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(54) **CRIMPER AND METHOD FOR PRODUCING TOW BAND**

(57) A crimper (1) includes: a pair of nip rolls (2) including respective peripheral surfaces between which conveyed filaments (11) pass; a first member (6) and a second member (7) including contact surfaces (6a, 7a) that come into contact with the filaments and being disposed on a downstream side of the pair of nip rolls in a conveyance direction of the filaments, the respective

contact surfaces being disposed facing each other across a gap; and a pressing member (5) disposed in the gap and configured to press the filaments toward the contact surface of any of the first member and the second member. A surface roughness Ra of the contact surfaces is set to a value in a range of from 0.1 to 1.0.

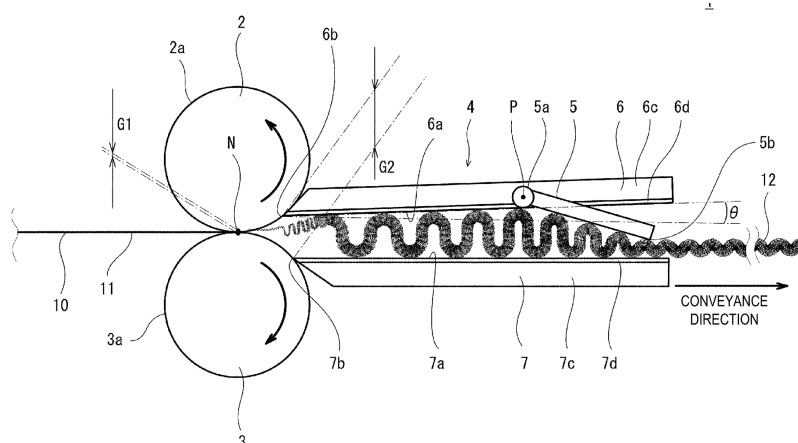


FIG. 1

Description

Technical Field

5 **[0001]** The present disclosure relates to a crimper that crimps filaments, and a method for producing a tow band made of the crimped filaments.

Background Art

10 **[0002]** A crimper such as that disclosed in Patent Document 1 is used when producing a crimped tow band. This crimper includes a pair of nip rolls, a pair of plate members (chamber), and a pressing member (flapper). In the crimper, filaments are inserted between the pair of nip rolls while being conveyed and are then crimped. The filaments that have passed through the pair of nip rolls are conveyed while being made to meander by plate surfaces of the pair of plate members, and are pressed against one of the plate surfaces of the pair of plate members by the pressing member. As
15 a result, the filaments are further crimped.

Citation List

Patent Document

20 **[0003]** Patent Document 1: JP (Translation of PCT Application) 2009-501282 T

Summary of Invention

25 Technical Problem

[0004] The crimper having the configuration described above needs to be appropriately set up to prevent the filaments being subject to, from the plate surfaces of the pair of plate members, frictional force that is excessively large relative to force (hereinafter, may be simply referred to as conveyance force) for sending the filaments toward the downstream side in a conveyance direction using the pair of nip rolls. When such set up is inappropriate, a tow band that is uniformly crimped may be difficult to produce stably. When the crimping of a tow band is not uniform, for example, the pressure drop (PD) of a cigarette filter produced using this tow band will vary, whereby the quality of the cigarette filter will decrease.
30 **[0005]** In view of the above, an object of the present disclosure is to enable stable production of uniformly crimped tow bands.

35 Solution to Problem

[0006] To solve the problems described above, a crimper according to one aspect of the present disclosure includes: a pair of nip rolls including respective peripheral surfaces between which conveyed filaments pass; a first member and
40 a second member including respective contact surfaces that come into contact with the filaments and being disposed on a downstream side of the pair of nip rolls in a conveyance direction of the filaments, the contact surfaces being disposed facing each other across a gap; and a pressing member disposed in the gap and configured to press the filaments toward the contact surface of any of the first member and the second member. In the crimper according to one aspect of the present disclosure, a surface roughness Ra of the contact surfaces of the pressing member is set to a value in a range of from 0.1 to 1.0.

[0007] With the configuration described above, the surface roughness Ra of the contact surfaces of the first member and the second member is set to a value in the range of from 0.1 to 1.0. Thus, the frictional force applied to the filaments by the pair of contact surfaces is adjusted to a value that is not excessively large with respect to the conveyance force applied to the filaments by the pair of nip rolls, and thus the filaments can be more uniformly crimped by the crimper. As
50 a result, the uniformly crimped tow band can be stably produced.

[0008] The Rockwell hardness HRC of the first member and the second member may be set to a value in a range of from 50 to 60. Furthermore, the Vickers hardness HV of the first member and the second member may be set to a value of 350 or greater. Since the types of hardness of the first member and the second member are set to values in the appropriate ranges, wear of the contact surfaces can be suppressed. This makes it possible to stably crimp the filaments.

55 **[0009]** At least one of the first member or the second member may include a substrate having a flat plate shape and a coating film that covers a surface of the substrate and is harder than the substrate, the coating film including the contact surface that is positioned on an opposite side of the coating film from the substrate. In this case, the coating film may be a chromium nitride film. By using a member including the substrate and the coating film, the wear of the contact

surfaces of the first member and the second member can be suppressed over a long period of time.

