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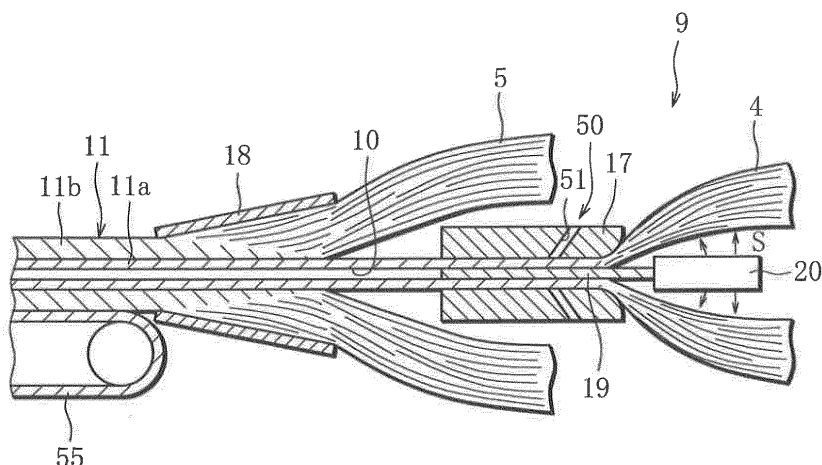
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(54) **METHOD FOR PRODUCING FILTER CIGARETTE, FILTER, AND FILTER CIGARETTE**

(57) A filter cigarette producing method includes a core forming fiber processing step of adding a plasticizer to core forming fibers (4) having a total fineness of 23000 denier to 70000 denier so as to attain an additive rate of 13% to 40%; a sheath forming fiber processing step of adding a plasticizer to sheath forming fibers (5) having a total fineness of 10000 denier to 47000 denier so as to attain an additive rate of 15% or less, or adding no plasticizer to the sheath forming fibers so as to attain an additive rate of 0%; a hollow filter forming step of forming a hollow filter (11) subsequent to the core forming fiber

processing step and the sheath forming fiber processing step in such a manner that the core forming fibers (4) are hardened into a core (11a) including a hole (10) extending from one end surface toward the other end surface, and an outside of the core (11a) is covered with the sheath forming fibers (5) so as to form a sheath (11b), thereby forming the hollow filter (11); and a post-treatment step of conveying the hollow filter (11) through a narrower section that is smaller than a diameter of the hollow filter (11), and greater than a diameter of the core (11a) subsequent to the hollow filter forming step.

FIG. 2



**Description****Technical Field**

5 [0001] The present invention relates to a filter cigarette producing method, a filter, and a filter cigarette.

**Background Art**

10 [0002] Widely known are filter producing machines that produce hollow filters where through holes are formed in their axial direction (see Patent Document 1, for example). A filter including such a through hole, compared to an ordinary filter, has a heavier weight of cellulose acetate tow, and also has a higher additive rate of a plasticizer added to the cellulose acetate tow. This configuration provides sufficient stiffness of the filter, and retains a through hole shape of the filter.

**Prior Art Document****Patent Document**

20 [0003] Patent Document 1: International Publication No. 2011/114440

**Summary of the Invention****Problems to be solved by the Invention**

25 [0004] Unfortunately, for convenience of production, each produced hollow filter is needed to be conveyed through a passage narrower than its filter diameter with the filter being squeezed in a post-treatment, such as a step of wrapping a tipping paper to connect the filter to a cigarette. At this time, the shape of the through hole may be deformed at end portions of the filter. Particularly, in a filter attaching apparatus for wrapping each filter with the tipping paper, there is provided a projection projecting toward the passage for the sake of triggering off rotation of the filters so that the filters are securely fed into the passage. Enhancement of conveyance speed of the filters due to improvement of producing performance in the apparatus raises a significant problem that causes deformation in shape of the through holes when the filters are passed through the above projection.

30 [0005] An object of the present invention, which has been made in order to solve the problems described above, is to provide a filter cigarette producing method, a filter, and a filter cigarette that are capable of reducing deformation in shape of a through hole of a hollow filter even if the hollow filter is pressed in a post-treatment step of producing a filter cigarette using the hollow filter.

**Means for Solving the Problems**

40 [0006] In order to achieve the above object, the present invention provides a filter cigarette producing method including: a core forming fiber processing step of adding a plasticizer to core forming fibers having a total fineness of 23000 denier to 70000 denier so as to attain an additive rate of 13% to 40%; a sheath forming fiber processing step of adding a plasticizer to sheath forming fibers having a total fineness of 10000 denier to 47000 denier so as to attain an additive rate of 15% or less, or adding no plasticizer to the sheath forming fibers so as to attain an additive rate of 0%; a hollow filter forming step of forming a hollow filter subsequent to the core forming fiber processing step and the sheath forming fiber processing step in such a manner that the core forming fibers are hardened into a core including a hole extending from one end surface toward the other end surface, and an outside of the core is covered with the sheath forming fibers so as to form a sheath, thereby forming the hollow filter; and a post-treatment step of conveying the hollow filter through a narrower section that is smaller than a diameter of the hollow filter, and greater than a diameter of the core subsequent to the hollow filter forming step.

50 [0007] The additive rate of the plasticizer (%) in the present specification is defined by a calculation formula: (weight of plasticizer/weight of tow (fibers)) x 100.

[0008] It is also defined as  $\text{denier (g/9000 m)} \times 0.1111 = \text{tex (g/1000 m)}$ .

55 [0009] It is preferable that the additive rate of the plasticizer relative to the core forming fibers be 13% to 35%, and the additive rate of the plasticizer relative to the sheath forming fibers be approximately 3% to 12%.

[0010] It is preferable that the post-treatment step include a filter attaching step of feeding the hollow filter and cigarettes through a rolling passage as the narrower section, the rolling passage being provided with a projection projecting inward of the rolling passage so as to trigger off rolling of the hollow filter and the cigarettes when the hollow filter and the

cigarettes are introduced into the rolling passage; and wrapping the hollow filter and the cigarettes with tipping paper in the rolling passage, thereby connecting the hollow filter and the cigarette to each other.

[0011] The present invention further provides a filter comprising: a cylindrical hollow filter including a hole extending from one end surface toward the other end surface; and an adsorbing filter continuously connected to the hollow filter in a longitudinal direction, wherein the hollow filter further includes: a core having the hole extending from one end surface toward the other end surface; and a sheath covering an outside of the core, a boundary line is present between the core and the sheath, the core has a total fineness of 23000 denier to 70000 denier, and an additive rate of a plasticizer of 13% to 40%, and the sheath has a total fineness of 10000 denier to 47000 denier, and an additive rate of the plasticizer of 0% to 15%.

[0012] The present invention further provides a filter comprising: a cylindrical hollow filter including a hole extending from one end surface toward the other end surface; and an adsorbing filter continuously connected to the hollow filter in a longitudinal direction, wherein the hollow filter further includes: a core member having the hole extending from one end surface toward the other end surface; and a sheath covering an outside of the core, a boundary line is present between the core and the sheath, the core has a hardness of 0 mm/10 or more and less than 5 mm/10, and the sheath has a hardness of 5 mm/10 or more and 10 mm/10 or less.

[0013] It is preferable that the core have a total fineness of 23000 denier to 70000 denier, and an additive rate of a plasticizer of 13% to 40%, and the sheath have a total fineness of 10000 denier to 47000 denier, and an additive rate of the plasticizer of 0% to 15%.

[0014] In addition, the present invention provides a filter cigarette comprising: the aforementioned filter; a cigarette formed by wrapping cut tobacco with cigarette paper; and tipping paper used for wrapping the filter and the cigarette in a manner as to connect the filter and the cigarette in a longitudinal direction.

### Advantageous Effects of the Invention

[0015] According to the present invention, it is possible to reduce deformation in shape of the through holes even if the hollow filters are pressed in the post-treatment step of producing the filter cigarettes using the hollow filters.

### Brief Description of the Drawings

[0016]

FIG. 1 is a schematic view of a filter cigarette producing machine.

FIG. 2 is a schematic view of a hole forming device.

FIG. 3 is a schematic view of a hollow filter.

FIG. 4 is a schematic sectional view of a filter cigarette.

FIG. 5 is a flow chart of a filter cigarette producing method.

FIG. 6 is a schematic view of a filter attaching apparatus.

FIG. 7 is a schematic view showing a section of a rolling passage included in the filter attaching apparatus.

FIG. 8 is a schematic view showing an example of a cross section of the hollow filter.

FIG. 9 is a schematic view showing an example of a cross section of the hollow filter.

