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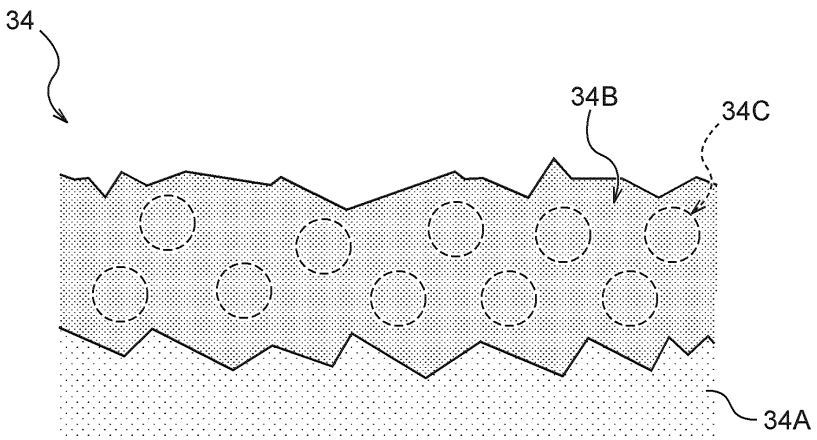
(54) **MANDREL USED IN DEVICE FOR MANUFACTURING HOLLOW ACETATE TUBE AND MANUFACTURING METHOD OF MANDREL, AND DEVICE AND METHOD FOR MANUFACTURING HOLLOW ACETATE TUBE**

(57) Provided is a mandrel used in a device for manufacturing a hollow acetate tube to be used in a heating type smoking article, said mandrel comprising a metallic mandrel body and a composite resin coating film which is formed on the surface of the mandrel body by melting a composite resin comprising one or more resins selected from the group consisting of a PEEK resin, a PEKK resin, a PPS resin and a PES resin together with a fluorine resin, wherein the composite resin coating film has bubbles in the film.

Fig. 11



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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a mandrel for use in a manufacturing apparatus for manufacturing a hollow acetate tube and a manufacturing method of a mandrel, and an apparatus and method for manufacturing a hollow acetate tube.

BACKGROUND ART

[0002] Conventionally, in a field of flavor aspirators, a hollow filter constituting a part of a consumable material to be smoked is manufactured by manufacturing a hollow acetate tube and cutting this tube. Then, a metal core called a mandrel is used in an apparatus for manufacturing the hollow acetate tube. See, for example, PTL 1.

CITATION LIST

PATENT LITERATURE

[0003] PTL 1: Japanese Translation of PCT International Application Publication No. 2019-502369

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] However, in a process of manufacturing a hollow acetate tube, a mandrel may deteriorate. Specifically, a manufacturing apparatus may be stopped by a tow clogged in the manufacturing apparatus, which is a material of the hollow acetate tube, due to wear on the surface of the mandrel, or a defective product may occur among manufactured hollow acetate tubes.

[0005] The present disclosure provides a mandrel for use in a manufacturing apparatus for manufacturing a hollow acetate tube and a manufacturing method of thereof, and an apparatus and method for manufacturing a hollow acetate tube, with improved durability as a component and improved quality of a manufactured product.

SOLUTION TO PROBLEM

[0006] A first aspect of the present disclosure provides a mandrel for use in a manufacturing apparatus for manufacturing a hollow acetate tube to be applied to a heating type tobacco product, the mandrel comprising a metal mandrel body, and a composite resin film formed on the surface of the mandrel body by melting a composite resin including one or more resins selected from the group consisting of a PEEK resin, a PEKK resin, a PPS resin and a PES resin together with a fluorine resin, wherein the composite resin film includes bubbles inside the film.

[0007] In the above first aspect, the surface of the mandrel is coated with the composite resin film made of a predetermined material, and bubbles are formed within the composite resin film. According to the first aspect, favorable results are obtained in an endurance time of the mandrel and a rejection rate of the hollow acetate tube.

[0008] A second aspect of the present disclosure provides the mandrel in the above first aspect, wherein the composite resin film has a thickness of 50 μm to 200 μm.

[0009] In the above second aspect, the thickness of a layer of the composite resin film formed on the surface of the mandrel is from 50 μm to 200 μm. According to the second aspect, more favorable results are obtained in the endurance time of the mandrel and the rejection rate of the hollow acetate tube.

[0010] A third aspect of the present disclosure provides the mandrel in the above first or second aspect, wherein the bubbles have a minimum delivery length of 5 μm or more.

[0011] In the above third aspect, the minimum delivery length of the bubbles formed in the layer of the composite resin film is 5 μm or more. According to the third aspect, more favorable results are obtained in the endurance time of the mandrel and the rejection rate of the hollow acetate tube.

[0012] A fourth aspect of the present disclosure provides the mandrel in the above first to third aspects, wherein the composite resin film has a surface roughness Ra of 15 μm to 40 μm.

[0013] In the fourth aspect, the surface roughness Ra of the composite resin film is from 15 μm to 40 μm. According to the fourth aspect, more favorable results are obtained in the endurance time of the mandrel and the rejection rate of the hollow acetate tube.

[0014] A fifth aspect of the present disclosure provides the mandrel in the fourth aspect, wherein the composite resin film exhibits the surface roughness Ra of 15 μm to 40 μm after being rubbed over 10 hours by the hollow acetate tube moving at a speed of 200 m/min to 300 m/min by driving the manufacturing apparatus.

[0015] In the fifth aspect, after the manufacturing apparatus is driven for N hours to manufacture the hollow acetate tube, the composite resin film keeps the surface roughness Ra of 15 μm to 40 μm. According to the fifth aspect, more favorable results are obtained in the endurance time of the mandrel and the rejection rate of the hollow acetate tube.

[0016] A sixth aspect of the present disclosure provides a mandrel for use in a manufacturing apparatus for manufacturing a hollow acetate tube to be applied to a heating type tobacco product, the mandrel comprising a metal mandrel body, and a carbide hard chromium plating film formed on the surface of the mandrel body.

[0017] In the sixth aspect, the surface of the metal mandrel body is coated with carbide hard chromium plating. According to the sixth aspect, favorable results are obtained in the endurance time of the mandrel and the

rejection rate of the hollow acetate tube.

[0018] A seventh aspect of the present disclosure provides an apparatus for manufacturing a hollow acetate tube, comprising the mandrel according to the above first to sixth aspects.

[0019] According to the above seventh aspect, it is possible to provide the apparatus for manufacturing the hollow acetate tube that obtains a favorable result in the rejection rate of the hollow acetate tube.

[0020] An eighth aspect of the present disclosure provides a method for manufacturing a hollow acetate tube to be applied to a heating type tobacco product, the method comprising: rubbing the surface of a mandrel with fiber as a material of the hollow acetate tube moving in a manufacturing apparatus for manufacturing the hollow acetate tube, the mandrel for use in the manufacturing apparatus, comprising a metal mandrel body, and a composite resin film formed on the surface of the mandrel body by melting a composite resin including one or more resins selected from the group consisting of a PEEK resin, a PEKK resin, a PPS resin and a PES resin together with a fluorine resin, wherein the composite resin film includes bubbles inside the film.

[0021] The above eighth aspect includes rubbing, with the fiber as the material of the hollow acetate tube, the surface of the metal mandrel body coated with the composite resin film made of a predetermined material and including the bubbles formed within the composite resin film. According to the eighth aspect, favorable results are obtained in the endurance time of the mandrel and the rejection rate of the hollow acetate tube.

[0022] A ninth aspect of the present disclosure provides a method for manufacturing a hollow acetate tube to be applied to a heating type tobacco product, the method comprising: rubbing the surface of a mandrel with fiber as a material of the hollow acetate tube moving in a manufacturing apparatus for manufacturing the hollow acetate tube, the mandrel for use in a component of the manufacturing apparatus, comprising a metal mandrel body, and a carbide hard chromium plating film formed on the surface of the mandrel body.

[0023] The ninth aspect includes rubbing, with the fiber as the material of the hollow acetate tube, the surface of the metal mandrel body coated with the carbide hard chromium plating film. According to the ninth aspect, favorable results are obtained in the endurance time of the mandrel and the rejection rate of the hollow acetate tube.

[0024] A tenth aspect of the present disclosure provides a method for manufacturing a mandrel for use in a manufacturing apparatus for manufacturing a hollow acetate tube to be applied to a heating type tobacco product, the method comprising: blasting the surface of a metal mandrel body, and mixing, applying and melting one or more resins selected from the group consisting of a PEEK resin, a PEKK resin, a PPS resin and a PES resin together with a fluorine resin to form a composite resin film on the blasted surface.

[0025] The above tenth aspect includes blasting the surface of the metal mandrel body and then coating the surface with the composite resin film formed by a predetermined process. According to the tenth aspect, favorable results are obtained in the endurance time of the mandrel and the rejection rate of the hollow acetate tube.

[0026] An eleventh aspect of the present disclosure provides a method for manufacturing a mandrel for use in a manufacturing apparatus for manufacturing a hollow acetate tube to be applied to a heating type tobacco product, the method comprising blasting the surface of a metal mandrel body and forming a carbide hard chromium plating film on the blasted surface.

[0027] The eleventh aspect includes blasting the surface of the metal mandrel body and then coating the surface with the carbide hard chromium plating film. According to the eleventh aspect, favorable results are obtained in the endurance time of the mandrel and the rejection rate of the hollow acetate tube.

BRIEF DESCRIPTION OF DRAWINGS

[0028]

Fig. 1 is a schematic cross-sectional side view showing an example of a consumable material of a flavor aspirator.