[0010] A coefficient of kinetic friction between the contact surfaces and the filaments may be set to a value in a range of from 0.1 to 0.5. Thus, the frictional force applied to the filaments by the pair of contact surfaces is easily adjusted to a value that is not excessively large with respect to the conveyance force applied to the filaments by the pair of nip rolls.

[0011] A velocity CV, represented by Equation 1, of the filaments conveyed in the gap may be set to a value between 0% and 100%:

[Equation 1]

$$\text{Velocity CV (\%)} = (\sigma/V_m) \times 100,$$

where V_m is an average velocity value that is an average of measured values of a velocity of the filaments immediately before the velocity of the filaments is shifted from acceleration to deceleration within a unit time and of a velocity of the filaments immediately before the velocity is shifted from deceleration to acceleration within the unit time, and σ is a standard deviation of the measured values.

[0012] With this configuration, since the filaments are conveyed at a stable velocity inside the crimper, the crimper can efficiently and easily crimp the filaments uniformly.

[0013] The content of titanium oxide in the filaments may be set to a value in a range of from 0 wt.% to 0.1 wt.%. The crimper can easily crimp the filaments uniformly even when the amount of titanium oxide is set to a value in the range described above.

[0014] A method for producing a tow band according to one aspect of the present disclosure includes a step, the step including: causing conveyed filaments to pass between respective peripheral surfaces of a pair of nip rolls; introducing the filaments having passed between the pair of nip rolls into a gap between a first member and a second member disposed on a downstream side of the pair of nip rolls in a conveyance direction of the filaments and having respective contact surfaces disposed facing each other across the gap; and pressing the filaments toward the contact surface of any of the first member and the second member using a pressing member disposed in the gap, in which, in the step, the first member and the second member used have a surface roughness R_a of the contact surfaces set to a value in a range of from 0.1 to 1.0.

[0015] With the production method described above, by setting the surface roughness R_a of the contact surfaces of the first member and the second member to a value in the range of from 0.1 to 1.0, the frictional force applied to the filaments by the pair of contact surfaces can be adjusted to a value that is not excessively large with respect to the conveyance force applied to the filaments by the pair of nip rolls. This makes it possible to uniformly crimp the filaments. As a result, a uniformly crimped tow band can be stably produced.

[0016] In the step described above, the first member and the second member having a Rockwell hardness HRC set to a value in a range of from 50 to 60 may be used. In the step described above, the first member and the second member having a Vickers hardness HV set to a value of 350 or greater may be used. With each of these production methods, the hardness of the contact surfaces of the first member and the second member can be set to a value in an appropriate range, and thus the wear of the contact surfaces can be suppressed. This makes it possible to stably crimp the filaments.

[0017] In the step described above, at least one of the first member or the second member including a substrate having a flat plate shape and a coating film that covers a surface of the substrate and is harder than the substrate may be used, and the coating film including the contact surface that is positioned on an opposite side of the coating film from the substrate. In this case, in the step described above, the first member and the second member in which the coating films are chromium nitride films may be used. By using such members including the substrates and the coating films, the wear of the contact surfaces of the first member and the second member can be suppressed over a long period of time.

[0018] In the step described above, the first member and the second member used having a coefficient of kinetic friction between the contact surfaces and the filaments set to a value in a range of from 0.1 to 0.5 may be used. Thus, the frictional force applied to the filaments by the pair of contact surfaces is more easily adjusted to a value that is not excessively large with respect to the conveyance force applied to the filaments by the pair of nip rolls. This makes it possible to more stably crimp the filaments.

[0019] In the step described above, a velocity CV, represented by Equation 1, of the filaments conveyed in the gap may be set to a value between 0% and 100%:

[Equation 1]

$$\text{Velocity CV (\%)} = (\sigma/V_m) \times 100,$$

where V_m is an average velocity value that is an average of measured values of a velocity of the filaments immediately before the velocity of the filaments is shifted from acceleration to deceleration within a unit time and of a velocity of the filaments immediately before the velocity is shifted from deceleration to acceleration within the unit time, and σ is a standard deviation of the measured values.

[0020] With this method, the filaments are conveyed at a stable velocity in the gap, and thus the filaments can be efficiently and easily crimped uniformly.

[0021] In the step described above, the filaments having a content of titanium oxide set to a value from 0 wt.% to 0.1 wt.% may be used. The filaments can be easily crimped uniformly even when the amount of titanium oxide is set to a value in the range described above.

Advantageous Effects of Invention

[0022] According to the aspects of the present disclosure, a uniformly crimped tow band can be stably produced.

Brief Description of Drawings

[0023]

FIG. 1 is a schematic view of a crimper according to an embodiment.

FIG. 2 is a graph showing a relationship between the surface roughness R_a of contact surfaces of a first member and a second member and a velocity CV of a yarn bundle in a chamber.

Description of Embodiments

Embodiment

[0024] An embodiment will be described below with reference to the drawings. The term "conveyance direction" hereinafter refers to the conveyance direction of a yarn bundle (a bundle of a plurality of filaments 11) 10.