FIG. 10 is a schematic view showing an example of a cross section of the hollow filter.

FIG. 11 is a schematic view showing an example of a cross section of the hollow filter.

FIG. 12 is a schematic view showing another example of the hollow filter.

FIG. 13 is a diagram explaining measurement of hardness of the hollow filter.

FIG. 14 is a diagram explaining a pressurizing test.

FIG. 15 is a table showing specifications of samples subjected to the pressurizing test.

FIG. 16 is a graph showing results of the pressurizing test.

### Mode for Carrying out the Invention

[0017] First, a filter cigarette producing machine 1 used for producing filters will be described. As shown in FIG. 1, the filter cigarette producing machine 1 includes a first and a second feed paths 2, 3 where core forming fibers 4 and sheath forming fibers 5 are continuously fed and travel in respective arrow directions in the drawing. The respective arrows along the feed paths 2, 3 in FIG. 1 indicate respective traveling directions of the core forming fibers 4 and the sheath forming fibers 5. At each starting end of the feed paths 2, 3, there is provided a tow bale 28 of a bunch of the core forming fibers 4 or a bunch of the sheath forming fibers 5 that are formed of, for example, cellulose acetate fibers. Each of the feed paths 2, 3 is guided by a guide 36 and a guide roller 6. A first fiber-opening and plasticizer-applying device 7 is provided in the first feed path 2. The first fiber-opening and plasticizer-applying device 7 opens the core forming fibers

4 traveling in the first feed path 2 using a conventional banding jet, a pair of pretension rollers, a pair of blooming rollers, and the like. A plasticizer is added to the opened core forming fibers 4 using a conventional jet spray or the like. A second fiber-opening and plasticizer-applying device 8 having the same function as that of the first fiber-opening and plasticizer-applying device 7 is provided in the second feed path 3 where the sheath forming fibers 5 travel.

**[0018]** The first and the second feed paths 2, 3 are connected to a hole forming device 9. The hole forming device 9 (see FIG. 2) will be described later. The hole forming device 9 produces an intermediate 54 for hollow filters, the intermediate 54 having a through hole 10 formed therein along its longitudinal direction. The intermediate 54 is fed through a conveyance path 12 to a paper wrapping device 13. Actually, the intermediate 54 is produced through a trumpet guide 18 provided at an inlet side of the paper wrapping device 13, but in the present specification, the trumpet guide 18 is treated as a part of the hole forming device 9 for convenience. The paper wrapping device 13 wraps the intermediate 54 with wrapping paper 30 (see FIG. 4) into a hollow filter rod (see FIG. 3). After the hollow filter rod 11 is cut into hollow filters 11 in the paper wrapping device 13, each hollow filter 11 and an adsorbing filter 31 for adsorbing components in smoke are wrapped together around their entire outer peripheries with forming paper 32 (see FIG. 4) in a state of being aligned in their longitudinal direction. The hollow filter 11 and the adsorbing filter 31 wrapped together with the forming paper 32 constitute a filter 22 (see FIG. 4), and then each filter 22 is conveyed to a filter attaching device 14 so as to be connected to a cigarette 16 through tipping paper 15. The hollow filter 11 may adsorb components in the smoke, or substantially may not adsorb the components in the smoke.

**[0019]** As described above, the intermediate 54 is produced in the hole forming device 9. As shown in FIG. 2, the hole forming device 9 includes a hole forming tube 17, the trumpet guide 18, and a mandrel 19. The mandrel 19 is supported at its one end by a support base 20, and extends from an inlet side for the core forming fibers 4 into the hole forming tube 17. The hole forming tube 17 has a hollow cylindrical shape, the trumpet guide 18 has a hollow cylindrical shape having an inlet side with an enlarged diameter, and the sheath forming fibers 5 are squeezed to be fed together with the core forming fibers 4 through the trumpet guide 18.

**[0020]** The core forming fibers 4 having passed through the first fiber-opening and plasticizer-applying device 7 are fed into the hole forming tube 17. The core forming fibers 4 are passed through a passage defined by the hole forming tube 17 and the mandrel 19, and then are heated in the hole forming tube 17 to be formed into a core 11a of a hollow cylindrical shape including a through hole 10 which is formed by the outer shape of the mandrel 19 and extends in the longitudinal direction of the mandrel 19.

**[0021]** The heating process is carried out by means of a heating device 50. The heating device 50 is provided as holes 51 extending through a peripheral wall of the hole forming tube 17, and steam is sent into the hole forming tube 17 through these holes 51. The heating device 50 encourages plasticization of the core forming fibers 4 to be hardened while the core forming fibers 4 are passed through the hole forming tube 17. A new heat source, such as microwaves, heated air, and heating wires, may be used instead of using the steam.

**[0022]** The hole forming tube 17 has a diameter gradually enlarged toward an inlet thereof for the sake of facilitating stable introduction of the core forming fibers 4. In the case of FIG. 2, the inlet of the hole forming tube 17 has a curved shape.

**[0023]** The plasticizer may be added from the inside of the core forming fibers 4 onto the fibers 4 before the core forming fibers 4 is introduced into the hole forming tube 17. For example, part of the support base 20 is formed as a spray nozzle to add the plasticizer therefrom (arrows S in FIG. 2). The plasticizer is supplied to a portion which is to become a surface of the through hole 10 by adding the plasticizer from the above position, thereby appropriately hardening the surface of the through hole 10. Such local addition of the plasticizer from the support base 20 enables sufficient hardening of the core forming fibers 4 even with a small amount of the plasticizer. The through hole 10 having the surface hardened in the above manner can be prevented from being crushed at the cross section of the hollow filter 11 when the hollow filter 11 is obtained by cutting.

**[0024]** The trumpet guide 18 having the same axis as that of the hole forming tube 17 is disposed on an outlet side of the hole forming tube 17. The core 11a formed by the hole forming tube 17 is delivered out as it is, and then is introduced into the trumpet guide 18. The sheath forming fibers 5 having passed through the second fiber-opening and plasticizer-applying device 8 are introduced into the trumpet guide 18. The sheath forming fibers 5 are passed through a passage formed by the trumpet guide 18 and the core 11a so as to be formed into a sheath 11b that covers the outside of the core 11a. Thereafter, the intermediate 54 is wrapped with the wrapping paper 30 on a garniture belt 55 to be formed into the hollow filter rod.

**[0025]** The wrapping paper 30 on the garniture belt 55 is not shown in FIG. 2 for convenience of showing the state of the sheath 11b covering the outside of the core 11a.

**[0026]** The hollow filter 11 formed in the above manner has a double structure having the core 11a as an inner tube and the sheath 11b as an outer tube, as shown in FIG. 3. The core 11a and the sheath 11b are clearly separated at a boundary line 21 in a cross section of the hollow filter 11. In the hollow filter 11 having an ordinary size, the diameter thereof may be 7.4 mm to 8.0 mm, and the diameter of the core 11a may be 4.6 mm to 5.2 mm. In the hollow filter 11 used for a slim-type cigarette, the diameter thereof may be 5.0 mm to 7.3 mm, and the diameter of the core 11a may be 2.4 mm to 4.7 mm. The core 11a for the hollow filter 11 whose diameter is 7.4 mm to 8.0 mm may have a diameter

of 2.4 mm to 4.7 mm. Such a hollow filter 11 is produced in the following producing method (see FIG. 5).

**[0027]** First, a core forming fiber processing step is carried out (step S1). The core forming fiber processing step is carried out by using the first fiber-opening and plasticizer-applying device 7. The total fineness of the core forming fibers 4 is set to be 23000 denier to 70000 denier (2555.3 tex to 7777 tex). The fibers may be formed of cellulose acetate fibers, etc. The core forming fibers 4 fed into the first feed path 2 are opened, and the plasticizer is added to the fibers at an additive rate of 13% to 40% (preferably 15 to 35%, most preferably 17 to 30%). This additive rate of the plasticizer is a value defined by the sum of addition of the plasticizer through the first fiber-opening and plasticizer-applying device and local addition of the plasticizer from the support base 20. Meanwhile, a sheath fiber processing step is carried out (step S2). The sheath forming fiber processing step is carried out by using the second fiber-opening and plasticizer-applying device 8. The total fineness of the sheath forming fibers 5 is set to be 10000 denier to 47000 denier (1888.7 tex to 2999.7 tex). The fibers may be formed of cellulose acetate fibers, etc. The sheath forming fibers 5 fed into the second feed path 3 are opened, and the plasticizer is added to the fibers at an additive rate of 15% or less (preferably 3 to 12%, most preferably 6 to 9%). Alternatively, no plasticizer may be added.