Fig. 2 is a perspective view showing a hollow acetate tube.

Fig. 3 is a conceptual diagram showing a manufacturing process of the hollow acetate tube.

Fig. 4A is a perspective view showing an example of a defective product of the hollow acetate tube.

Fig. 4B is a perspective view showing an example of the defective product of the hollow acetate tube.

Fig. 4C is a perspective view showing an example of the defective product of the hollow acetate tube.

Fig. 5 is a top view showing a mandrel.

Fig. 6A is a perspective view showing a main part of a hollow acetate tube manufacturing apparatus.

Fig. 6B is a perspective view showing the main part of the hollow acetate tube manufacturing apparatus.

Fig. 6C is a perspective view showing the main part of the hollow acetate tube manufacturing apparatus.

Fig. 7A is an enlarged view showing the surface of the mandrel before use.

Fig. 7B is an enlarged view showing the surface of the mandrel after the use.

Fig. 8 is a conceptual diagram showing a coating of the mandrel surface.

Fig. 9 is a table showing experimental results when a hollow acetate tube manufacturing apparatus using mandrels according to first to third examples and a hollow acetate tube manufacturing apparatus using mandrels according to first and second comparative examples are driven to limit of use of the mandrel.

Fig. 10 is a table showing experimental results when the hollow acetate tube manufacturing apparatus

using the mandrel according to the first example and the hollow acetate tube manufacturing apparatus using the mandrel according to the first comparative example are driven for six hours.

Fig. 11 is a conceptual diagram showing the surface of the mandrel according to the first example.

Fig. 12A is a cross-sectional view showing the surface of the mandrel according to the first example.

Fig. 12B is a cross-sectional view showing the surface of the mandrel according to the second example.

Fig. 12C is a cross-sectional view showing the surface of the mandrel according to the third example.

DESCRIPTION OF EMBODIMENTS

[0029] Hereinafter, embodiments of the present disclosure will be described with reference to the drawings. In the drawings described below, the same or corresponding components are denoted with the same reference sign and duplicate descriptions are omitted.

[0030] Fig. 1 is a schematic cross-sectional side view of a consumable material 110, which is an example of a consumable material for use in a flavor aspirator. The flavor aspirator and the consumable material 110 may constitute a smoking system. In the example shown in Fig. 1, the consumable material 110 includes a smokeable material 111, a tubular member 114, a hollow filter portion 116, and a filter portion 115. The smokeable material 111 is wrapped in first wrapping paper 112. The tubular member 114, the hollow filter portion 116, and the filter portion 115 are wrapped in second wrapping paper 113 that is different from the first wrapping paper 112. The second wrapping paper 113 is also for wrapping a part of the first wrapping paper 112 that wraps the smokeable material 111. Thus, the tubular member 114, the hollow filter portion 116, and the filter portion 115 are coupled to the smokeable material 111. However, the second wrapping paper 113 may be omitted, and the first wrapping paper 112 may be used to couple the tubular member 114, the hollow filter portion 116, and the filter portion 115 to the smokeable material 111. A lip release agent 117 is applied to an outer surface of the second wrapping paper 113 in the vicinity of an end of the second wrapping paper 113 on a filter portion 115 side to prevent a user's lips from sticking to the second wrapping paper 113. A portion of the consumable material 110 to which the lip release agent 117 is applied functions as a mouthpiece of the consumable material 110. The consumable material 110 is an example of heating type tobacco of the present disclosure.

[0031] The smokeable material 111 may include, for example, a flavor source such as tobacco and an aerosol source. Furthermore, the first wrapping paper 112 that wraps the smokeable material 111 may be a breathable sheet member. The tubular member 114 may be a paper tube or a hollow filter. In the example shown in Fig. 1, the consumable material 110 includes the smokeable material 111, the tubular member 114, the hollow filter portion 116, and the filter portion 115, but the consumable material 110 is not limited to this configuration.

[0032] The tubular member 114 and the hollow filter portion 116 of the consumable material 110 may be formed integrally. Hereinafter, in the present disclosure, the tubular member 114 and the hollow filter portion 116 will be described as an integral hollow filter. The hollow filter in which the tubular member 114 and the hollow filter portion 116 are integrally formed is an example of the filter of the present disclosure.

[0033] The hollow filter is formed by cutting a hollow acetate tube 20 into a predetermined length. Fig. 2 is a perspective view of the hollow acetate tube 20. As an example, three hollow filters are obtained by dividing the hollow acetate tube 20 equally into three along a longitudinal direction.

[0034] The hollow acetate tube 20 is a hollow tube formed from a material called acetate. A raw material of the hollow acetate tube 20 is cellulose. For example, cellulose obtained from wood can be used. Cellulose is reacted with acetic acid to produce cellulose acetate (also called acetyl cellulose or acetate), and cellulose acetate is dissolved in a solvent such as acetone, injected through thin holes, and dried using warm air to form fiber. The fiber is spun to form a bundle called tow.

[0035] Hereinafter, a manufacturing process of the hollow acetate tube 20 using a hollow acetate tube manufacturing apparatus 30 will be described. Fig. 3 is a conceptual diagram showing the manufacturing process of the hollow acetate tube 20. Figs. 4A to 4C are perspective views showing an example of a defective product of the hollow acetate tube 20. Fig. 5 is a top view of a mandrel 34. Figs. 6A to 6C are perspective views showing a main part of the hollow acetate tube manufacturing apparatus 30.

[0036] As shown in Fig. 3, an acetate tow 1 delivered from a package of the acetate tow 1 receives air discharged from a first banding jet 21 and a second banding jet 22 and is made uniform and spread to a predetermined width. Afterward, the acetate tow 1 passes through pretension rollers 11, blooming rollers 12, stretch rollers 13 and a third banding jet 23 and proceeds toward a liquid addition booth 4. The acetate tow 1 is pretreated by impregnating the acetate tow with triacetin as a plasticizer in the liquid addition booth 4 to form a pretreated acetate tow 5. The pretreated acetate tow 5 is sent to a transport jet 31 via nip rolls 15 and a delivery roller 14.

[0037] In the transport jet 31, the pretreated acetate tow 5 receives compressed air. As a result, the pretreated acetate tow 5 is made uniform and conveyed into an internal space of the transport jet 31 extending along the longitudinal direction. When conveyed through the transport jet 31, the pretreated acetate tow 5 changes from a wide band shape to a substantially cylindrical rod-like shape through a mandrel holder 35. The internal space of the transport jet 31 extends substantially parallel to a transfer direction A of an uncut continuous hollow

acetate tube 6 manufactured by the hollow acetate tube manufacturing apparatus 30.

[0038] The pretreated acetate tow 5 flows out from an outlet opening of the transport jet 31 and is introduced into a tongue 32 via a trumpet guide 26 and compressed, thereby substantially determining an outer shape of the uncut continuous hollow acetate tube 6. The mandrel holder 35 and the mandrel 34 held by the mandrel holder 35 are arranged within the transport jet 31, the trumpet guide 26, the tongue 32 and a thermoforming part 33, and a hollow portion of the uncut continuous hollow acetate tube 6 is formed. In the thermoforming part 33, steam is applied to the pretreated acetate tow 5, and by heat of the steam, the pretreated acetate tow 5 is rapidly plasticized and solidified, to form the uncut continuous hollow acetate tube 6.

[0039] A filter cutting part 7 located downstream of the thermoforming part 33 cuts the uncut continuous hollow acetate tube 6 to a predetermined length with a knife, forms the hollow acetate tube 20, and sends the tube to an inspection unit 8.

[0040] The inspection unit 8 optically inspects the hollow acetate tube 20. The inspection unit 8 is a member for rejecting defective products of the hollow acetate tube 20. The inspection unit 8 optically detects a state of an end of the hollow acetate tube 20 and inspects presence or absence of molding defects.

[0041] Figs. 4A to 4C show examples of the defective product of the hollow acetate tube 20 having the end at which a manufacturing defect occurs. In Fig. 4A, fluffing occurs on an inner circumference of the hollow acetate tube 20. In Fig. 4B, a protrusion occurs on the inner circumference of the hollow acetate tube 20 and results in a molding defect. In FIG. 4C, an inner circumferential circle of the hollow acetate tube 20 deviates from a predetermined shape (thick line).

[0042] Since the inspection unit 8 merely inspects only one end of the hollow acetate tube 20, the defective products cannot completely be rejected. That is, the inspection unit 8 cannot detect a defective product in which a molding defect occurs only around a center of the hollow acetate tube 20 in the longitudinal direction and in which no molding defect appears at the end of the hollow acetate tube. Such a defective product of the hollow acetate tube 20 not detected by the inspection unit 8 is rejected, for example, by sample inspection with human power in a post-process of the hollow filter manufacturing process.

[0043] Hereinafter, the rejection of the defective product of the hollow acetate tube 20 referred to in the present disclosure means that the molding defect determined by the inspection unit 8 is rejected, and a rejection rate of defective products indicates a rate of a number of defective products determined as molding defects by the inspection unit 8 and rejected out of a total number of the hollow acetate tubes 20.

[0044] The hollow acetate tube 20 that has passed through the inspection unit 8 is sent to a defective product storage or normal product storage (not shown). The hollow acetate tube 20 determined to be defective in the inspection unit 8 is sent to the defective product storage, and the hollow acetate tube 20 from which no molding defect is detected in the inspection unit 8 is sent to the normal product storage. Only the hollow acetate tubes 20 accumulated in the normal product storage are sent to a post-forming process of the hollow filter.