[0025] FIG. 1 is a schematic view of a crimper 1 according to an embodiment. The crimper 1 crimps a plurality of filaments 11 to be conveyed. The content of titanium oxide in the filaments 11 of the present embodiment is set to a value in a range of from 0 wt.% to 0.1 wt.% as an example. That is, the filaments 11 of the present embodiment have a very low content of titanium oxide, or do not contain any titanium oxide. The plurality of filaments 11 are introduced to the crimper 1 on the upstream side of the crimper 1 in a state where water has been applied to the filaments 11.

[0026] As illustrated in FIG. 1, the crimper 1 includes a pair of nip rolls 2 and 3 (first nip roll 2 and second nip roll 3), a chamber (stuffing box) 4, and a pressing member 5. As illustrated in FIG. 1, the pair of nip rolls 2 and 3 are axially supported with the respective peripheral surfaces facing each other in one direction (here, the vertical direction) perpendicular to the conveyance direction of the yarn bundle 10 to be conveyed. The pair of nip rolls 2 and 3 are rotated inversely to each other. A gap $G1$ between the pair of nip rolls 2 and 3 is adjusted by pressing the nip roll 2 toward the nip roll 3 using a pressing device (not illustrated).

[0027] The pair of nip rolls 2 and 3 cause the yarn bundle 10 to pass between their peripheral surfaces and crimp the yarn bundle 10. The yarn bundle 10 is nipped at a nip point N of the pair of nip rolls 2 and 3 with the plurality of filaments 11 arranged in a flat band shape along the axial directions of the pair of nip rolls 2 and 3. As a result, the plurality of filaments 11 constituting the yarn bundle 10 are primarily crimped.

[0028] The material of the nip rolls 2 and 3 can be selected as appropriate. Examples of the material of the peripheral surface of the nip rolls 2 and 3 include SACM (aluminum-chromium-molybdenum steel). The nip rolls 2 and 3 have a hard coating film formed on their peripheral surfaces.

[0029] The chamber 4 is disposed downstream of the pair of nip rolls 2 and 3 in the conveyance direction. The chamber 4 includes a first member 6 and a second member 7. The first member 6 and the second member 7 have contact surfaces 6a and 7a, respectively, that are in contact with the filaments 11. The contact surfaces 6a and 7a are disposed facing each other across a gap.

[0030] Specifically, the first member 6 and the second member 7 have a long flat plate shape, for example, and extend in the conveyance direction of the yarn bundle 10 that has passed between the peripheral surfaces of the pair of nip rolls 2 and 3. At this time, the width direction of the first member 6 and the second member 7 are aligned with the axial direction of the pair of nip rolls 2 and 3. The coefficient of kinetic friction between the contact surfaces 6a and 7a and the filaments 11 is set to a value in a range of from 0.1 to 0.5. The coefficient of kinetic friction can be adjusted by, for example, changing the surface shapes of the contact surfaces 6a and 7a. The coefficient of kinetic friction decreases as the surface shapes of the contact surfaces 6a and 7a become smoother, and increases as the surface shapes become rougher in a certain range, for example.

[0031] The first member 6 and the second member 7 of the present embodiment are plate members. The contact surfaces 6a and 7a are plate surfaces of the first member 6 and the second member 7, respectively. The material of the members 6 and 7 can be set as appropriate. As an example, the members 6 and 7 have substrates 6c and 7c each having a flat plate shape and coating films 6d and 7d that each cover the surfaces of the substrates 6c and 7c and are harder than the substrates 6c and 7c, respectively. The coating films 6d and 7d are disposed facing each other. The contact surfaces 6a and 7a are surfaces that are positioned on opposite sides of the coating films 6d and 7d from the substrates 6c and 7c, respectively. The thickness dimension of the coating films 6d and 7d can be set as appropriate, and for example, can be set to a value in a range of from several micrometers to several tens of micrometers. Note that at least one of the first member 6 or the second member 7 is not necessarily a plate member.

[0032] Examples of the material of the substrates 6c and 7c include beryllium copper (BeCu) (C1720(T) and the like), stainless steel (SUS304 (austenitic stainless steel)), SUS440C (martensitic stainless steel), and the like, and ceramic. Examples of the material of the coating films 6d and 7d include chromium nitride. In the present embodiment, the substrates 6c and 7c are made of SUS440C. The coating films 6d and 7d are chromium nitride films.

[0033] An upstream end 6b of the first member 6 in the conveyance direction is close to the peripheral surface of the first nip roll 2. The contact surface 6a of the first member 6 is disposed away from the contact surface 7a of the second member 7 while inclining at an inclination angle θ with respect to the contact surface 7a from the end 6b of the first member 6 toward the other end of the first member 6. An upstream end 7b of the second member 7 in the conveyance direction is close to the peripheral surface of the second nip roll 3. A gap G2 between the ends 6b and 7b is the shortest gap between the members 6 and 7, and can be set as appropriate.

[0034] The pressing member 5 is disposed in the gap between the members 6 and 7, and presses the filaments 11 toward the contact surfaces 6a and 7a of either of the members 6 and 7. As an example, the pressing member 5 is a plate member that extends in the axial direction of the pair of nip rolls 2 and 3. The pressing member 5 is axially supported by the first member 6 in a state where an upstream end 5a of the pressing member 5 can turn in the conveyance direction about a rotation axis P. The pressing member 5 is biased by a biasing member (not illustrated) having an elastic body such as a spring. Thus, the pressing member 5 presses the yarn bundle 10 against the contact surface 7a in the direction from the first member 6 toward the second member 7 at a downstream end 5b of the pressing member 5 in the conveyance direction.