**[0028]** Then, a hollow filter forming step is carried out (step S3). The hollow filter forming step is carried out by using the hole forming device 9. In the hole forming device 9, as aforementioned, the core forming fibers 4 are formed into the core 11a in a cylindrical shape including the through hole 10 extending in its longitudinal direction, and the outer periphery of the core 11a is covered with the sheath forming fibers 5, thereby producing the sheath 11b; and this sheath 11b is wrapped with the wrapping paper 30 to be formed into the hollow filter rod, or the hollow filter 11.

**[0029]** The hollow filter 11 is subjected to a filter attaching step (step S4) as an example of a post-treatment step, and the filter attaching apparatus 14 used in this step will be described, herein. More specifically, the filter attaching device 14 shown in FIG. 6 is used for producing filter cigarettes 27 by using the hollow filters 11. Firstly, in the filter attaching apparatus 14, each filter plug 37 is placed between two cigarettes 16. The filter plug 37 has a length equivalent to two filters 22 with the adsorbing filters 31 located at both ends of the filter plug 37. In this manner, an intermediate product 25 of a double filter cigarette 49 is produced. Subsequently, the intermediate product 25 is so wrapped with the tipping paper 15 having adhesive on the surface thereof as to be formed into the double filter cigarette 49. The filter attaching apparatus 14 is provided with a conveyance path 39 defined by a first conveyance drum 38 and a second conveyance drum 23. More specifically, the conveyance path 39 for the intermediate product 25 is provided by rotation of the first conveyance drum 38 in a direction indicated by an arrow R1, and rotation of the second conveyance drum 23 in a direction indicated by an arrow R2. The conveyance path 39 is a path for conveying the intermediate products 25. The first conveyance drum 38 defines an upstream part of the conveyance path 39, and the second conveyance drum 23 defines a downstream part of the path 39.

**[0030]** The first conveyance drum 38 is also referred to as a swash plate drum. The second conveyance drum 23 is also referred to as a rolling drum. Each of the first conveyance drum 38 and the second conveyance drum 23 has a plurality of suction grooves (not shown) for sucking the intermediate products 25 in a manner as to partially accommodate the intermediate products 25 in the suction grooves. The intermediate products 25 are conveyed one by one with each intermediate product 25 being accommodated in each suction groove, along the peripheral direction of the first conveyance drum 38 and the second conveyance drum 23.

**[0031]** Meanwhile, a feed drum 40 rotating in a direction indicated by an arrow R3 is disposed adjacent to the first conveyance drum 38. The tipping paper 15 is distributed from the feed drum 40, and the leading edge of the tipping paper 15 adheres to the intermediate product 25 conveyed along the first conveyance drum 38. A guide member 24 is disposed adjacent to the second conveyance drum 23 along the peripheral direction of the second conveyance drum 23. The guide member 24 rolls each intermediate product 25 together with the second conveyance drum 23 in a manner as to wrap the intermediate product 25 with the tipping paper 15.

**[0032]** The filter attaching step (step S4) will be described as an example of the post-treatment step to actually wrap each intermediate product 25 with the tipping paper 15 by using the filter attaching apparatus 14 having the above structure. Each double cigarette DS produced to have a length equivalent to two cigarettes by a conventional means is cut into two cigarettes 16 during conveyance of the double cigarette DS (arrow F1 in FIG. 6). Subsequently, the two cigarettes 16 are separated in the axial direction thereof into respective cigarette rows (arrows F2 in FIG. 6). Then, the cigarette rows are fed to the first conveyance drum 38 (arrows F3 in FIG. 6).

**[0033]** The aforementioned filter plugs 37 are subjected to a grading processing in the conveyance direction, and then are aligned into one row; and subsequently, they are fed via an accelerating drum 41 rotating in a direction indicated by an arrow R4 to the first conveyance drum (swash plate drum) 38.

**[0034]** In the above cigarette rows, distance is secured between the cigarette rows so as to accept the filter plugs 37, and the cigarette rows are fed to the first conveyance drum 38 while retaining the distance. When the cigarette rows are fed to the first conveyance drum 38, two cigarettes of the cigarette rows are aligned with the corresponding filter plug 37. The first conveyance drum 38 is provided with a pair of floating discs (not shown) at both sides thereof, and the two cigarettes 16 are moved by the floating discs in the axial direction thereof to reduce distance between the two cigarettes 16 with the rotation of the first conveyance drum 38 being progressed. In this way, the intermediate product 25 of the

double filter cigarette including the filter plug 37 disposed between the two cigarettes 16 is produced.

**[0035]** Meanwhile, a web W of the tipping paper is fed out from a roll of the tipping paper not shown in the drawing (in a direction indicated by arrows E in FIG. 6). The web W is led to the feed drum (coke drum) 40. Adhesive (glue) is applied on one surface of the web W upstream of the feed drum 40. Specifically, an adhesive roller 42 is disposed upstream of the feed drum 40, and this adhesive roller 42 rotates with its half lower portion dipped in an adhesive solution 43. A transfer roller 44 is adjacently disposed above the adhesive roller 42, and the adhesive applied on an outer peripheral surface of the adhesive roller 42 is transferred to an outer peripheral surface of the transfer roller 44 at a predetermined thickness. The transfer roller 44 rotatably contacts the above one surface of the web W when the web W passes through the transfer roller 44, thereby applying the adhesive to the web W in accordance with a predetermined application pattern.

**[0036]** The feed drum 40 has a suction surface around its outer periphery, and rotates while holding the web W on the suction surface. A cutter drum 45 is disposed adjacent to the feed drum 40. The cutter drum 45 has a number of coke knives (not shown) on its outer periphery. These coke knives are arranged at regular intervals, and revolute synchronically with the feed drum 40 while the cutter drum 45 rotates. The web W is cut into each tipping paper 15 on the suction surface of the feed drum 40 with these rotating coke knives.

**[0037]** While being held by suction on the feed drum 40, each tipping paper 15 moves to be supplied to each intermediate product 25 on the first conveyance drum 38. A gap between the feed drum 40 and the first conveyance drum 38 is defined as a pasting passage 46. A leading edge of the tipping paper 15 adheres to an outer surface of the intermediate product 25, and then is conveyed together with the intermediate product 25 on the first conveyance drum 38. Each intermediate product 25 with the tipping paper 15 adhering thereon is transferred from the first conveyance drum 38 to the second conveyance drum (rolling drum) 23. A gap between the first conveyance drum 38 and the second conveyance drum 23 is defined as a delivery passage 47. The intermediate products 25 are conveyed between the second conveyance drum 23 and the guide member 24 while the second conveyance drum 23 rotates.

**[0038]** The guide member 24 extends along the rotational direction of the second conveyance drum 23. A rolling passage 26 for the intermediate products 25 is defined between the outer periphery of the second conveyance drum 23 and the guide member 24, and the rolling passage 26 is curved along the outer periphery of the second conveyance drum 23. When each intermediate product 25 passes through the rolling passage 26, each intermediate product 25 is wrapped with the tipping paper 15 to be produced into the double filter cigarette 49. Then, the double filter cigarette 49 is cut at a position of the hollow filter 11 to be produced into the filter cigarettes 27, each having the hollow filter 11 located at the mouthpiece end side thereof.

**[0039]** The conveyance path 39 includes a narrower section 48 (the pasting passage 46, the delivery passage 47, and the rolling passage 26, for example) that has a width narrower than the filter plug 37 conveyed as a part of the intermediate product 25, that is, the diameter of the hollow filter 11, and greater than the diameter of the core 11a. For example, the tipping paper 15 should be pasted to the intermediate product 25 while pressing the intermediate product 25 in the radial direction to some extent in the pasting passage 46; and the intermediate product 25 is sucked onto the drums 38, 23 through air suction, and thus the intermediate product 25 should be pressed in the radial direction to some extent in the delivery passage 47 in order to be securely delivered while preventing air leakage. In addition, the intermediate product 25 should also be rotatably pressed in the radial direction to some extent in the rolling passage 26 so as to be securely wrapped with the tipping paper 15. As described above, the conveyance path 39 requires the narrower section 48 for some purpose.

**[0040]** At an inlet of the guide member 24 as viewed in the conveyance direction, there is provided a projection 29 projecting into the rolling passage 26 for the sake of triggering off the rolling of the intermediate product 25. When passing through the rolling passage 26, the intermediate product 25 is wrapped with the tipping paper 15 adhering thereto to be formed into the double filter cigarette 49 with the hollow filter 11.