[0045] As shown in Fig. 5, the mandrel 34 is a metal core and is used to form a hollow portion of the hollow acetate tube 20 in the hollow acetate tube manufacturing apparatus 30.

[0046] With reference to Figs. 6A to 6C, a configuration of the main part of the hollow acetate tube manufacturing apparatus 30 shown in Fig. 3 will be described. Fig. 6A is a view showing an excerpt including the transport jet 31, the trumpet guide 26, and the tongue 32. Hereinafter, the transport jet 31, the trumpet guide 26 and the tongue 32 are also collectively referred to as a tongue part. Fig. 6B is a view showing an excerpt including the mandrel holder 35 and the mandrel 34. Fig. 6C is a view showing an excerpt including the tongue part and the thermoforming part 33.

[0047] As shown in Figs. 6A to 6C, the transport jet 31, the trumpet guide 26 and the tongue 32 are arranged in this order substantially parallel to the transfer direction A. The mandrel 34 held in a rod-shaped portion of the mandrel holder 35 extends substantially parallel to the transfer direction A. Here, the mandrel holder 35 and the mandrel 34 held by the mandrel holder 35 are arranged within the transport jet 31, the trumpet guide 26, the tongue 32 and the thermoforming part 33.

[0048] The pretreated acetate tow 5 is introduced from an inlet opening of the transport jet 31, subjected to compressed air and made uniform. When conveyed in the transport jet 31, the pretreated acetate tow 5 is evenly disposed around the mandrel holder 35 due to influence of compressed air, changes from a wide band shape to a substantially cylindrical rod shape and flows out from the outlet opening of the transport jet 31.

[0049] Subsequently, when conveyed in the trumpet guide 26 and the tongue 32, the pretreated acetate tow 5 is narrowed down around the mandrel holder 35 with the trumpet guide 26 and compressed around the mandrel holder 35 with the tongue 32, thereby defining a hollow in the tow. Afterward, when conveyed in the thermoforming part 33, the pretreated acetate tow 5 is plasticized and solidified around the mandrel 34 with steam sprayed from a plurality of holes (not shown) arranged in the thermoforming part 33, to form the uncut continuous hollow acetate tube 6.

[0050] As described above, only the hollow acetate tube 20 accumulated in the normal product storage is sent to the post-forming process of the hollow filter. Then, the manufactured hollow filter is combined with the smokeable material 111 wrapped in the first wrapping paper 112 and the filter portion 115 prepared according to respective predetermined configurations and wrapped in

the second wrapping paper 113, to couple respective members. Furthermore, by applying the lip release agent 117 to the outer surface of the second wrapping paper 113 in the vicinity of the end of the second wrapping paper on the filter portion 115 side, the consumable material 110 shown in Fig. 1 is manufactured.

[0051] Next, with reference to Figs. 7A, 7B, and 8, a structure of the surface of the mandrel 34 will be described. Fig. 7A is an enlarged view showing the surface of the mandrel 34 before being used in the hollow acetate tube manufacturing apparatus 30. Fig. 7B is an enlarged view showing the surface of the mandrel 34 after being used in the hollow acetate tube manufacturing apparatus 30. Fig. 8 is a conceptual diagram showing a coating on the surface of the mandrel 34.

[0052] As shown in Fig. 7A, the surface of an unused metal mandrel body 34A is provided with unevenness by blasting. The mandrel body 34A can maintain constant unevenness even after being used for a certain time or can maintain the constant unevenness even if worn. As shown in FIG. 7B, after attaching the mandrel body 34A to the mandrel holder 35 and driving the hollow acetate tube manufacturing apparatus 30 for a predetermined time, the mandrel body 34A is worn in contact with the pretreated acetate tow 5 and has reduced unevenness on the surface of the mandrel body.

[0053] In the present disclosure, as shown in Fig. 8, various coatings 34B are applied to the surface of the metal mandrel body 34A. In the embodiment of the present disclosure, three types of mandrels 34 are manufactured by performing three types of processing on the surface of the mandrel body 34A. Hereinafter, each of these three examples will be described.

(First Example: PEEK Fluorine Composite Coating)

[0054] A first example provides a mandrel 34 obtained by blasting the surface of a metal mandrel body 34A, and then performing composite resin processing described in literature (Japanese Patent No. 3905730) of NIKKEN COATING INDUSTRY CO., LTD. to form a coating 34B on the surface. Hereinafter, a manufacturing process of the coating 34B according to the first example will be described.

[0055] First, the process includes pretreating the surface of the metal mandrel body 34A. Such pretreatment includes a first step of dry heating the mandrel body 34A, for example, at 400°C. Consequently, dirt such as oil content adhered to the surface of the mandrel body 34A is removed. The pretreatment includes a second step of blasting the surface, for example, with alumina. Consequently, other impurities remaining on the surface of the mandrel body 34A are removed and the unevenness shown in Fig. 7A is formed. The blasting is not limited to alumina, but may be fine particles of sand, metal, ceramic, or the like as long as it can be hit against the surface.

[0056] Next, the process includes subjecting the surface of the mandrel body 34A to surface treatment. The surface treatment includes a first step of applying a primer for adhering a composite resin to the surface of the mandrel body 34A. The surface treatment includes a second step of firing the mandrel body 34A with the primer applied thereto, for example, at 400°C for 60 minutes. Consequently, the surface of the mandrel body 34A and a primer layer adhere to each other.

[0057] Subsequently, the process includes applying the composite resin to the surface of the mandrel body 34A. The composite resin is a mixture of one or more resins selected from the group consisting of a PEEK resin, a PEKK resin, a PPS resin and a PES resin and a fluorine resin. As an example, the PEEK resin and a PFA resin as the fluorine resin can be used as the composite resin, and a ratio of PEEK resin:PFA resin = about 80: about 20 can be adopted as a blending ratio.

[0058] Next, the process includes applying this composite resin onto the primer layer formed on the surface of the mandrel body 34A. The applying can be performed by a known coating method such as electrostatic powder coating, flow immersion, or spray coating. By adjusting the blending ratio of the composite resin and a film thickness, surface roughness of a composite resin film as the coating 34B formed can be set to a desired value. In the first example, the blending ratio of the composite resin and the film thickness are adjusted such that a surface roughness Ra of the composite resin film as the coating 34B is in a range of 15 μm to 40 μm. As an example, the thickness of the composite resin film is from 50 μm to 200 μm.

[0059] Subsequently, the process includes firing the applied composite resin in a firing furnace. The composite resin is fired, for example, at 420°C (melting temperature) for 60 minutes. Thus, the composite resin is melted and adheres to the primer layer. Finally, the composite resin film integrally adhered to the primer layer is cooled to cure the composite resin, thereby completing the coating 34B according to the first example. The composite resin film as the coating 34B has a surface formed in an uneven shape and is provided with slipperiness by a fluorine resin and formed integrally adhering to the surface of the mandrel body 34A.

(Second Example: PEEK Coating)

[0060] A second example provides a mandrel 34 obtained by blasting the surface of a metal mandrel body 34A, and then performing resin processing with a PEEK resin to form a coating 34B on the surface. Hereinafter, a manufacturing process of the coating 34B according to the second example will be described.

[0061] First, the process includes subjecting the surface of the metal mandrel body 34A to pretreatment and surface treatment. The pretreatment and surface treatment are the same as the treatments described in the first example. Next, the process includes applying the PEEK resin onto a primer layer formed on the surface of the

mandrel body 34A by the coating method described in the first example.

[0062] Subsequently, the process includes firing the applied PEEK resin in a firing furnace. The PEEK resin is fired in the same manner as in the first example, so that a PEEK resin is melted and adheres to the primer layer. Finally, the process includes cooling the PEEK resin film integrally adhered to the primer layer to cure the PEEK resin, thereby completing the coating 34B according to the second example.

(Third Example: Carbide Hard Chromium Plating)

[0063] A third example provides a mandrel 34 obtained by subjecting the surface of a metal mandrel body 34A to processing called Blastron (registered trademark) of Chiyoda Dai-ichi Kogyo Co., Ltd. to form a coating 34B. Hereinafter, a manufacturing process of the coating 34B according to the third example will be described.

[0064] First, the process includes pretreating the surface of the metal mandrel body 34A. This pretreatment includes a first step of dry heating the mandrel body 34A, for example, at 400°C. Consequently, dirt such as oil content adhered to the surface of the mandrel body 34A is removed. The pretreatment includes a second step of blasting the surface, for example, with alumina. Consequently, other impurities remaining on the surface of the mandrel body 34A are removed and the unevenness shown in Fig. 7A is formed.

[0065] Next, the process includes subjecting the surface of the mandrel body 34A to carbide hard chromium plating, to form a carbide hard chromium plating film. Subsequently, the process includes blasting the carbide hard chromium plating film formed on the surface of the mandrel body 34A, for example, with alumina, to complete the coating 34B according to the third example. Specifically, the coating 34B according to the third example is formed by processing called Blastron #120. Here, a numerical after Blastron indicates surface roughness of the coating 34B. For example, Blastron #200 indicates a surface roughness Ra of about 0.45 μm, and Blastron #400 indicates a surface roughness Ra of about 0.35 μm. As the coating 34B, Blastron #120 to #440 may be used.

(Experimental Result)

[0066] Experiments were performed using a hollow acetate tube manufacturing apparatus 30 in which mandrels 34 according to the first to third examples of the embodiment of the present disclosure described above were used, and a hollow acetate tube manufacturing apparatus in which mandrels according to first and second comparative examples were used. Experimental results will be described as follows.