[0035] After passing between the pair of nip rolls 2 and 3, the yarn bundle 10 is pressed into the chamber 4. In the crimper 1, the yarn bundle 10 is highly crimped as the yarn bundle 10 moves toward the downstream side in the conveyance direction while meandering between the members 6 and 7 and pressed by the pressing member 5 against the contact surface 7a. The conveyance velocity of the yarn bundle 10 when conveyed in the chamber 4 varies. As illustrated in FIG. 1, after the yarn bundle 10 passes through the crimper 1, the yarn bundle 10 becomes a crimped tow band 12.

[0036] Here, in the crimper 1, a surface roughness Ra of the contact surfaces 6a and 7a of the members 6 and 7 is set to a value in a range of from 0.1 to 1.0. The surface roughness Ra herein is a center-line average surface roughness Ra, and is a value calculated by the method according to JIS B 0601 (1994) using the high precision shape measurement system KS-1100 (available from Keyence Corporation).

[0037] Thus, by setting the surface roughness Ra of the contact surfaces 6a and 7a of the members 6 and 7 to the above value, the frictional force applied to the filaments 11 by the contact surfaces 6a and 7a is set to a value in an appropriate range. Thus, the difference between the conveyance force applied to the filaments 11 by the pair of nip rolls 2 and 3 and the frictional force applied to the filaments 11 by the contact surfaces 6a and 7a is adjusted to a certain value that is not excessively small. As a result, the conveyance velocity of the yarn bundle 10 (filaments 11) conveyed in the chamber 4 is stabilized, and a tow band 12 in which the filaments 11 are uniformly crimped by the crimper 1 can be obtained.

[0038] The value of the surface roughness Ra of the contact surfaces 6a and 7a in the above range is preferably set depending on the type of the tow band 12 to be produced (for example, the total denier (TD) of the tow band 12, the filament denier (FD) of the filaments 11, the cross-sectional shape of the filaments 11, and the composition of the filaments 11 such as the content of titanium oxide). The surface shape of the contact surfaces 6a and 7a can be formed by known methods including various blasting methods such as sandblasting and methods using discharge machining.

[0039] In the present embodiment, the Rockwell hardness HRC of the members 6 and 7 (value obtained by a Rockwell hardness HRC test using the C scale according to JIS Z2245 (2011)) is set to a value in a range of from 50 to 60. Furthermore, the Vickers hardness HV of the members 6 and 7 (value obtained by a Vickers hardness test according to JIS Z2244 (2009)) is set to a value of 350 or greater.

[0040] By setting the hardness of the contact surfaces 6a and 7a to predetermined values in this manner, the surface shape of the contact surfaces 6a and 7a with the surface roughness Ra set to the value described above can be stably retained over a long period of time.

[0041] In the crimper 1, by using the members 6 and 7 including the coating films 6d and 7d, the wear of the contact surfaces 6a and 7a of the members 6 and 7 can be suppressed over a long period of time. Furthermore, by setting the

thickness dimension of the coating films 6d and 7d to the value described above, the coating films 6d and 7d can suppress wear of the contact surfaces 6a and 7a, and the characteristics of the substrates 6c and 7c can be easily exhibited.

[0042] Furthermore, in the crimper 1, when the surface roughness Ra of the contact surfaces 6a and 7a of the members 6 and 7 is set to a value in the range of from 0.1 to 1.0, a velocity CV, represented by Equation 1, of the filaments 11 conveyed in the gap between the members 6 and 7 is set to a value between 0% and 100%.

[Equation 1]

$$\text{Velocity CV (\%)} = (\sigma/V_m) \times 100$$

where V_m is an average velocity value that is an average of the measured values of the velocity of the filaments 11 immediately before the velocity of the filaments 11 is shifted from acceleration to deceleration within a unit time and of the velocity of the filaments 11 immediately before the velocity is shifted from deceleration to acceleration within the unit time, and σ is the standard deviation of the measured values. The unit time can be set as appropriate, and is 1 second, for example.

[0043] The velocity CV represented by Equation 1 is defined as a variation in the velocity of the filaments 11 passing between the members 6 and 7 in the conveyance direction. When the velocity CV exceeds 100%, the conveyance velocity of the filaments 11 in the chamber 4 varies significantly. As a result, while the filaments 11 are being spun by a plurality of cabinets, excessive tension can act from the crimper 1 on the filaments 11 conveyed from each of the cabinets when the filaments 11 are crimped by the crimper 1 on the downstream side of the cabinets in the conveyance direction, and thus the filaments 11 conveyed from all the cabinets may be cut. In the crimper 1 of the present embodiment, by setting the velocity CV to 100% or less, excessive tension is prevented from acting on the filaments 11.

[0044] As an example, when the velocity CV is desirably low, the conveyed filaments 11 are stably and uniformly crimped by the crimper 1. The velocity CV is preferably a value in a range of from 0% to 80%, more preferably a value in a range of from 0% to 70%, and still more preferably a value in a range of from 0% to 60%.