**[0041]** Each filter cigarette 27 with the hollow filter 11 includes the filter 22 having the hollow filter 11 disposed at the mouthpiece end of the filter 22, as shown in FIG. 4. The adsorbing filter 31 is continuously connected to the hollow filter 11 in the longitudinal direction of the hollow filter 11. The hollow filter 11 and the adsorbing filter 31 are each wrapped with the wrapping paper 30. The hollow filter 11 and the adsorbing filter 31 are further integrally wrapped with the forming paper 32 into one. The cigarette 16 is formed by wrapping cut tobacco 33 with cigarette paper 34. As aforementioned, the filter 22 and the cigarette 16 are integrally connected to each other through the tipping paper 15.

**[0042]** In the filter cigarette 27, the core 11a has a hardness of 0 mm/10 to 5 mm/10, and the sheath 11b has a hardness of 5 mm/10 to 10 mm/10. This means that the core 11a has a greater hardness, and the sheath 11b has a smaller hardness. The core 11a has a diameter smaller than the width of the narrower section. As a specific example, the post-treatment step is the filter attaching step using the filter attaching apparatus 14. The rolling passage 26 has an especially narrow width at a section where the projection 29 at the inlet of the rolling passage 26 is provided, and the diameter of the core 11a is further narrower than the width of the section in the conveyance passage where the projection 29 is disposed.

**[0043]** In this manner, the core 11a and the sheath 11b are configured to have different total finenesses and additive rates of the plasticizer from each other such that the core 11a becomes harder, and the sheath 11b becomes softer;

therefore, even if the sheath 11b is squeezed when passing through the above narrower section 48, the sheath 11b absorbs an external pressure in a manner as to reduce the pressure to be applied onto the core 11a. Accordingly, it is possible to reduce deformation in shape of the through hole 10. In addition, at least the core 11a has a smaller diameter than the width of the narrower section 48, which prevents the through hole 10 from being directly squeezed. For example,

as shown in FIG. 7, when the hollow filter 11 passes through the rolling passage 26 (the narrower section 48) having a narrower width than the diameter of the intermediate product 25, that is, the hollow filter 11, the sheath 11b is directly squeezed, but the core 11a is not directly squeezed.

**[0044]** This effect is particularly exerted when the intermediate product 25 passes through the projection 29 disposed at the inlet of the rolling passage 26 in the filter attaching apparatus 14. This is because the inlet has an especially narrow width in the narrower section 48 that is narrower than the diameter of the hollow filter 11. The core 11a and the sheath 11b are clearly separated at the boundary line 21 in the cross sectional view of the hollow filter 11. Accordingly, compared to a structure having so-called gradational layers in which the core forming fibers 4 and the sheath forming fibers 5 are mixed, and a proportion between the core forming fibers 4 and the sheath forming fibers 5 is gradually changed in the radial direction of the hollow filter 11, the present structure blocks an external pressure at the boundary line 21, thereby effectively preventing the core 11a from the external pressure, which facilitates production of the filters having the same quality.

**[0045]** An excessively great amount of the plasticizer added to the core 11a may cause a sharp smell of the plasticizer. An excessively small amount of the plasticizer may hinder satisfactory formation, so that fuzz is likely to be caused on the surface of the through hole, which makes it hard to retain the shape of the through hole. An excessively small total fineness is likely to cause a factor of hole defects or the like when the fibers are formed into the core 11a. An excessively great total fineness makes it hard to insert the fibers into the first hole forming tube 17, which hinders uniform application of the plasticizer. It should be noted that the core 11a becomes harder as the values of the additive rate of the plasticizer and the total fineness become greater, and the core 11a becomes softer as the values of the additive rate of the plasticizer and the total fineness become smaller. Excessive softness of the core 11a causes the fuzz, which makes it hard to retain the shape of the through hole. Taking these facts into account, it is preferable to make the core forming fibers 4 used for forming the core 11a to have a total fineness of 23000 denier to 70000 denier, further preferably 26000 denier to 60000 denier, and most preferably 30000 denier to 50000 denier. It is preferable to make the core forming fibers 4 to have an additive rate of the plasticizer of 13% to 40%, further preferably 15% to 35%, and most preferably 17% to 30%. In addition, it is preferable to make the core 11a to have a hardness of 0 mm/10 or more and less than 5 mm/10 using the above total fineness and additive rate of the plasticizer.

**[0046]** On the other hand, an excessively great amount of the plasticizer added to the sheath 11b may cause a sharp smell of the plasticizer. An excessively small total fineness is likely to result in a smaller diameter of the hollow filter 11 than a desired value when the sheath 11b are formed. An excessively great total fineness is likely to result in a greater diameter of the hollow filter 11 than a desired value. It should be noted that the core 11a becomes harder as the values of the additive rate of the plasticizer and the total fineness become greater, and the core 11a becomes softer as the values of the additive rate of the plasticizer and the total fineness become smaller. Excessive softness of the sheath 11b makes it hard to retain the position of the core at a desired position, which is likely to cause fuzz on a cut surface thereof. Excessive hardness of the sheath 11b hinders sufficient absorption of the external pressure during passing through the conveyance passage having a narrower width, and makes the filter surface excessively hard when the sheath 11b is formed into the filter 22, which results in unfavorable feeling of the filter when a user holds the filter in his or her mouth. Taking these facts into account, it is preferable to make the core forming fibers 4 used for forming the sheath 11b to have a total fineness of 10000 denier to 47000 denier, further preferably 10000 denier to 40000 denier, and most preferably 12000 denier to 30000 denier. It is preferable to make the sheath 11b to have an additive rate of the plasticizer of 0% to 15%, further preferably 3% to 12%, and most preferably 6% to 9%. In addition, it is preferable to make the sheath 11b to have a hardness of 5 mm/10 or more and 10 mm/10 or less using the above total fineness and additive rate of the plasticizer.

**[0047]** As shown in FIG. 8, the through hole 10 and the core 11a have circular cross sections, both of which are defined by concentric circles around the axis of the hollow filter 11. As other examples, as shown in FIG. 9, the center of the through hole 10 may deviate from the axis of the hollow filter 11. The through hole 10 may have a cross section in a star shape as shown in FIG. 10. Alternatively, various shapes, such as a cross shape and a heart shape, may also be used although not shown in the drawing. As shown in FIG. 11, the core 11a may have a rectangular cross section. Alternatively, any polygon, such as a triangle, may also be used although not shown in the drawing. Meanwhile, the through hole 10 has been exemplified as a hole formed in the core 11a with reference to FIG. 3, but the hole formed in the core 11a may not always be a through hole as far as the hole extends from one end surface toward the other end surface thereof. For example, as shown in FIG. 12, in the case of cutting the hollow filter 11 at a cutting line C, there may be formed holes 35 extending from one end surface of the hollow filter 11 to the half way of the other end surface. In the hollow filter 11 including the hole 35, it is also possible to prevent crush, deformation or the like of the hole 35. The hole 35 may be formed by introducing the core forming fibers 4 into the hole forming tube through insertion and pull-out of the mandrel

19 in the hole forming device 9.

[0048] A pressurizing test was conducted on the hollow filter 11 shown in FIG. 3 as an example, and on a conventional filter including a through hole without the core 11a and the sheath 11b as a comparative. The pressurizing test was carried out on tree hollow filters 11: Sample 1 to Sample 3 as the example, and tree filters: Sample 4 to Sample 6 as the comparative. In each of Samples 1 to 3 of the example, each core was set to have a single fiber fineness of 4.0 denier, the total fineness of 40000 denier, and the additive rate of the plasticizer of 17%. Each sheath was set to have a single fiber fineness of 8.0 denier, a total fineness of 15000 denier, and an additive rate of the plasticizer of 6%. In each of Samples 4 to 6 of the comparative, only fibers were used that had a single fiber fineness of 5.0, a total fineness of 47000 denier, and an additive rate of the plasticizer of 19%. Cellulose acetate fibers were used for each core of the example, each sheath of the example, and the comparative. Each hardness of the cores and the sheaths of Sample 1 to Sample 3, and each hardness of Sample 4 to Sample 6 are as shown in FIG. 15. Each sheath of Sample 1 to Sample 6 was wrapped with wrapping paper having air permeability of 10000 CORESTA units, and a basis weight of 24.0 g/m<sup>2</sup>. [0049] The above hardness denotes hardness defined by the following method.

[0050] Cylindrical filters, each having a length of 112 mm and an approximately constant diameter along its entire length were prepared as filters for measurement M.