[0067] The mandrel according to the first comparative example is an existing mandrel manufactured by Hauni Maschinenbau AG with a resin coating formed on the surface of a mandrel body. Furthermore, the mandrel according to the second comparative example is a mandrel with the surface of a mandrel body subjected only to blasting.

[0068] First, the hollow acetate tube manufacturing apparatus 30 using the mandrels 34 according to the first to third examples and the hollow acetate tube manufacturing apparatus using the mandrels according to the first and second comparative examples were each driven to use limit of the mandrel, and time to the use limit, a reason for the use limit, and a rejection rate of defective products were verified.

[0069] Fig. 9 is a table showing experimental results when the hollow acetate tube manufacturing apparatus 30 using the mandrels 34 according to the first to third examples and the hollow acetate tube manufacturing apparatus using the mandrels according to the first and second comparative examples were driven to the use limit of the mandrel. Here, a mechanical speed of each hollow acetate tube manufacturing apparatus, that is, a moving speed of the hollow acetate tube is 500 m/min, and various settings are on the same conditions.

[0070] In FIG. 9, the mandrel use limit is defined after start of use of a new mandrel until a machine cannot be operated or rejection of defective products frequently occurs, due to the mandrel. Furthermore, the rejection rate of defective products indicates the rejection rate of defective products when a hollow acetate tube is manufactured for 15 minutes after the start of use of the new mandrel.

[0071] As shown in Fig. 9, in the first example (PEEK fluorine composite coating), after 48 hours from the start of use of the mandrel, tow clogging frequently occurred in a tongue unit due to wear on the surface of the mandrel, and the mandrel reached the limit of use. Furthermore, the defective product rejection rate in the first example was 1.02%.

[0072] Also, in the second example (PEEK coating), after four hours from the start of use of the mandrel, the tow clogging frequently occurred in the tongue unit due to wear on the surface of the mandrel, and the mandrel reached the limit of use. Furthermore, the defective product rejection rate in the second example was 0.94%.

[0073] Furthermore, in the third example (carbide hard chromium plating), after five hours from the start of use of the mandrel, fluffing or deformation of the hollow acetate tube frequently occurred, and the mandrel reached the limit of use. At this time, any wear was not observed on the surface of the mandrel. The defective product rejection rate in the second example was 0.86%.

[0074] Additionally, in the first comparative example (existing mandrel manufactured by Hauni Maschinenbau AG), after six hours from the start of use of the mandrel, the tow clogging frequently occurred in the tongue unit due to wear on the mandrel surface, and the mandrel reached the use limit. The defective product rejection rate in the first comparative example was 1.67%.

[0075] Furthermore, in the second comparative exam-

ple (surface blasted mandrel), after 0.2 hours from the start of use of the mandrel, fluffing or deformation of the hollow acetate tube occurred frequently, the tow clogging frequently occurred in the tongue unit, and the mandrel reached the use limit. In the second comparative example, the defective product rejection rate was from 20 to 30%. Specifically, in the second comparative example, a large number of defective products were generated, and only 70 to 80% of the manufactured hollow acetate tubes 20 could be manufactured as non-defective products.

[0076] As seen from Fig. 9, according to the first to third examples, much better results can be obtained than in the second comparative example in terms of the mandrel use limit and the defective product rejection rate. Furthermore, according to the first example, better results can be obtained than in the first comparative example in terms of the mandrel use limit and the defective product rejection rate. Furthermore, according to the second and third examples, better results can be obtained than in the first comparative example in terms of the defective product rejection rate.

[0077] Next, the hollow acetate tube manufacturing apparatus 30 using the mandrel 34 according to the first example and the hollow acetate tube manufacturing apparatus using the mandrel according to the first comparative example were each driven for six hours, and a rejection rate for each rejection content of defective products was verified.

[0078] Fig. 10 is a table showing experimental results when the hollow acetate tube manufacturing apparatus 30 using the mandrel 34 according to the first example and the hollow acetate tube manufacturing apparatus using the mandrel according to the first comparative example were each driven for six hours. Here, the mechanical speed of each hollow acetate tube manufacturing apparatus, that is, the moving speed of the hollow acetate tube, is 500 m/min, and various settings are on the same conditions.

[0079] In Fig. 10, fluffing of an inner circle indicates the defective product shown in Fig. 4A. Deformation of the inner circle indicates the defective product shown in Fig. 4B. Roundness and wall thickness indicate the defective product shown in Fig. 4C.

[0080] As shown in Fig. 10, in the first example (PEEK fluorine composite coating), the defective product rejection rate due to the fluffing of the inner circle was 0%, the defective product rejection rate due to the deformation of the inner circle was 0.02%, and the defective product rejection rate due to the roundness and wall thickness was 0.09%. As a result, the defective product rejection rate when driving the hollow acetate tube manufacturing apparatus 30 using the mandrel 34 according to the first example for six hours was 0.11 % in total.

[0081] Furthermore, in the first comparative example (existing mandrel manufactured by Hauni Maschinenbau AG), the defective product rejection rate due to the fluffing of the inner circle was 0.01%, the defective product rejection rate due to the deformation of the inner circle was 0.16%, and the defective product rejection rate due to the roundness and wall thickness was 0.19%. As a result, the defective product rejection rate when driving the hollow acetate tube manufacturing apparatus using the mandrel according to the first comparative example for six hours was 0.36% in total.

[0082] As seen from Fig. 10, in the first example, better results can be obtained than in the first comparative example in terms of each of rejection contents, and better results can be obtained than in the first comparative example in terms of the defective product rejection rate obtained by summing the rejection rates for each rejection content.

[0083] As shown in Fig. 11, the inventors according to the present disclosure have found that a large number of bubbles 34C were formed inside a composite resin film as a coating 34B of the mandrel 34 according to the first example. The bubbles 34C are considered to contribute to maintaining the surface unevenness of the mandrel body 34A against wear due to contact with the pretreated acetate tow 5. Specifically, since the bubbles 34C having a certain volume are crushed, the wear on the coating 34B occurs discontinuously rather than continuously, so that new unevenness is considered to appear. The bubbles 34C have a minimum delivery length of 5 μm or more.

[0084] The composite resin film as the coating 34B of the mandrel 34 according to the first example retains the surface roughness Ra even after use of the mandrel 34. Specifically, after driving the hollow acetate tube manufacturing apparatus 30 using the mandrel 34 according to the first example for 10 hours, the surface roughness Ra of the composite resin film as the coating 34B indicated a range of 15 μm to 40 μm.

[0085] The results obtained according to the first example were the endurance time until tow clogging being about 50 hours, and the defective product rejection rate of 1.02% in 15 minutes evaluation. The results are desirable values as compared to the second comparative example.

[0086] Through the three examples described above, when driving the hollow acetate tube manufacturing apparatus 30 using the mandrel 34 including the metal mandrel body 34A having the surface coated with the coating 34B to manufacture the hollow acetate tube 20, an occurrence rate of nonconforming products determined to be molding defects and rejected by the inspection unit 8 in 15 minutes is in a range of 0.86% or more to 1.67% or less. However, as described above, this numerical range is based on the evaluation by the inspection unit 8 that optically inspects only the end of the hollow acetate tube 20, and it is assumed that more nonconforming products are actually generated.

[0087] Furthermore, in comparison of the three examples with each other, the third example can largely reduce the defective product rejection rate but lacks in durability. On the other hand, the first example shows results that significantly exceed the other two examples in durability.

[0088] Figs. 12A to 12C show evaluations of cross

sections of coatings 34B according to the first to third examples, respectively. Each cross section depends on how to take a cut surface, but general tendency can be known. Particularly, in the first example, large unevenness is formed on the surface of the mandrel body 34A, to which the above-described bubbles 34C are considered to contribute.

[0089] Although embodiments of the present disclosure have been described above, the present disclosure is not limited to the above embodiments, and various modifications are possible within the scope of the claims and technical thoughts illustrated in the specification and drawings. Note that any shape or material not directly described in the specification and drawings is within the scope of the technical thoughts of the present disclosure if it produces action of the present disclosure.

REFERENCE SIGNS LIST

[0090]

1	acetate tow
4	liquid addition booth
5	pretreated acetate tow
6	hollow acetate tube
7	filter cutting part
8	inspection unit
11	pretension rollers
12	blooming rollers
13	stretch rollers
14	delivery roller
15	nip rolls
20	hollow acetate tube
21	first banding jet
22	second banding jet
23	third banding jet
26	trumpet guide
30	hollow acetate tube manufacturing apparatus
31	transport jet
32	tongue
33	thermoforming part
34	mandrel
34A	mandrel body
34B	coating
34C	bubbles
35	mandrel holder
110	consumable material
111	smokeable material
112	first wrapping paper
113	second wrapping paper
114	tubular member
115	filter portion
116	hollow filter portion
117	lip release agent

Claims

1. A mandrel for use in a manufacturing apparatus for manufacturing a hollow acetate tube to be applied to a heating type tobacco product, the mandrel comprising:

a metal mandrel body, and
a composite resin film formed on the surface of the mandrel body by melting a composite resin including one or more resins selected from the group consisting of a PEEK resin, a PEKK resin, a PPS resin and a PES resin together with a fluorine resin,
wherein the composite resin film includes bubbles inside the film.

2. The mandrel according to claim 1, wherein the composite resin film has a thickness of 50 μm to 200 μm.

3. The mandrel according to claim 1 or 2, wherein the bubbles have a minimum delivery length of 5 μm or more.

4. The mandrel according to any one of claims 1 to 3, wherein the composite resin film has a surface roughness Ra of 15 μm to 40 μm.