[0045] Here, the velocity CV is a value that can be measured using the crimper 1, which is the machine actually used for producing the tow band 12. Thus, the method for adjusting the crimper 1 to appropriately crimp the filaments 11 based on the measured velocity CV is more advantageous than a method for adjusting a crimper, being the actual machine used, by using a test crimper with specifications different from those of the actual crimper to examine the behavior of the filaments 11 in the test crimper, for example, because accurate adjustment of the crimping machine 1 can be made more directly and quickly.

[0046] FIG. 2 is a graph showing a relationship between the surface roughness Ra of the contact surfaces 6a and 7a of the first member 6 and the second member 7 and the velocity CV of the yarn bundle 10 in the chamber 4. In this graph, measured data is plotted for a crimper 1 in which the material of the members 6 and 7 is beryllium copper (hereinafter referred to as a crimper A), and a crimper 1 in which the material of the members 6 and 7 is SUS440C (hereinafter referred to as a crimper B). Furthermore, the graph depicts results of measuring the velocity CV of the crimpers A and B multiple times when the surface roughness Ra of the contact surfaces 6a and 7a was set to a specific value.

[0047] As shown in the graph in FIG. 2, it was found regarding the crimper A that the average value of the velocity CV was a value close to 100% when the surface roughness Ra of the contact surfaces 6a and 7a was about 0.14, and that the average value of the velocity CV was about 95% when the surface roughness Ra of the contact surfaces 6a and 7a was about 4.6. Thus, in the crimper A, the velocity CV is assumed to slowly decrease as the surface roughness Ra of the contact surfaces 6a and 7a increases, with the surface roughness Ra of the contact surfaces 6a and 7a falling within the range of from 0.14 to 4.6.

[0048] It was found regarding the crimper B that the average value of the velocity CV was a value close to 100% when the surface roughness Ra of the contact surfaces 6a and 7a was about 0.24, and that the average value of the velocity CV was about 65% when the surface roughness Ra of the contact surfaces 6a and 7a was about 0.44. Thus, in the crimper B, the velocity CV is assumed to slowly decrease as the surface roughness Ra of the contact surfaces 6a and 7a increases, with the surface roughness Ra of the contact surfaces 6a and 7a falling within the range of from 0.24 to 0.44.

[0049] Furthermore, it was found regarding the crimper B that the average value of the velocity CV was 75% when the surface roughness Ra of the contact surfaces 6a and 7a was 0.8. Thus, for the crimper B, there was a change point at which the velocity CV shifted from deceleration to acceleration as the surface roughness Ra of the contact surfaces 6a and 7a increased, with the surface roughness Ra of the contact surfaces 6a and 7a falling within the range of from 0.44 to 0.8. However, from the tendency indicated by the graph in FIG. 2, it is expected that the average value of the velocity CV of the crimper B does not exceed about 100%, at least when the surface roughness Ra of the contact surfaces 6a and 7a falls within the range of from 0.15 to 0.9.

[0050] From the measurement results of the crimpers A and B and the observations therefrom, it is expected that a uniformly crimped tow band 12 can be stably produced by limiting the velocity CV when the surface roughness Ra of

the contact surfaces 6a and 7a falls within a range of from 0.1 to 1.0. As an example, the surface roughness Ra of the contact surfaces 6a and 7a is more preferably a value in a range of from 0.15 to 0.9, still more preferably a value in a range of from 0.3 to 0.8, and yet more preferably a value in a range of from 0.4 to 0.75. In yet another example, to keep the velocity CV less than 100%, the surface roughness Ra of the contact surfaces 6a and 7a is preferably a value in a range of from 0.2 to 0.9.

[0051] In yet another example, to limit the velocity CV, the lower limit value of the surface roughness Ra of the contact surfaces 6a and 7a is preferably any of 0.1, 0.15, 0.2, 0.3, or 0.4, and the upper limit value of the surface roughness Ra of the contact surfaces 6a and 7a is preferably any of 0.75, 0.8, 0.9, or 1.0.

[0052] As described above, in the crimper 1, the surface roughness Ra of the contact surfaces 6a and 7a of the members 6 and 7 is set to a value in the range of from 0.1 to 1.0. Thus, the frictional force applied to the filaments 11 by the pair of contact surfaces 6a and 7a is adjusted to a value that is not excessively large with respect to the conveyance force applied to the filaments 11 by the pair of nip rolls 2 and 3, and thus the filaments 11 can be more uniformly crimped by the crimper 1. As a result, a uniformly crimped tow band 12 can be stably produced.

[0053] In the crimper 1, the Rockwell hardness HRC of the first member 6 and the second member 7 is set to a value in a range of from 50 to 60. Furthermore, the Vickers hardness HV of the first member 6 and the second member 7 is set to a value of 350 or greater. Thus, since the types of hardness of the members 6 and 7 are set to values in the appropriate ranges, wear of the contact surfaces 6a and 7a can be suppressed. As a result, the filaments 11 can be stably crimped. Furthermore, when the Rockwell hardness HRC of the members 6 and 7 is kept to 60 or less, the members 6 and 7 are easily produced.