[0051] Next, each filter for measurement M was placed on a stage 56 as shown in FIG. 13, and a pressing member 53 having a diameter of 15 mm was brought into contact with the filter for measurement M from above the filter for measurement M so as to pressurize the filter for measurement M at a weight of 300 g for 10 seconds (in a direction indicated by an arrow L in FIG. 13).

[0052] Hardness (mm/10) is defined by the following formula, where h1(mm) denotes a distance between an upper surface of the stage 56 and a pressing surface of the pressing member 53 when the pressing member 53 was brought into contact with the filter for measurement without applying the weight of 300 g; and h2 (mm) denotes a distance between the upper surface of the stage 56 and the pressing surface of the pressing member 53 when the filter for measurement was pressurized for 10 seconds.

$$\text{Hardness (mm/10)} = (h1 - h2) \times 10$$

[0053] In measurement of the hardness of each hollow filter including a sheath and a core, the hardness of each sheath was measured by using filters each having the core, the sheath, and wrapping paper as the filters for measurement M (the wrapping paper, and the boundary line between the core and the sheath are not shown); the hardness of each core was measured by using filters each including only a core as the filters for measurement M.

[0054] As shown in FIG. 14, the testing method was such that each hollow filter 11 (the wrapping paper 30 is omitted in the drawing) of Sample 1 to Sample 3, which had a diameter of approximately 7.6 mm, a core diameter of approximately 5.0 mm, and a length of approximately 84 mm, was held between two metal plates 52, and the hollow filter 11 was pressurized until a distance between the two metal plates 52 became 6.0 mm. In this test, respective shapes of a through hole of each filter before the pressurizing, during the pressurizing, and after the pressurizing (immediately after the pressurizing) were photographed for the purpose of measuring a distortion rate of a hole diameter in each filter. Specifically, of a diameter in the horizontal direction and a diameter in the vertical direction in a cross section of each through hole, a longer diameter having a longer length was defined as A, a shorter diameter having a shorter length was defined as B, and then the distortion rate (A/B) was calculated. An average value of this rate was also calculated for each sample. A smaller distortion rate indicates that the shape of the through hole is better retained against an external pressure. The same pressurizing test was conducted in the same manner on Sample 4 to Sample 6 that are the filters of the comparative.

[0055] As shown in FIG. 15, the results were such that the average value of the distortion rate before the pressurizing was 1.02 in each Sample of the example and the comparative. The average value of the distortion rate during the pressurizing was 1.22 in the example, and 2.07 in the comparative, which indicates that the shape of the through hole was better retained in the example than that in the comparative. The average value of the distortion rate after the pressurizing was 1.03 in the example, and 1.29 in the comparative, which also indicates that the shape of the through hole was better retained in the example. These results are represented in a graph in FIG. 16, where the example has smaller distortion rates both during and after the pressurizing.

## Explanation of Reference Signs

[0056]

- 1 filter cigarette producing machine
- 2 first feed path



	3	second feed path
	4	core forming fiber
	5	sheath forming fiber
	6	guide roller
5	7	first fiber-opening and plasticizer-applying device
	8	second fiber-opening and plasticizer-applying device
	9	hole forming device
	10	through hole
	11	hollow filter
10	11a	core
	11b	sheath
	12	conveyance path
	13	paper wrapping device
	14	filter attaching apparatus
15	15	tipping paper
	16	cigarette
	17	hole forming tube
	18	trumpet guide
	19	mandrel
20	20	support base
	21	boundary line
	22	filter
	23	second conveyance drum
	24	guide member
25	25	intermediate product
	26	rolling passage
	27	filter cigarette
	28	tow bale
	29	projection
30	30	wrapping paper
	31	adsorbing filter
	32	forming paper
	33	cut tobacco
	34	cigarette paper
35	35	hole
	36	guide
	37	filter plug
	38	first conveyance drum
	39	conveyance path
40	40	feed drum
	41	accelerating drum
	42	adhesive roller
	43	adhesive solution
	44	transfer roller
45	45	cutter drum
	46	pasting passage
	47	delivery passage
	48	narrower section
	49	double filter cigarette
50	50	heating device
	51	hole
	52	plate
	53	pressing member
	54	intermediate
55	55	garniture belt
	56	stage

**Claims****1.** A filter cigarette producing method comprising:

5 a core forming fiber processing step of adding a plasticizer to core forming fibers having a total fineness of 23000 denier to 70000 denier so as to attain an additive rate of 13% to 40%;  
 a sheath forming fiber processing step of adding a plasticizer to sheath forming fibers having a total fineness of 10000 denier to 47000 denier so as to attain an additive rate of 15% or less, or adding no plasticizer to the  
 10 sheath forming fibers so as to attain an additive rate of 0%;  
 a hollow filter forming step of forming a hollow filter subsequent to the core forming fiber processing step and the sheath forming fiber processing step in such a manner that the core forming fibers are hardened into a core including a hole extending from one end surface toward the other end surface, and an outside of the core is covered with the sheath forming fibers so as to form a sheath, thereby forming the hollow filter; and  
 15 a post-treatment step of conveying the hollow filter through a narrower section that is smaller than a diameter of the hollow filter, and greater than a diameter of the core, subsequent to the hollow filter forming step.

**2.** The filter cigarette producing method according to claim 1, wherein  
 the additive rate of the plasticizer relative to the core forming fibers is 13% to 35%, and the additive rate of the plasticizer relative to the sheath forming fibers is 3% to 12%.**3.** The filter cigarette producing method according to claim 1, wherein  
 the post-treatment step includes a filter attaching step of:

25 feeding the hollow filter and cigarettes through a rolling passage as the narrower section, the rolling passage being provided with a projection projecting inward of the rolling passage so as to trigger off rolling of the hollow filter and the cigarettes when the hollow filter and the cigarettes are introduced into the rolling passage; and  
 wrapping the hollow filter and the cigarettes with tipping paper in the rolling passage, thereby connecting the hollow filter and the cigarettes to each other.

**4.** A filter comprising:

a cylindrical hollow filter including a hole extending from one end surface toward the other end surface; and  
 an adsorbing filter continuously connected to the hollow filter in a longitudinal direction;  
 wherein  
 35 the hollow filter further includes a core having the hole extending from one end surface toward the other end surface, and a sheath covering an outside of the core,  
 a boundary line is present between the core and the sheath,  
 the core has a total fineness of 23000 denier to 70000 denier, and an additive rate of a plasticizer of 13% to 40%, and  
 40 the sheath has a total fineness of 10000 denier to 47000 denier, and an additive rate of the plasticizer of 0% to 15%.

**5.** A filter comprising:

45 a cylindrical hollow filter including a hole extending from one end surface toward the other end surface; and  
 an adsorbing filter continuously connected to the hollow filter in a longitudinal direction;  
 wherein  
 the hollow filter further includes a core having the hole extending from one end surface toward the other end surface, and a sheath covering an outside of the core,  
 50 a boundary line is present between the core and the sheath,  
 the core has a hardness of 0 mm/10 or more and less than 5 mm/10, and  
 the sheath has a hardness of 5 mm/10 or more and 10 mm/10 or less.

**6.** The filter according to claim 5, wherein

55 the core has a total fineness of 23000 denier to 70000 denier, and an additive rate of a plasticizer of 13% to 40%, and  
 the sheath has a total fineness of 10000 denier to 47000 denier, and an additive rate of the plasticizer of 0% to 15%.

**7.** A filter cigarette comprising:

## EP 2 893 820 A1

the filter according to claim 5;  
a cigarette formed by wrapping cut tobacco with cigarette paper; and  
tipping paper used for wrapping the filter and the cigarette in a manner as to connect the filter and the cigarette  
in a longitudinal direction.