5. The mandrel according to claim 4, wherein the composite resin film exhibits the surface roughness Ra of 15 μm to 40 μm after being rubbed over 10 hours by the hollow acetate tube moving at a speed of 200 m/min to 300 m/min by driving the manufacturing apparatus.

6. A mandrel for use in a manufacturing apparatus for manufacturing a hollow acetate tube to be applied to a heating type tobacco product, the mandrel comprising:

a metal mandrel body, and
a carbide hard chromium plating film formed on the surface of the mandrel body.

7. An apparatus for manufacturing a hollow acetate tube, comprising the mandrel according to any one of claims 1 to 6.

8. A method for manufacturing a hollow acetate tube to be applied to a heating type tobacco product, the method comprising:
rubbing the surface of a mandrel with fiber as a material of the hollow acetate tube moving in a manufacturing apparatus for manufacturing the hollow acetate tube, the mandrel for use in the manufacturing apparatus, comprising:

a metal mandrel body, and
a composite resin film formed on the surface of the mandrel body by melting a composite resin including one or more resins selected from the

group consisting of a PEEK resin, a PEKK resin, a PPS resin, and a PES resin together with a fluorine resin,
wherein the composite resin film includes bubbles inside the film.

9. A method for manufacturing a hollow acetate tube to be applied to a heating type tobacco product, the method comprising:
rubbing the surface of a mandrel with fiber as a material of the hollow acetate tube moving in a manufacturing apparatus for manufacturing the hollow acetate tube, the mandrel for use in the manufacturing apparatus, comprising:

a metal mandrel body, and
a carbide hard chromium plating film formed on the surface of the mandrel body.

10. A method for manufacturing a mandrel for use in a manufacturing apparatus for manufacturing a hollow acetate tube to be applied to a heating type tobacco product, the method comprising:

blasting the surface of a metal mandrel body, and
mixing, applying and melting one or more resins selected from the group consisting of a PEEK resin, a PEKK resin, a PPS resin and a PES resin together with a fluorine resin to form a composite resin film on the blasted surface.

11. A method for manufacturing a mandrel for use in a manufacturing apparatus for manufacturing a hollow acetate tube to be applied to a heating type tobacco product, the method comprising:

blasting the surface of a metal mandrel body, and
forming a carbide hard chromium plating film on the blasted surface.