[0054] At least one of the first member 6 or the second member 7 (here, both of them) includes the flat plate-like substrates 6c and 7c and the coating films 6d and 7d that cover the surfaces of the substrates 6c and 7c and are harder than the substrates 6c and 7c, the coating film 6d and 7d including the contact surfaces 6a and 7a are positioned on opposite sides of the coating film 6d and 7d from the substrates 6c and 7c. The coating films 6d and 7d are chromium nitride films as an example. By using such members 6 and 7 including the substrates 6c and 7c and the coating films 6d and 7d, wear of the contact surfaces 6a and 7a of the members 6 and 7 can be suppressed over a long period of time.

[0055] The coefficient of kinetic friction between the contact surfaces 6a and 7a of the members 6 and 7 and the filaments 11 is set to a value in a range of from 0.1 to 0.5. Thus, the frictional force applied to the filaments 11 by the pair of contact surfaces 6a and 7a is easily adjusted to a value that is not excessively large with respect to the conveyance force applied to the filaments 11 by the pair of nip rolls 2 and 3. This makes it possible to further stabilize the crimping of the filaments 11.

[0056] In the present embodiment, the velocity CV, represented by Equation 1, of the filaments 11 conveyed along the gap between the members 6 and 7 is set to a value between 0% and 100%. With this configuration, the filaments 11 are conveyed at a stable velocity inside the crimper 1, and thus the crimper 1 can efficiently and easily crimp the filaments 11 uniformly.

[0057] In the present embodiment, the content of titanium oxide in the filaments 11 is set to a value in a range of from 0 wt.% to 0.1 wt.%. The crimper 1 can easily crimp the filaments 11 uniformly even when the amount of titanium oxide in the filaments 11 is set to a value in the range described above.

[0058] A method for producing the tow band 12 according to one aspect of the present disclosure includes a step using the crimper 1. That is, this production method includes a step, the step including: causing the filaments 11 that are conveyed to pass between the peripheral surfaces of the pair of nip rolls 2 and 3, introducing the filaments 11 having passed between the pair of nip rolls 2 and 3 into the gap between the first member 6 and the second member 7 disposed on the downstream side of the pair of nip rolls 2 and 3 in the conveyance direction of the filaments 11 and having the respective contact surfaces 6a and 7a disposed facing each other across the gap, and pressing the filaments 11 toward the contact surface of any of the members 6 and 7 using the pressing member 5 disposed in the gap.

[0059] In the step described above of the present embodiment, the first member 6 and the second member 7 having a Rockwell hardness HRC set to a value in a range of from 50 to 60 are used. In the step described above, the first member 6 and the second member 7 having a Vickers hardness HV set to a value of 350 or greater are used. In the step described above, at least one of the first member 6 or the second member 7 (here, both of them) including the substrates 6c and 7c and the coating films 6d and 7d is used, and the coating films 6d and 7d including contact surfaces 6a and 7a that are positioned on opposite sides of the coating film 6d and 7d from the substrates 6c and 7c. In the step described above, the members 6 and 7 in which the contact surfaces 6a and 7a have chromium nitride films are used.

[0060] With each of the production methods described above, by setting the surface roughness Ra of the contact surfaces of the first member 6 and the second member 7 to a value in the range of from 0.1 to 1.0, the frictional force applied to the filaments 11 by the pair of contact surfaces 6a and 7a can be adjusted to a value that is not excessively large with respect to the conveyance force applied to the filaments 11 by the pair of nip rolls 2 and 3. This makes it possible to uniformly crimp the filaments 11. As a result, a uniformly crimped tow band 12 can be stably produced.

[0061] In the step described above, the members 6 and 7 having a coefficient of kinetic friction between the contact surfaces 6a and 7a and the filaments 11 set to a value in a range of from 0.1 to 0.5 are used. Thus, the frictional force

applied to the filaments 11 by the pair of contact surfaces 6a and 7a is more easily adjusted to a value that is not excessively large with respect to the conveyance force applied to the filaments 11 by the pair of nip rolls 2 and 3. This makes it easy to crimp the filaments 11 more stably.

[0062] In the step described above, the velocity CV, represented by Equation 1, of the filaments 11 conveyed in the gap between the members 6 and 7 is set to a value between 0% and 100%. With this method, the filaments 11 are conveyed at a stable velocity in the gap, and thus the filaments 11 can be efficiently and easily crimped uniformly.

[0063] In the step described above, the filaments 11 having a content of titanium oxide set to a value from 0 wt.% to 0.1 wt.% are used. The filaments 11 can be easily crimped uniformly even when the amount of titanium oxide in the filaments 11 is set to a value in the range described above.

Confirmation Test

[0064] A confirmation test will be described next, but the present disclosure is not limited to each Example described below. As listed in Table 1, crimpers 1 of Examples 1 to 7 with different configurations of the pair of nip rolls 2 and 3 and the members 6 and 7 were prepared.

