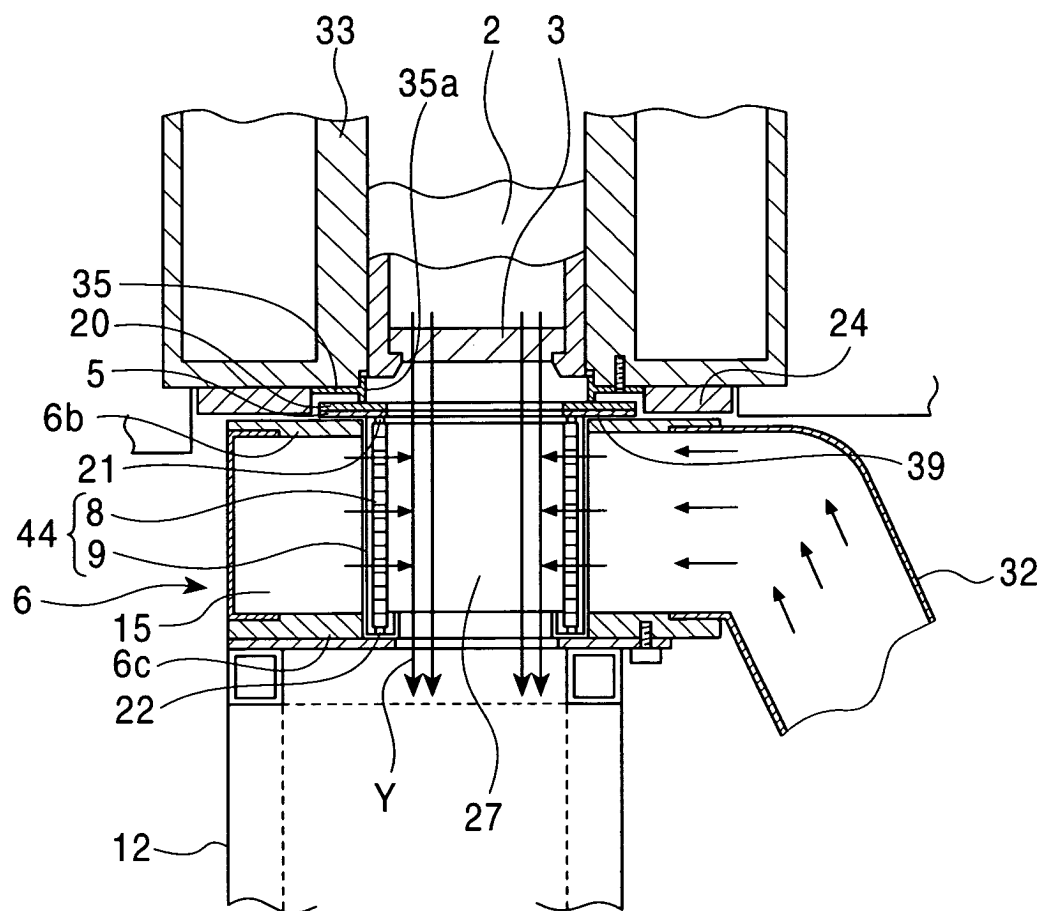


FIG. 8

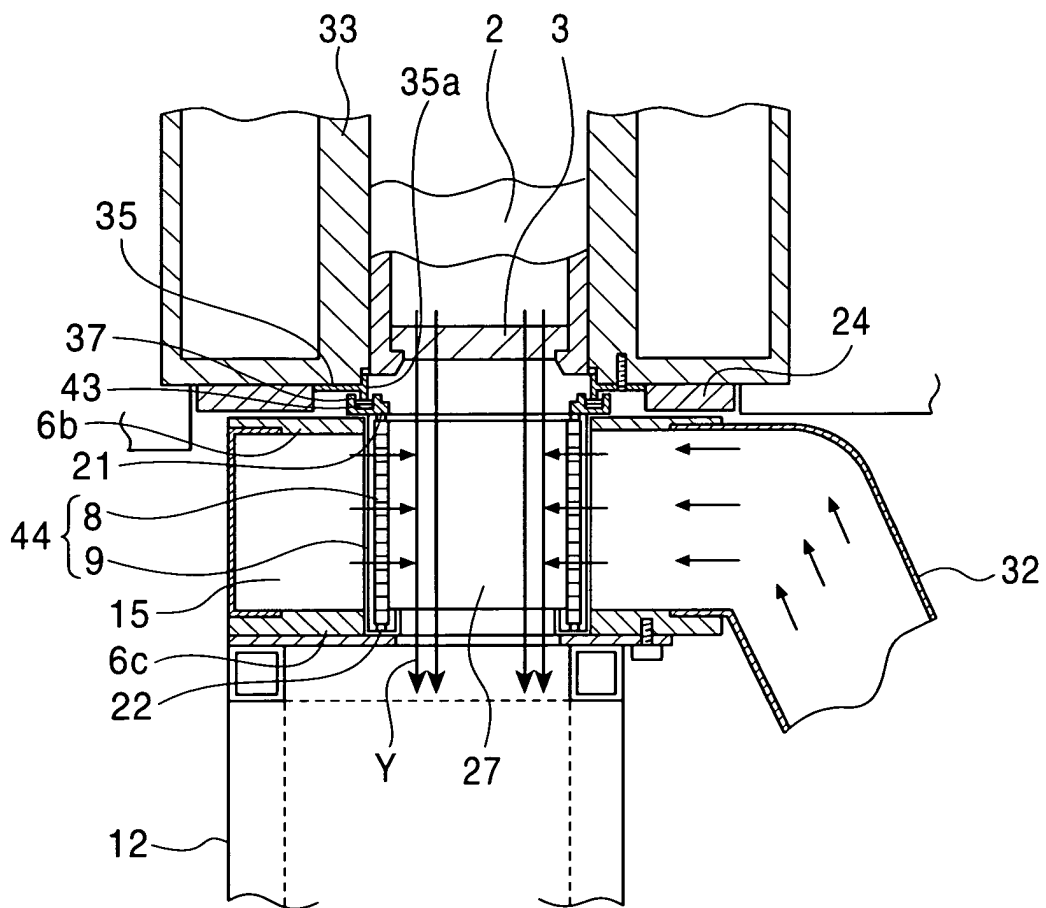
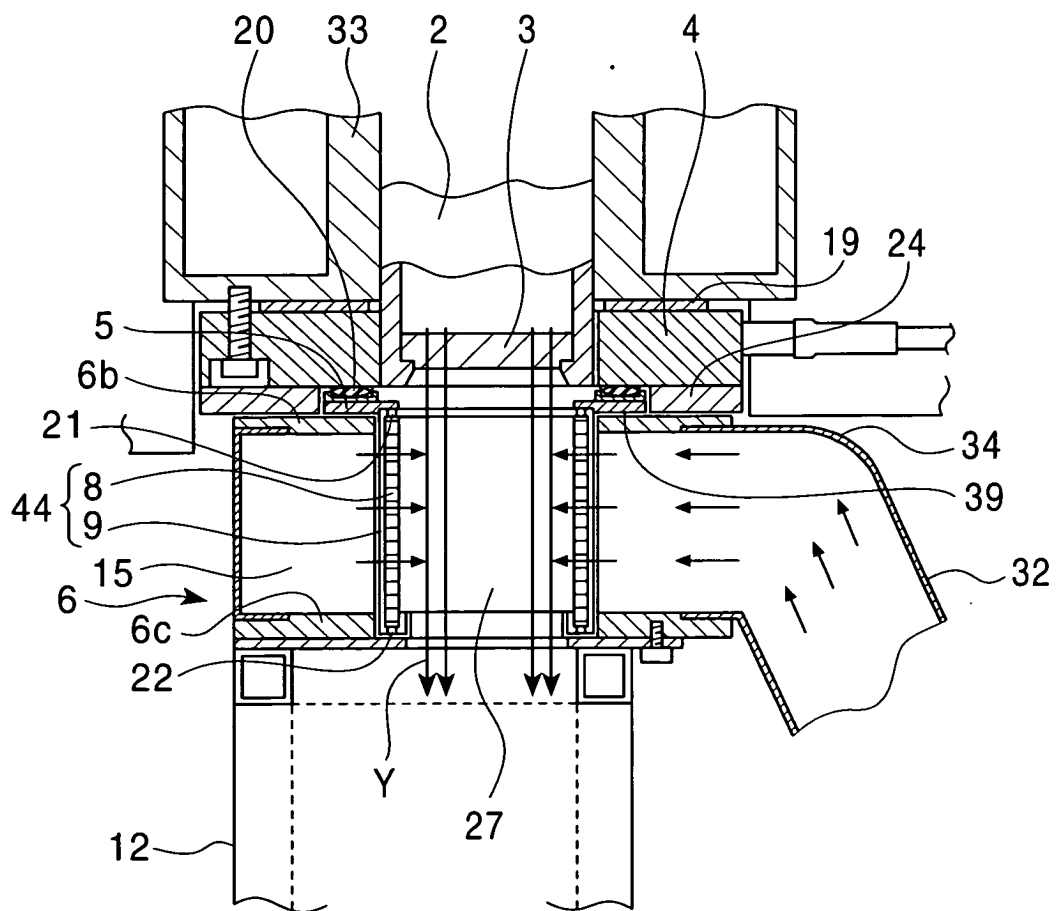


FIG. 9





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 01 7007

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,A	WO 01/79594 A (SCHULZ DETLEV ; BARMAG BARMER MASCHF (DE); FAULENBACH BERND (DE)) 25 October 2001 (2001-10-25) * the whole document *	1-8	D01D5/092 D01D5/08
A	US 4 681 522 A (LENK ERICH) 21 July 1987 (1987-07-21) * the whole document *	1-8	
A	GB 2 135 629 A (BARMAG BARMER MASCHF) 5 September 1984 (1984-09-05) * the whole document *	1-8	
A	US 3 257 487 A (DULIN JR GRADY N) 21 June 1966 (1966-06-21) * column 3, line 17 - line 21; figure 1 *	6	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			D01D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		3 December 2004	Tarrida Torrell, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 04 01 7007

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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03-12-2004

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 0179594	A	25-10-2001	AU 6587501 A	30-10-2001
			BR 0110103 A	07-01-2003
			CN 1404537 T	19-03-2003
			WO 0179594 A1	25-10-2001
			EP 1274887 A1	15-01-2003
			JP 2004501285 T	15-01-2004
			TW 500843 B	01-09-2002
			US 2003012835 A1	16-01-2003
US 4681522	A	21-07-1987	DE 3430847 A1	27-03-1986
			DE 3562280 D1	26-05-1988
			EP 0172556 A2	26-02-1986
GB 2135629	A	05-09-1984	CH 663222 A5	30-11-1987
			DE 3406347 A1	11-10-1984
			DE 3424253 A1	09-01-1986
			FR 2541692 A1	31-08-1984
			IT 1173352 B	24-06-1987
US 3257487	A	21-06-1966	BE 644707 A	01-07-1964
			DE 1435329 A1	30-01-1969
			FR 1385102 A	08-01-1965
			GB 1011644 A	01-12-1965
			NL 6402175 A	07-09-1964

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