Fig. 1

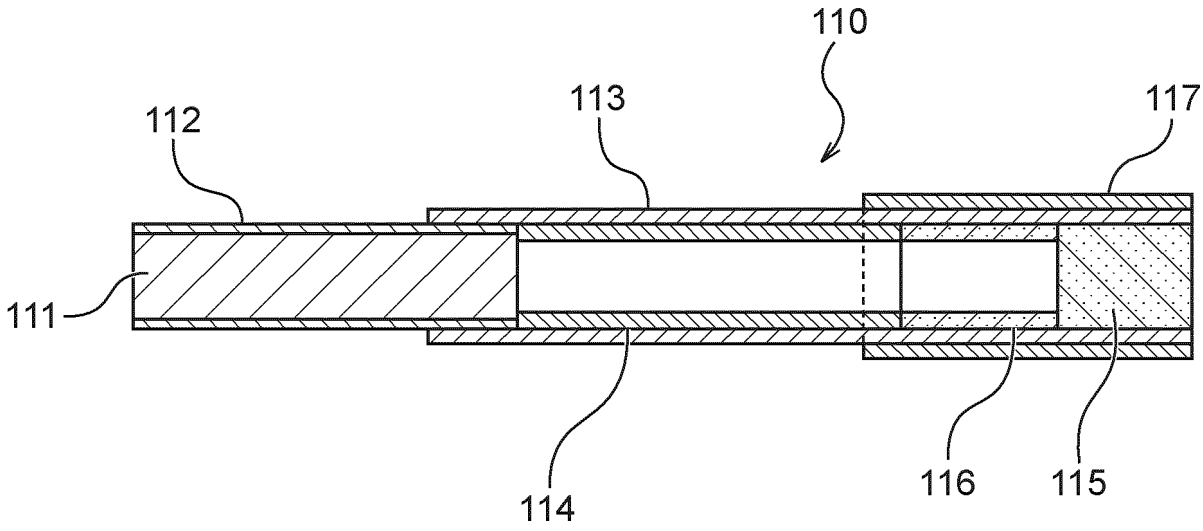


Fig. 2

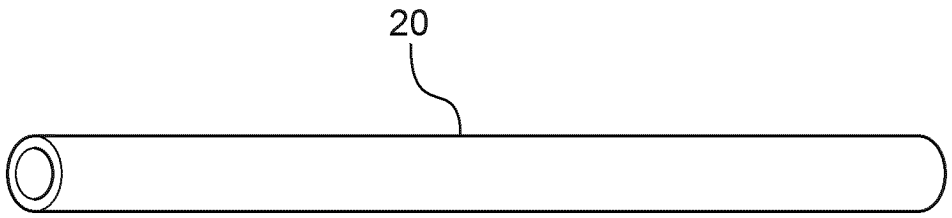


Fig. 3

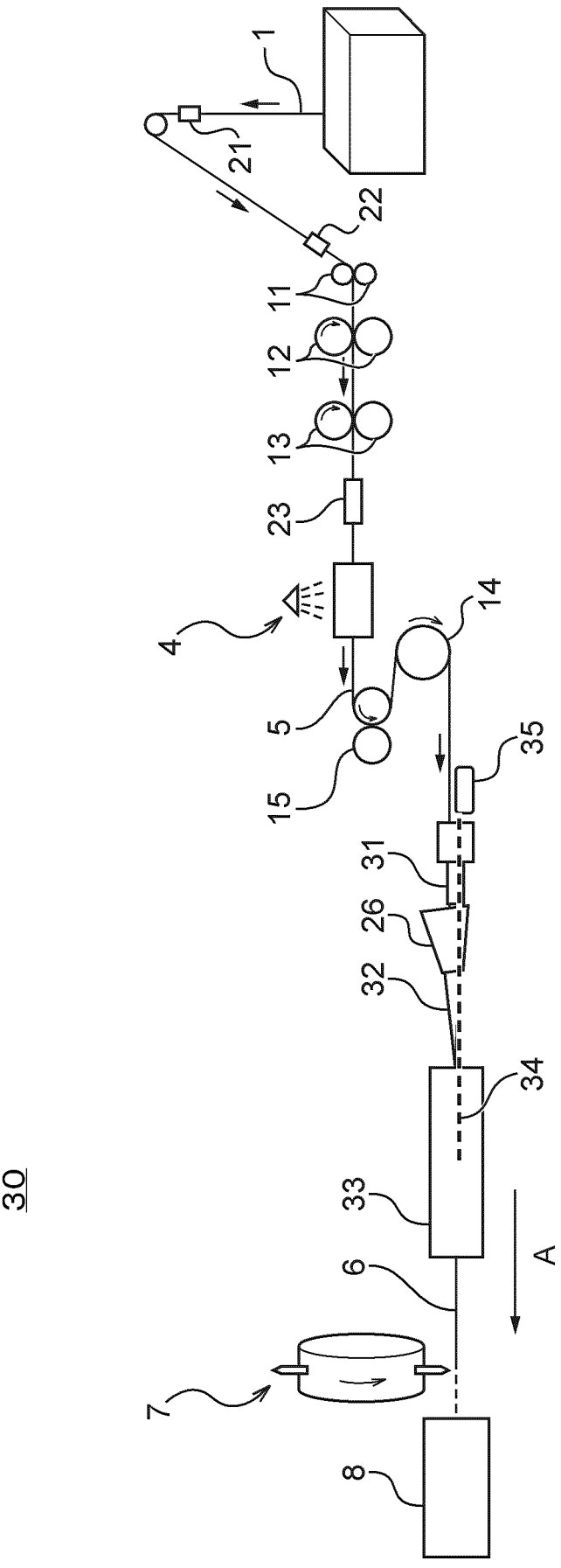


Fig. 4A

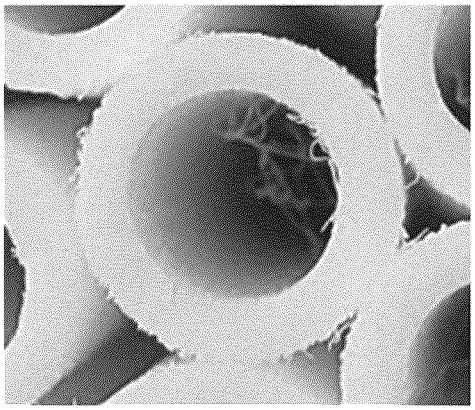


Fig. 4B

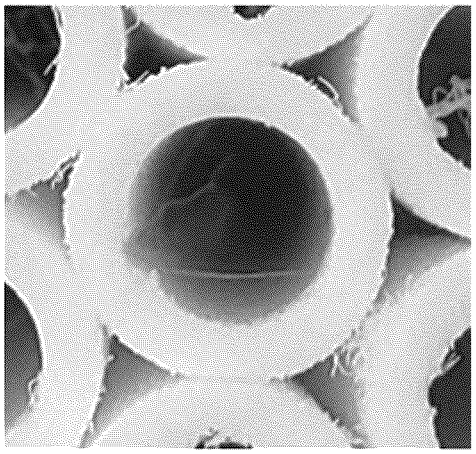


Fig. 4C

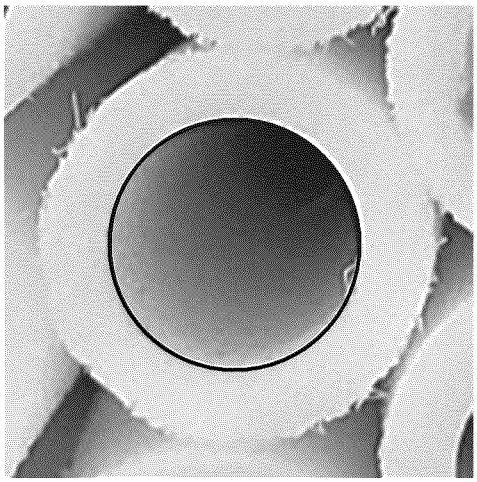
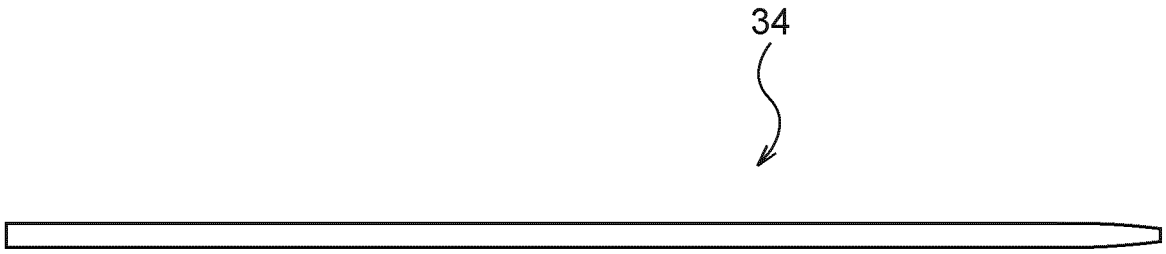