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FIG. 1

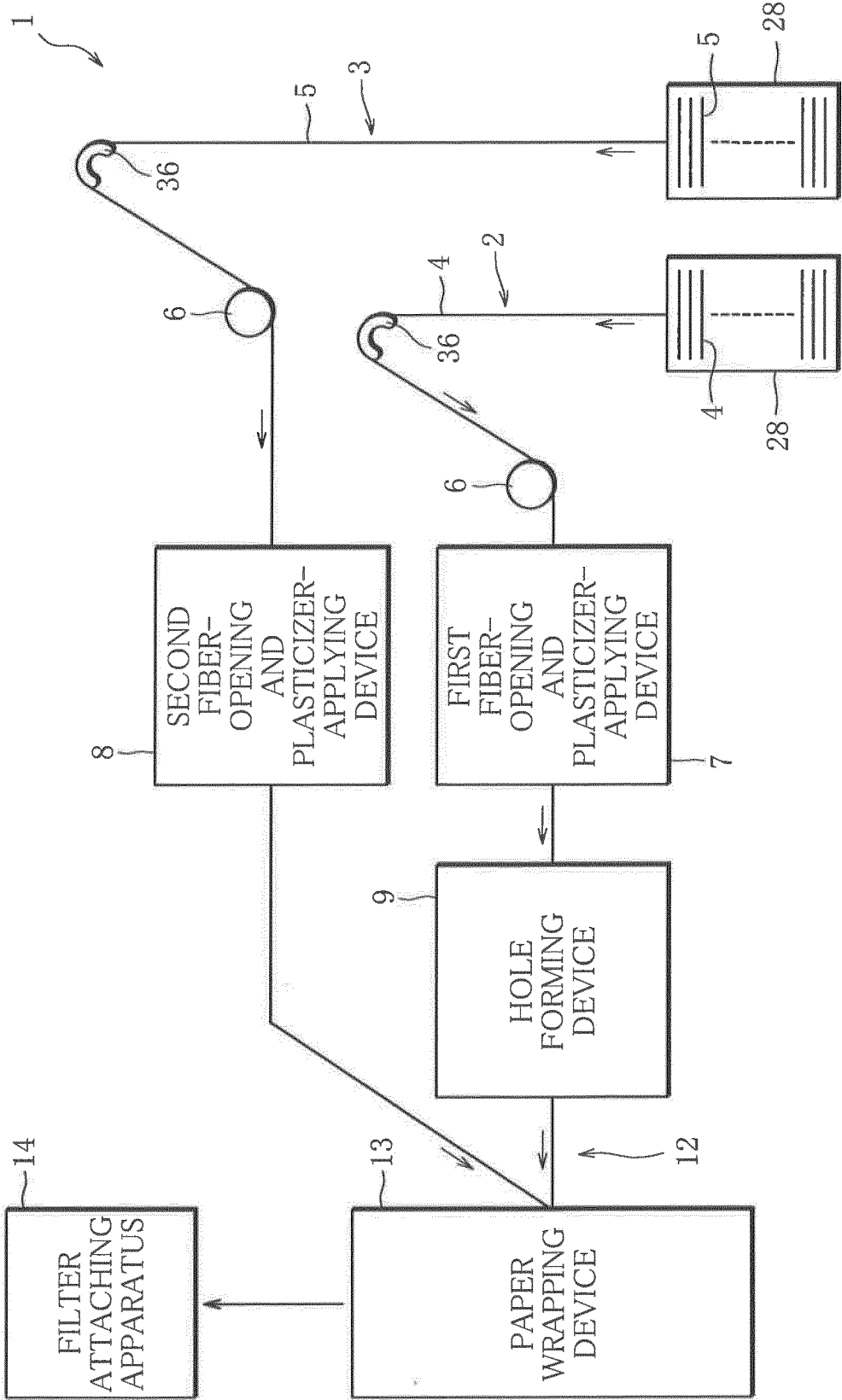


FIG. 2

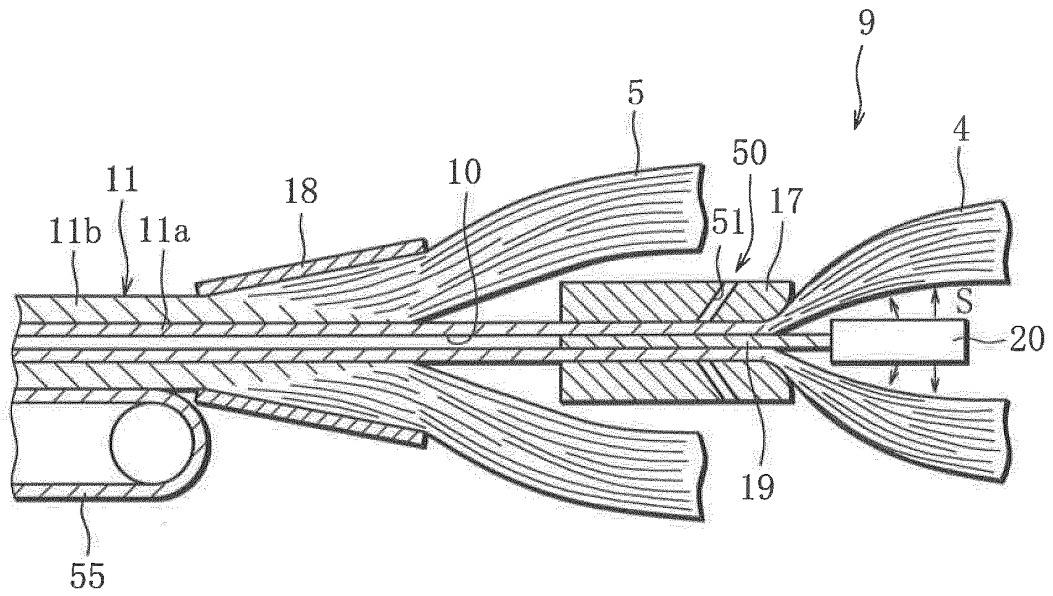


FIG. 3

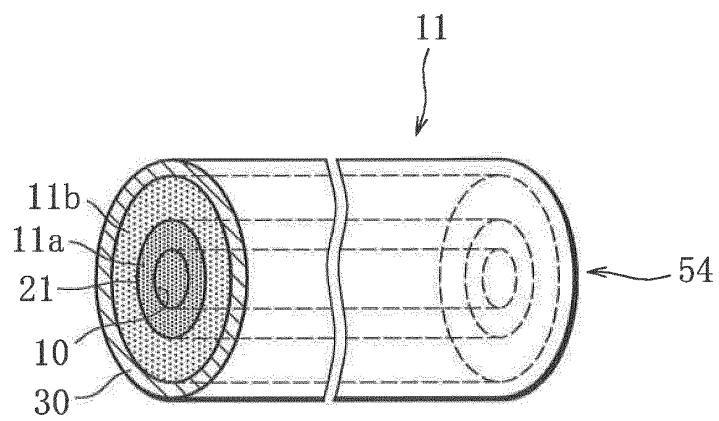


FIG. 4

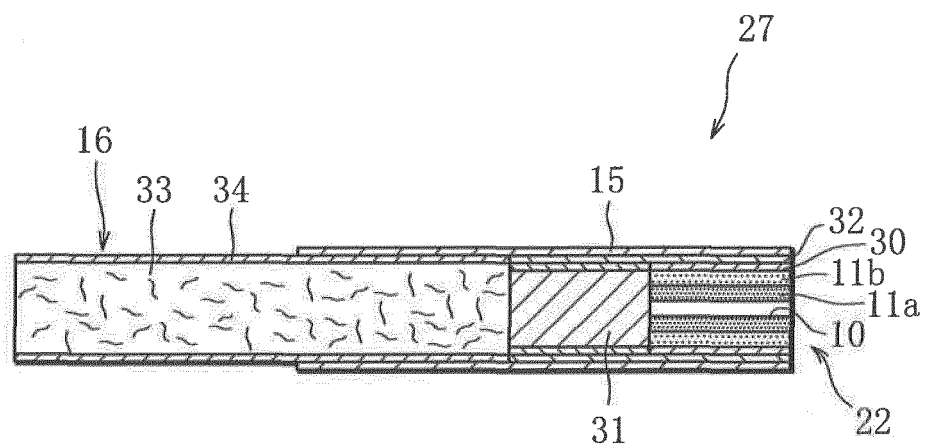


FIG. 5

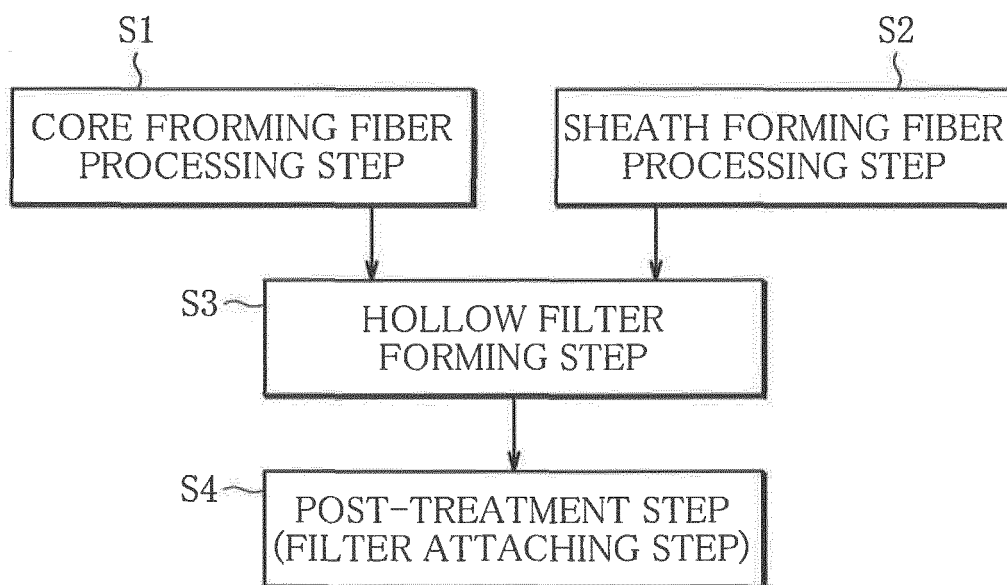


FIG. 6

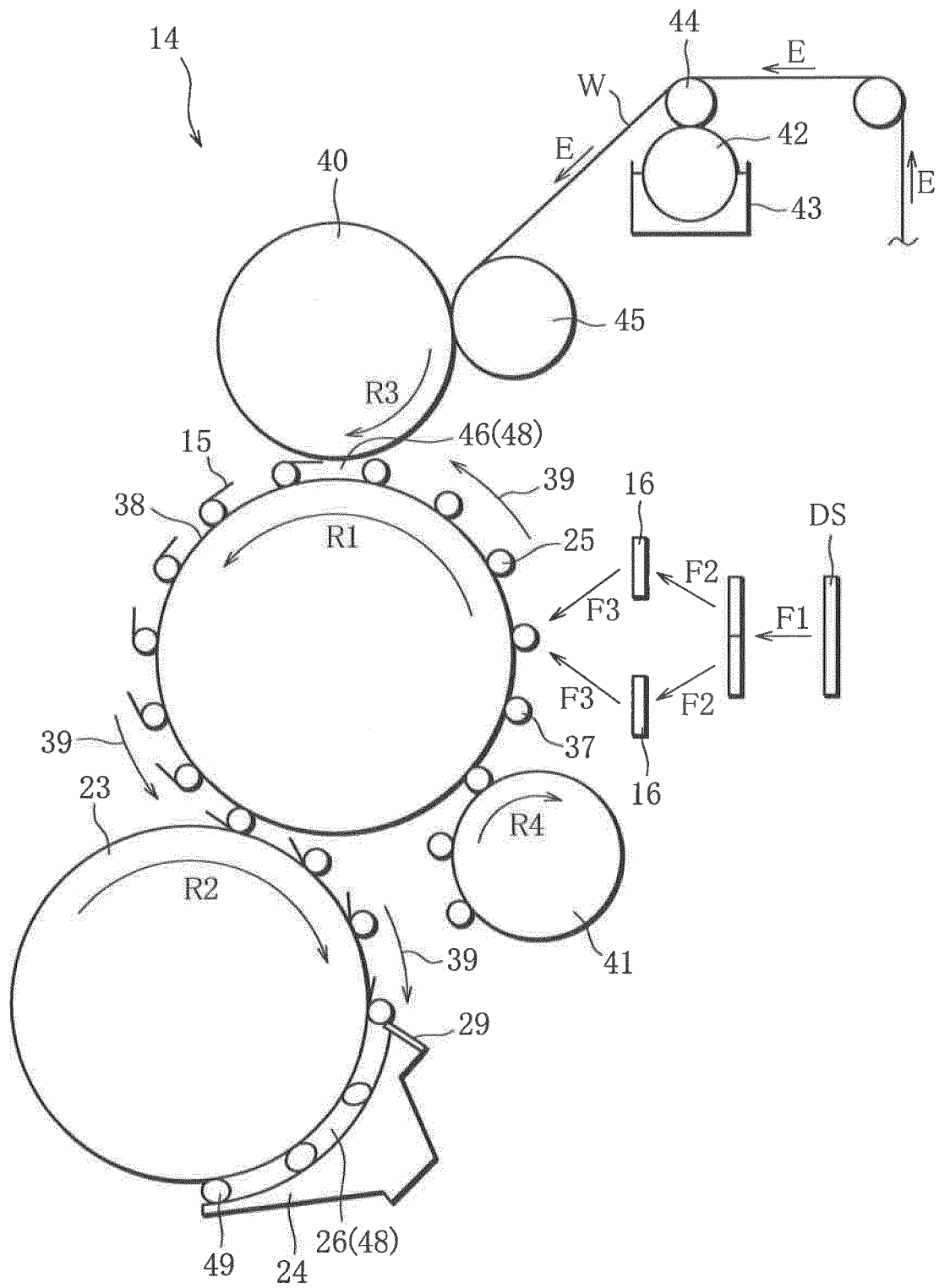


FIG. 7

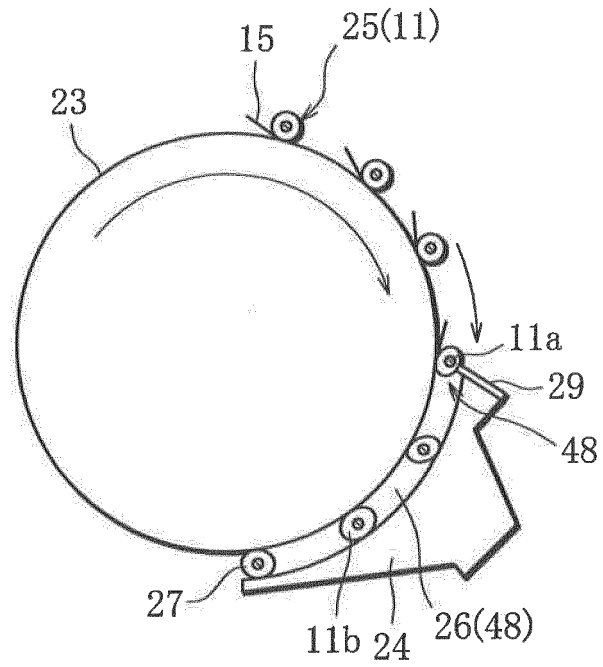


FIG. 8

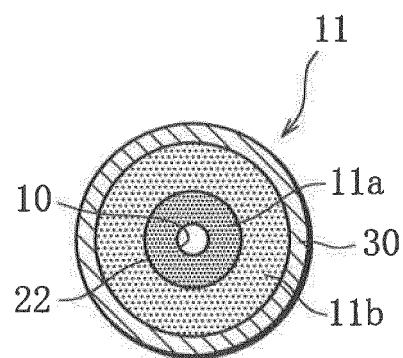




FIG. 9

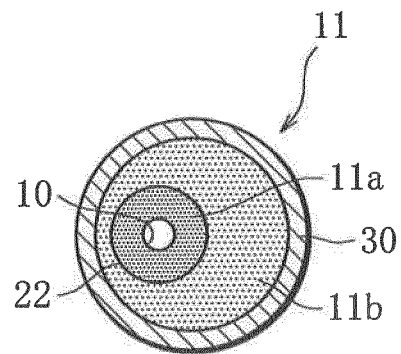


FIG. 10

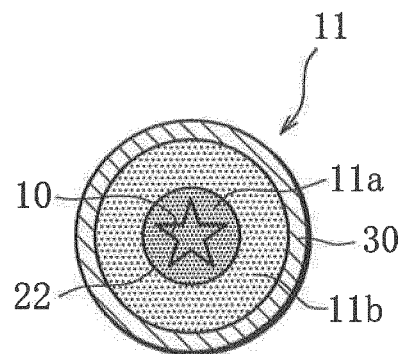


FIG. 11

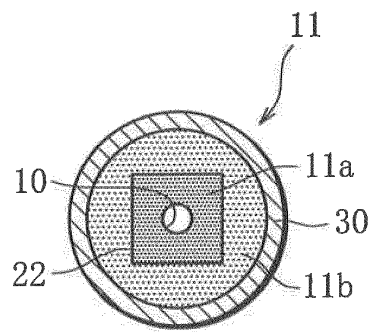


FIG. 12

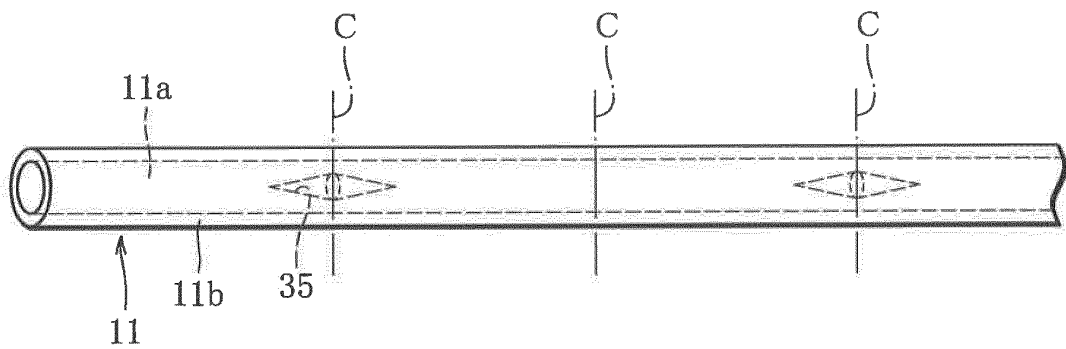


FIG. 13

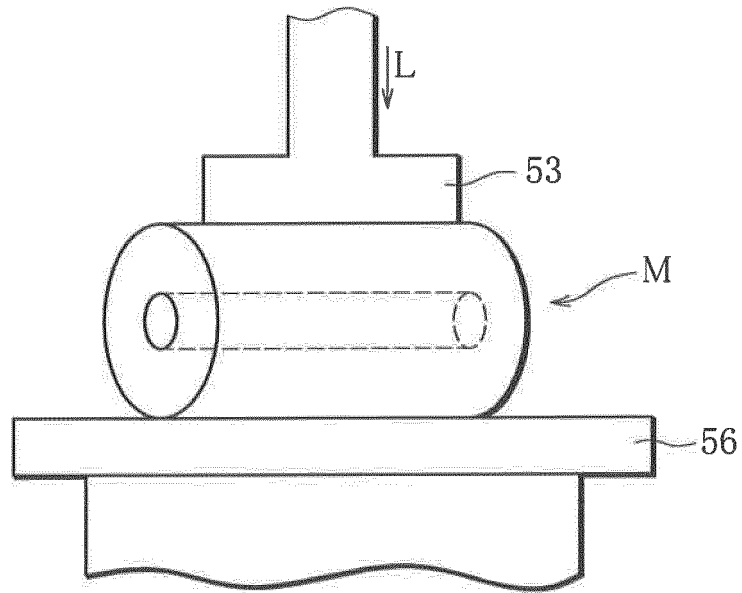


FIG. 14

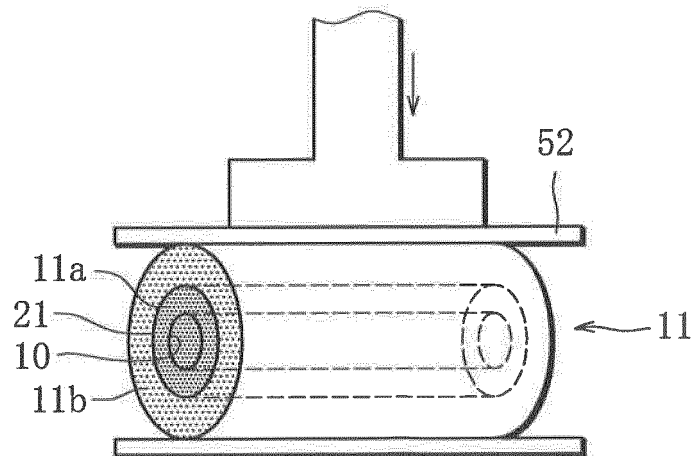
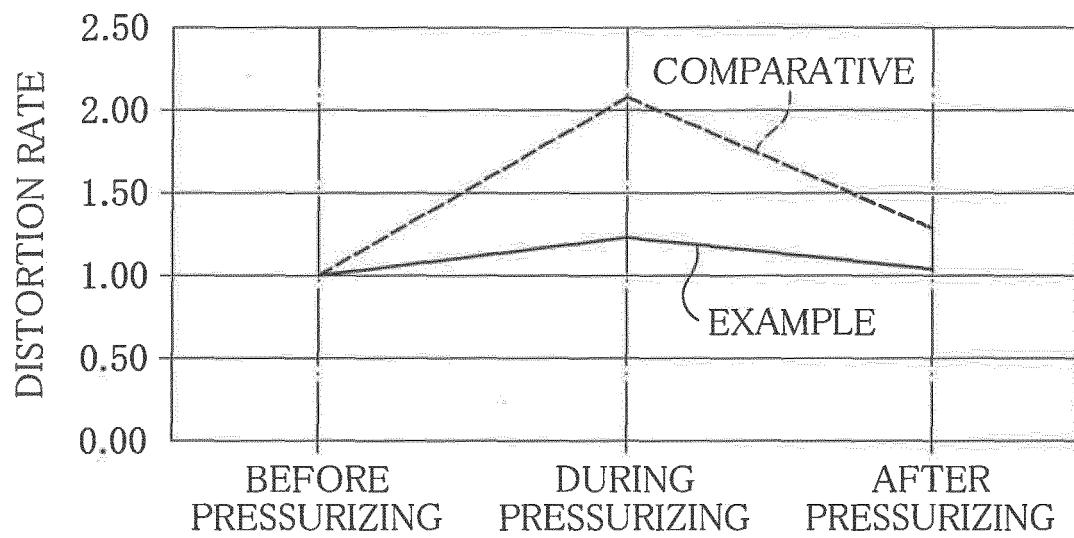


FIG. 15

	EXAMPLE					COMPARATIVE		
	SAMPLE 1	SAMPLE 2	SAMPLE 3	AVERAGE	SAMPLE 4	SAMPLE 5	SAMPLE 6	AVERAGE
BEFORE PRESSURIZING	LONGER DIAMETER A (mm)	1.26	1.30	1.27	1.22	1.28	1.26	1.25
	SHORTER DIAMETER B (mm)	1.24	1.22	1.25	1.22	1.23	1.25	1.23
	DISTORTION RATE	1.02	1.03	1.02	1.00	1.04	1.01	1.02