[Table 1]

	Material	Vickers hardness HV	Rockwell hardness HRC	Surface Roughness Ra
Example 1	Nip rolls: SACM	800	65	0.4
	First and second members: Beryllium copper	400	40	0.1
Example 2	Nip rolls: SACM	800	65	0.4
	First and second members: SUS304	187	13	0.2
Example 3	Nip rolls: SACM	800	65	0.4
	First and second members: SUS440C (contact surfaces polished)	Above 615	56	0.2
Example 4	Nip rolls: SACM	800	65	0.4
	First and second members: SUS440C (contact surfaces with normal roughness)	Above 615	56	0.4
Example 5	Nip rolls: SACM	800	65	0.4
	First and second members: SUS440C (contact surfaces blast-treated)	Above 615	56	0.8
	Nip rolls: SACM	800	65	0.4
Example 6	First and second members: SUS440C (with a coating film formed from a chromium nitride film)	2400	104	0.4
Example 7	Nip rolls: SACM (with a coating film formed from a chromium nitride film)	2500	106	0.4
	First and second members: SUS440C (with a coating film formed from a chromium nitride film)	2200	104	0.4

[0065] The crimpers 1 of Examples 1 to 7 were driven under the same driving condition to produce tow bands 12. Under this condition, based on Equation 1, the velocity CV was measured for each crimper 1 using a high-velocity camera capable of capturing images of the yarn bundle 10 conveyed in the chamber 4. The unit time was set to 1 second.

[0066] Filaments 11 having a Y-shaped cross-section with the FD set to 6.0 were used as the filaments 11 used for producing the tow band 12. The TD of the tow band 12 was set to 17000. Using the tow bands 12 produced by the crimpers 1 of Examples 1 to 7, cylindrical plugs (length dimension: 120 mm, circumferential length: 24.4 mm) were produced as semi-products immediately before producing (cutting out) cigarette filters with a predetermined length dimension.

[0067] Next, the pressure drop of each of the plugs produced by the crimpers 1 of Examples 1 to 7 and a value (PDCV)

of variation in the standard deviation of the pressure drop of the plugs were examined. The pressure drop was calculated with the tow weights and the plug circumference of the plugs corrected to be uniform. Furthermore, 15 plugs of each of Examples 1 to 7 were grouped as a single set, and a CV value indicating a variation in the pressure drop of each of the single set of plugs was calculated. Then, the PDCV was calculated as the average value of the CV values obtained from 10 sets.

[0068] The result indicates that the PDCV of the plugs using the tow band 12 of any of Examples 1 to 7 is within a predetermined standard value or less. Thus, it was confirmed that in Examples 1 to 7, a cigarette filter with uniform and excellent pressure drop can be produced.

[0069] The tow band 12 was produced using the crimper 1 of Example 4. A plug was produced using this tow band 12, and the pressure drop and PDCV of the plug was calculated by the method described above.

[0070] The results indicate that a plug produced by the crimper 1 of Example 6 achieves a PDCV even smaller than that achieved by the plug produced by the crimper 1 of Example 4. Furthermore, it was found that the performance of Example 6 was maintained after operating the crimper 1 of Example 6 for at least 90 days. Supposedly, this is due to the coating films 6d and 7d made of chromium nitride films formed on the members 6 and 7, leading to improved wear resistance of the contact surfaces 6a and 7a of the members 6 and 7 and ensuring that the surface shape of the contact surfaces 6a and 7a is maintained over a long period of time.

[0071] Considering the configurations of the crimpers 1 of Examples 1 to 7, it is expected that the Rockwell hardness HRC of the members 6 and 7 is preferably set to a value in a range of from 13 to 104, for example. Considering the wear resistance, ease of production, and the like of the members 6 and 7, it is expected that the Rockwell hardness HRC of the members 6 and 7 is more preferably set to a value in a range of from 50 to 60, for example. Alternatively, considering the results of the tests with Examples 1 to 7, it is expected that the lower limit value and the upper limit value of the Rockwell hardness HRC of the members 6 and 7 are preferably any of 13, 40, and 56 and any of 65, 104, and 106, respectively, for example.

[0072] Considering the configurations of the crimpers 1 of Examples 1 to 7, it is expected that the Vickers hardness HV of the members 6 and 7 is preferably set to a value in a range of from 187 to 2500, for example. Considering the wear resistance and the like of the members 6 and 7, it is expected that the Vickers hardness HV of the members 6 and 7 is more preferably set to a value of 350 or greater (with an upper limit value of 2500 or less as an example), for example. Alternatively, considering the results of the tests with Examples 1 to 7, it is expected that the lower limit value and the upper limit value of the Vickers hardness HV of the members 6 and 7 are preferably any of 187, 400, and 619 and any of 800, 2200, 2400, and 2500, respectively, for example.

[0073] Note that each of the configurations, combinations thereof, or the like in the embodiments are exemplary, and additions, omissions, replacements, and other changes to the configurations may be made as appropriate without departing from the spirit of the present disclosure. The present disclosure is not limited by the embodiments and is limited only by the claims. Each aspect disclosed in the present specification can be combined with any other feature disclosed herein. The filaments 11 of the yarn bundle 10 may contain titanium oxide exceeding 0.1 wt.% (set to a value in a range of from 0.3 wt.% to 0.4 wt.%, for example). The surface of the pressing member 5 that comes into contact with at least the filaments 11 may have a surface roughness that is similar to the surface roughness Ra of the contact surfaces 6a and 7a.

[0074] In a configuration where the members 6 and 7 include the coating films 6d and 7d, the coating films 6d and 7d may be locally disposed in regions of the members 6 and 7 that come into contact with the filaments 11. The Rockwell hardness HRC of the members 6 and 7 may be set to a value exceeding 60. As a result, the wear resistance of the contact surfaces 6a and 7a is further improved, and thus the surface shape of the contact surfaces 6a and 7a can be maintained stably over a longer period of time. The tow band 12 may also be used in articles other than cigarette filters (an absorbent article or a filtration member, for example).