Fig. 5



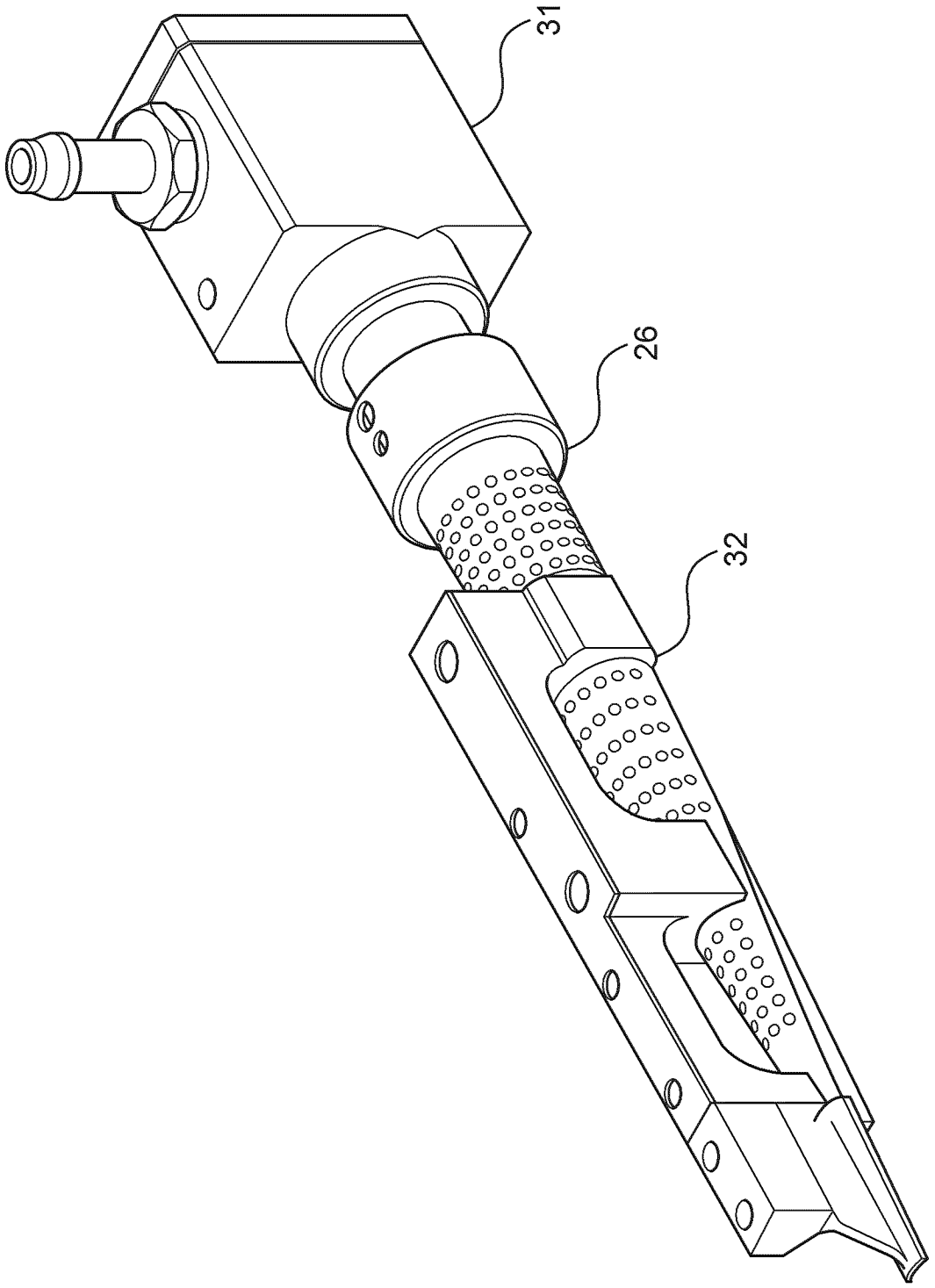


Fig. 6A

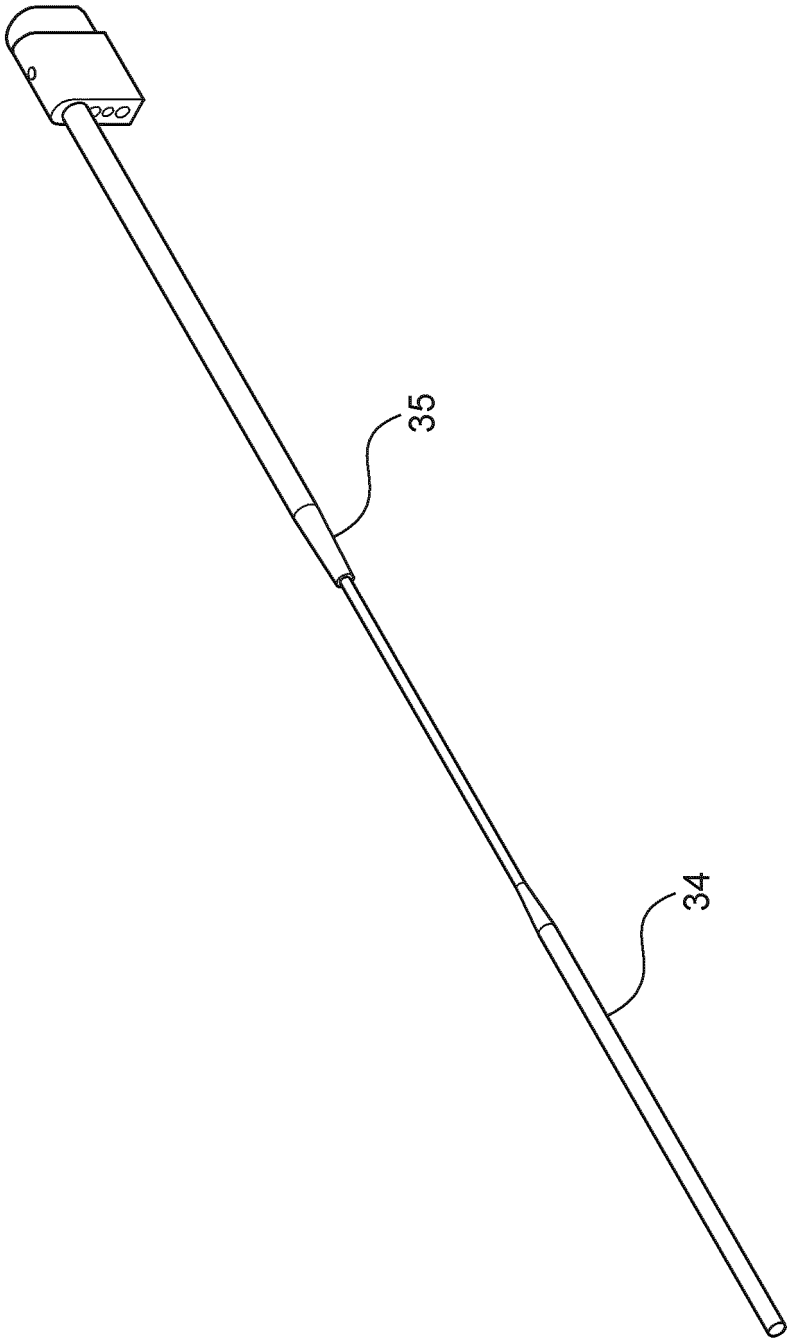


Fig. 6B

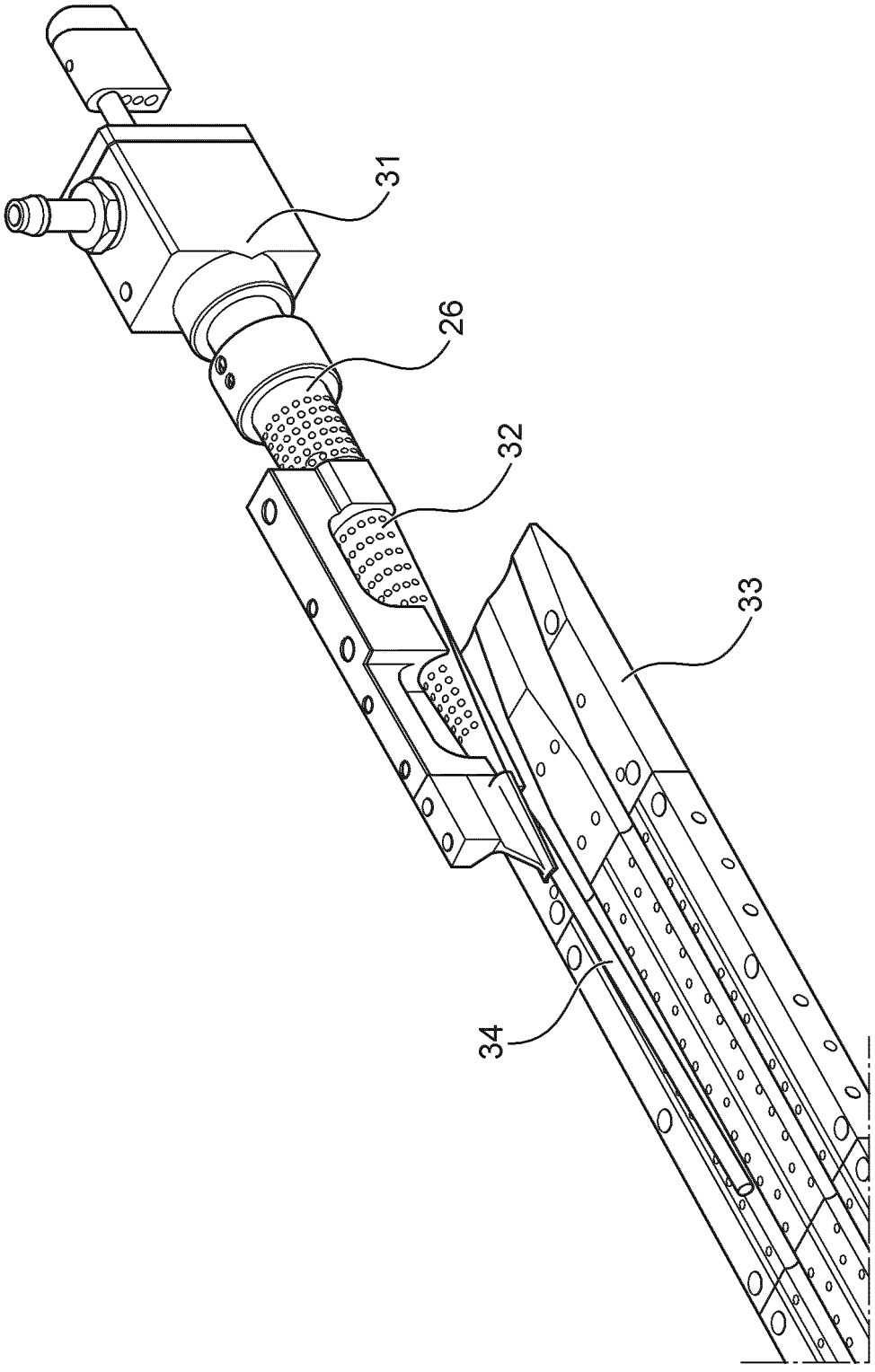


Fig. 6C

Fig. 7A

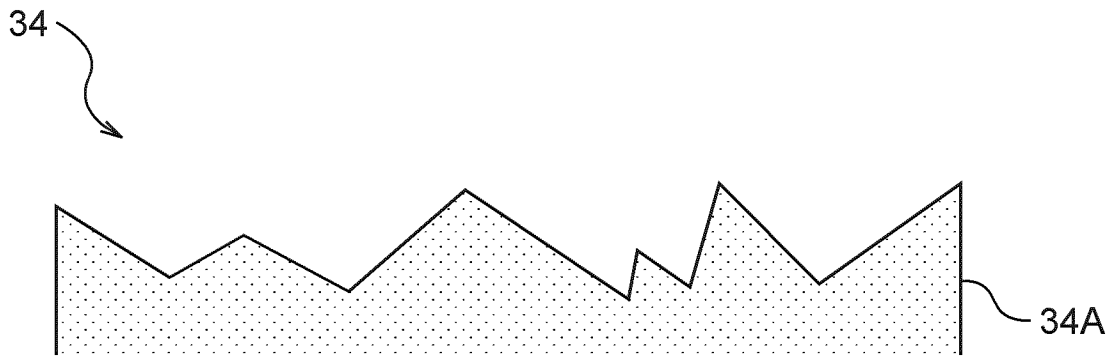


Fig. 7B

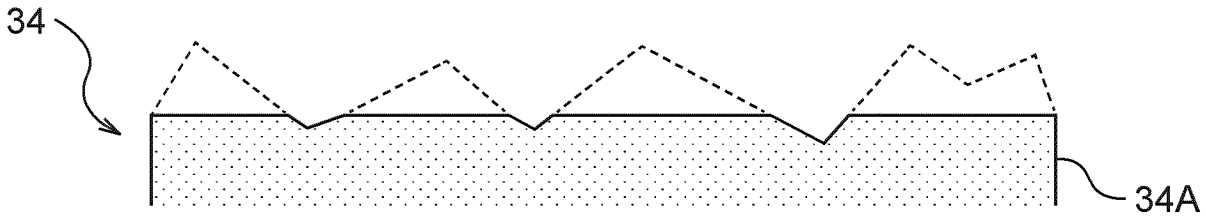


Fig. 8

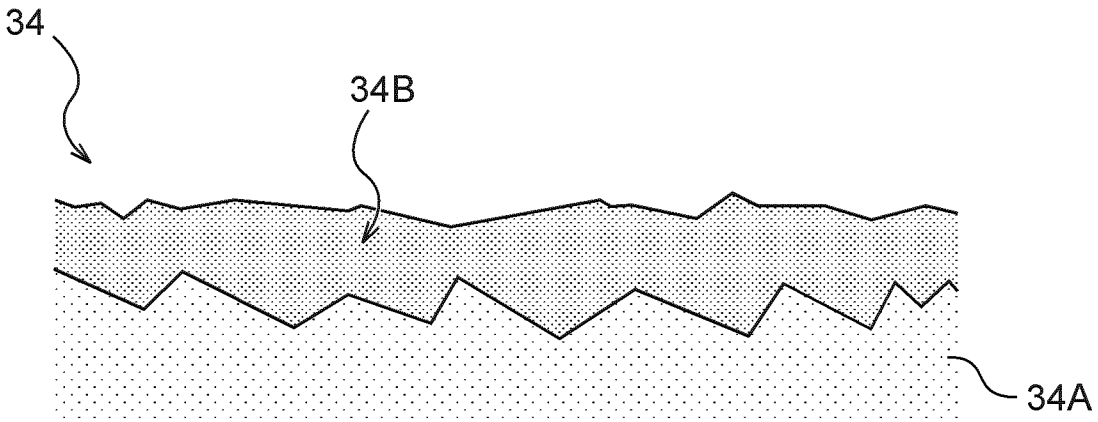


Fig. 9

	First example (PEEK fluorine composite coating)	Second example (PEEK coating)	Third example (carbide hard chromium plating)	First comparative example (existing mandrel manufactured by Hauni Maschinenbau AG)	Second comparative example (surface blasted mandrel)
Mandrel use limit Unit (h)	48	4	5	6	0.2
Reason for mandrel use limit	Frequent occurrence of tow clogging in tongue unit (due to wear on mandrel surface)	Frequent occurrence of tow clogging in tongue unit (due to wear on mandrel surface)	Frequent occurrence of fluffing or deformation (no wear on mandrel surface)	Frequent occurrence of tow clogging in tongue unit (due to wear on mandrel surface)	Frequent occurrence of fluffing or deformation Frequent occuarrence of tow clogging in tongue unit
Defective product rejection rate Unit (%)	1.02	0.94	0.86	1.67	20~30

Fig. 10

Rejection content	First example (PEEK fluorine composite coating)	First comparative example (existing mandrel manufactured by Hauni Maschinenbau AG)
Fluffing of inner circle Unit (%)	0	0.01
Deformation of inner circle Unit (%)	0.02	0.16
Roundness and wall thickness Unit (%)	0.09	0.19
Total	0.11	0.36