DURING PRESSURIZING	LONGER DIAMETER A (mm)	1.30	1.26	1.30	1.29	1.38	1.40	1.41
	SHORTER DIAMETER B (mm)	1.04	1.10	1.02	0.67	0.67	0.71	0.68
	DISTORTION RATE	1.25	1.15	1.27	2.16	2.06	1.97	2.07
AFTER PRESSURIZING	LONGER DIAMETER A (mm)	1.30	1.28	1.29	1.47	1.43	1.47	1.46
	SHORTER DIAMETER B (mm)	1.24	1.24	1.26	1.12	1.12	1.16	1.13
	DISTORTION RATE	1.05	1.03	1.02	1.31	1.28	1.27	1.29
SHEATH HARDNESS (mm/10)	7.8	6.8	6.8					
CORE HARDNESS (mm/10)	3.5	3.7	3.1					
HARDNESS (mm/10)					1.8	1.9	1.1	
CIRCUMFERENTIAL LENGTH (mm)	23.96	28.85	24.10		24.03	23.96	24.00	

FIG. 16



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/080465

## A. CLASSIFICATION OF SUBJECT MATTER

A24D3/02(2006.01) i, A24D3/04(2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A24D3/02, A24D3/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2011/114440 A1 (Japan Tobacco Inc.), 22 September 2011 (22.09.2011), entire text; all drawings (Family: none)	1-7
A	JP 3002173 B2 (Japan Tobacco Inc.), 24 January 2000 (24.01.2000), entire text; all drawings & JP 11-318418 A	1-7
A	JP 3022624 B2 (Japan Filter Technology, Ltd.), 21 March 2000 (21.03.2000), claim 3; paragraphs [0021] to [0023]; fig. 1 to 8 & JP 4-352862 A	1-7

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

\* Special categories of cited documents:

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"&amp;" document member of the same patent family

Date of the actual completion of the international search  
15 February, 2013 (15.02.13)Date of mailing of the international search report  
26 February, 2013 (26.02.13)Name and mailing address of the ISA/  
Japanese Patent Office

Authorized officer

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/080465

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 57-001226 B2 (Liggett Group Inc.), 09 January 1982 (09.01.1982), claims 4 to 7; all drawings & JP 53-94099 A & US 4037524 A & GB 1594228 A & GB 1594229 A & DE 2749947 A & FR 2369803 A & BE 860617 A & CH 625129 A & AR 217455 A & AT 796477 A & NL 7712239 A & NZ 185588 A & AU 3046377 A & ES 463851 A & ES 472269 A & FI 773331 A & BR 7707380 A	1-7
A	US 3095343 A (U.S.Filter Corp.), 25 June 1963 (25.06.1963), fig. 7 (Family: none)	1-7

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- WO 2011114440 A [0003]