Fig. 11

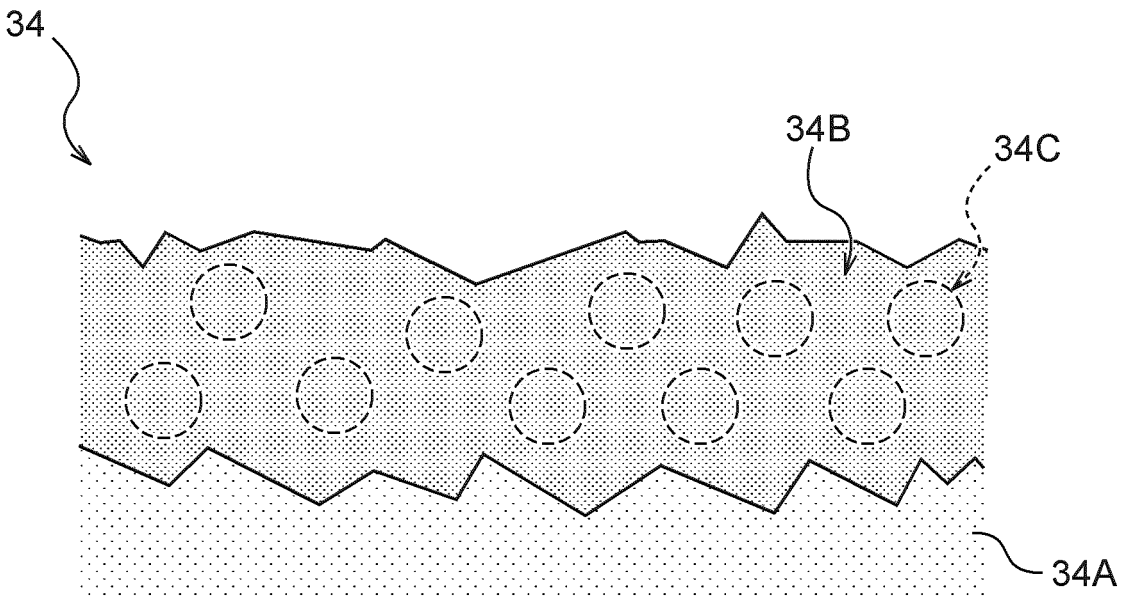


Fig. 12A

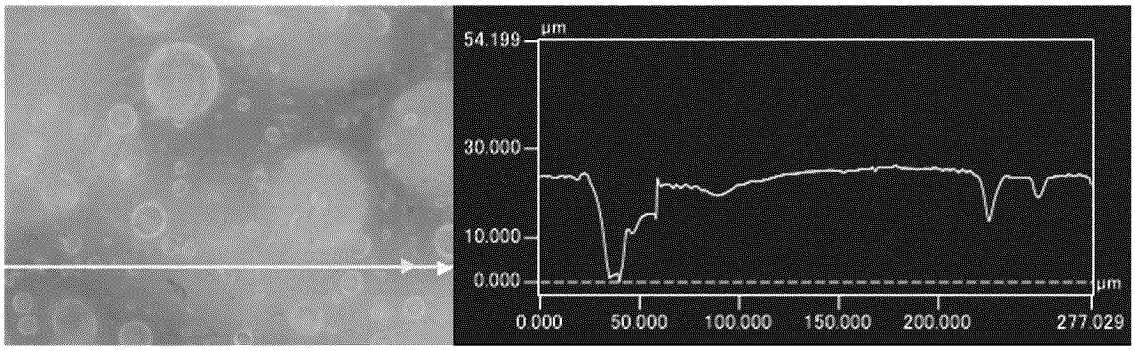


Fig. 12B

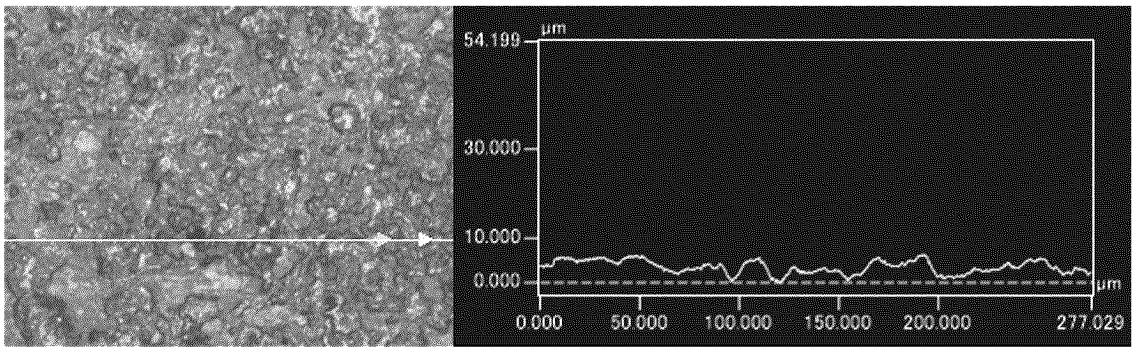
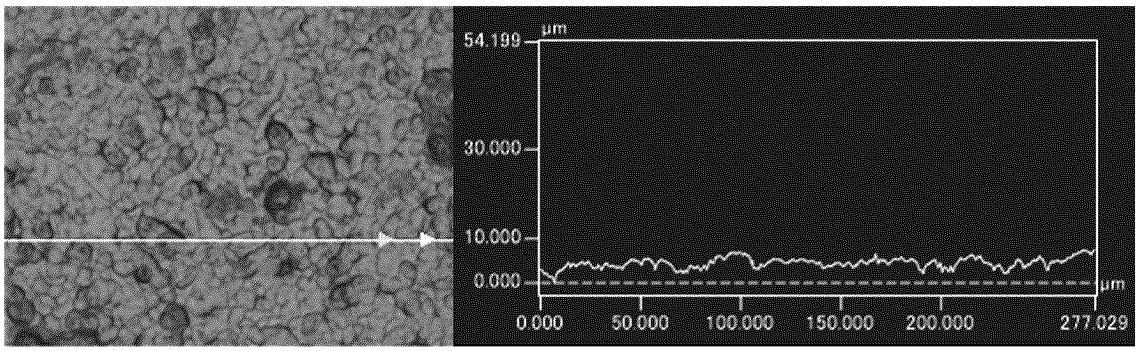


Fig. 12C



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/012610

A. CLASSIFICATION OF SUBJECT MATTER

A24D 3/02(2006.01)i; ***A24D 3/17***(2020.01)i
FI: A24D3/02; A24D3/17

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; A24D3/17

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

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.
Y	JP 2019-502369 A (PHILIP MORRIS PRODUCTS S.A.) 31 January 2019 (2019-01-31) paragraphs [0007]-[0064], fig. 1-4	1-11
Y	JP 2003-48273 A (NIKKEN TOSO KOGYO KK) 18 February 2003 (2003-02-18) paragraphs [0004]-[0012], fig. 1	1-5, 7-8, 10
Y	JP 2004-97220 A (HAUNI MASCHINENBAU AG) 02 April 2004 (2004-04-02) paragraphs [0012], [0042], fig. 2a	6-7, 9, 11
Y	JP 2000-83642 A (MITSUBISHI RAYON CO., LTD.) 28 March 2000 (2000-03-28) paragraphs [0013], [0014], [0016], fig. 1	6-7, 9, 11
Y	JP 2002-362991 A (ASAHI KASEI CORP.) 18 December 2002 (2002-12-18) paragraphs [0019]-[0025], fig. 3, 4	6-7, 9, 11
Y	JP 2009-281529 A (TOYO SEIKAN KAISHA LTD.) 03 December 2009 (2009-12-03) paragraphs [0005], [0047], fig. 2, 3	6-7, 9, 11

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 May 2022	**24 May 2022**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/012610

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Document 1: JP 2019-502369 A (PHILIP MORRIS PRODUCTS S.A.) 31 January 2019 (2019-01-31), paragraphs [0007]-[0064], fig. 1-4 & US 2018/0343918 A1, paragraphs [0007]-[0068], fig. 1-4 & WO 2017/089514 A1 & CN 108348000 A & KR 10-2018-0088374 A

The claims are classified into the following two inventions.

(Invention 1) Claims 1-5, 8 and 10 and claim 7 referring to claim 1

Claims 1-5, 8 and 10 and claim 7 referring to claim 1 have the special technical feature of "a mandrel used for a device for manufacturing a hollow acetate tube to be applied to a heated tobacco product, the mandrel comprising a metal mandrel body and a composite resin film formed on the surface of the mandrel body by melting a composite resin comprising a fluororesin and one or more resins selected from the group consisting of PEEK resins, PEKK resins, PPS resins and PES resins", and thus are classified as invention 1.

(Invention 2) Claims 6, 9 and 11 and claim 7 referring to claim 6

Claims 6, 9 and 11 and claim 7 referring to claim 6 and claims 1-5, 8 and 10 and claim 7 referring to claim 1 classified as invention 1 share the technical feature of a "mandrel used for a device for manufacturing a hollow acetate tube to be applied to a heated tobacco product, the mandrel comprising a metal mandrel body and a film formed on the surface of the mandrel body". However, said technical feature does not make a contribution over the prior art in light of the disclosures in document 1 and thus is not considered to be a special technical feature.

Moreover, there are no other same or corresponding special technical features between claim 6, 9 and 11 and claim 7 referring to claim 6 and claims 1-5, 8 and 10 and claim 7 referring to claim 1.

Further, claims 6, 9 and 11 and claim 7 referring to claim 6 are not dependent on claim 1.

In addition, claims 6, 9 and 11 and claim 7 referring to claim 6 are not substantially identical to or similarly closely related to any of the claims classified as invention 1.

Therefore, claims 6, 9 and 11 and claim 7 referring to claim 6 cannot be classified as invention 1.

Claims 6, 9 and 11 and claim 7 referring to claim 6 have the special technical feature of a "mandrel used for a device for manufacturing a hollow acetate tube to be applied to a heated tobacco product, the mandrel comprising a metal mandrel body and a hard chromium carbide plating film formed on the surface of the mandrel body", and thus are classified as invention 2.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☑ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/012610

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2019-502369 A	31 January 2019	US 2018/0343918 A1 paragraphs [0007]-[0068], fig. 1-4 WO 2017/089514 A1 CN 108348000 A KR 10-2018-0088374 A	
JP 2003-48273 A	18 February 2003	(Family: none)	
JP 2004-97220 A	02 April 2004	US 2004/0087424 A1 paragraphs [0012], [0045], fig. 2a EP 1397967 A1 CN 1489948 A	
JP 2000-83642 A	28 March 2000	(Family: none)	
JP 2002-362991 A	18 December 2002	(Family: none)	
JP 2009-281529 A	03 December 2009	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2019502369 W **[0003]**
- JP 3905730 B **[0054]**