Industrial Applicability

[0075] As described above, according to an embodiment of the present disclosure, filaments can be advantageously crimped uniformly. Therefore, it is useful to apply the present disclosure widely to crimpers and methods for producing tow bands that can achieve the significance of this advantage.

Reference Signs List

[0076]

- 1, A, B Crimper
- 2, 3 Nip roll
- 5 Pressing member

- 6 First member
- 6a Contact surface
- 6c Substrate
- 6d Coating film
- 7 Second member
- 7a Contact surface
- 7c Substrate
- 7d Coating film
- 10 Yarn bundle (plurality of filaments)
- 11 Filament
- 12 Tow band

Claims

1. A crimper comprising:

a pair of nip rolls including respective peripheral surfaces between which conveyed filaments pass;
 a first member and a second member including respective contact surfaces that come into contact with the filaments and being disposed on a downstream side of the pair of nip rolls in a conveyance direction of the filaments, the contact surfaces being disposed facing each other across a gap; and
 a pressing member disposed in the gap and configured to press the filaments toward the contact surface of any of the first member and the second member, wherein
 a surface roughness Ra of the contact surfaces is set to a value in a range of from 0.1 to 1.0.

2. The crimper according to claim 1, wherein a Rockwell hardness HRC of the first member and the second member is set to a value in a range of from 50 to 60.

3. The crimper according to claim 1 or 2, wherein a Vickers hardness HV of the first member and the second member is set to a value of 350.

4. The crimper according to any one of claims 1 to 3, wherein at least one of the first member or the second member includes a substrate having a flat plate shape and a coating film that covers a surface of the substrate and is harder than the substrate, the coating film including the contact surface that is positioned on an opposite side of the coating film from the substrate of the coating film.

5. The crimper according to claim 4, wherein the coating film is a chromium nitride film.

6. The crimper according to any one of claims 1 to 5, wherein a coefficient of kinetic friction between the contact surfaces and the filaments is set to a value in a range of from 0.1 to 0.5.

7. The crimper according to any one of claims 1 to 6, wherein a velocity CV, represented by Equation 1, of the filaments conveyed in the gap is set to a value between 0% and 100%:

[Equation 1]

$$\text{Velocity CV (\%)} = (\sigma/V_m) \times 100,$$

where Vm is an average velocity value that is an average of measured values of a velocity of the filaments immediately before the velocity of the filaments is shifted from acceleration to deceleration within a unit time and of a velocity of the filaments immediately before the velocity is shifted from deceleration to acceleration within the unit time, and σ is a standard deviation of the measured values.

8. The crimper according to any one of claims 1 to 7, wherein a content of titanium oxide in the filaments is set to a value in a range of from 0 wt.% to 0.1 wt.%.

9. A method for producing a tow band, the method comprising a step, the step including:

causing conveyed filaments to pass between respective peripheral surfaces of a pair of nip rolls;
 introducing the filaments having passed between the pair of nip rolls into a gap between a first member and a
 second member disposed on a downstream side of the pair of nip rolls in a conveyance direction of the filaments
 and having respective contact surfaces disposed facing each other across the gap; and
 pressing the filaments toward the contact surface of any of the first member and the second member using a
 pressing member disposed in the gap, wherein
 in the step, the first member and the second member having a surface roughness Ra of the contact surfaces
 set to a value in a range of from 0.1 to 1.0 are used.

10. The method for producing a tow band according to claim 9, wherein, in the step, the first member and the second member having a Rockwell hardness HRC set to a value in a range of from 50 to 60 are used.

11. The method for producing a tow band according to claim 9 or 10, wherein, in the step, the first member and the second member having a Vickers hardness HV set to a value of 350 or greater are used.

12. The method for producing a tow band according to any one of claims 9 to 11, wherein, in the step, at least one of the first member or the second member including a substrate having a flat plate shape and a coating film that covers a surface of the substrate and is harder than the substrate is used, the coating film including the contact surface that is positioned on an opposite side of the coating film from the substrate of the coating film, are used.

13. The method for producing a tow band according to claim 12, wherein, in the step, the first member and the second member in which the coating films are chromium nitride films are used.

14. The method for producing a tow band according to any one of claims 9 to 13, wherein, in the step, the first member and the second member having a coefficient of kinetic friction between the contact surfaces and the filaments set to a value in a range of from 0.1 to 0.5 are used.

15. The method for producing a tow band according to any one of claims 9 to 14, wherein, in the step, a velocity CV, represented by Equation 1, of the filaments conveyed in the gap is set to a value between 0% and 100%:

[Equation 1]

$$\text{Velocity CV (\%)} = (\sigma/V_m) \times 100,$$

where V_m is an average velocity value that is an average of measured values of a velocity of the filaments immediately before the velocity of the filaments is shifted from acceleration to deceleration within a unit time and of a velocity of the filaments immediately before the velocity is shifted from deceleration to acceleration within the unit time, and σ is a standard deviation of the measured values.

16. The method for producing a tow band according to any one of claims 9 to 15, wherein, in the step, the filaments having a content of titanium oxide set to a value from 0 wt.% to 0.1 wt.% are used.

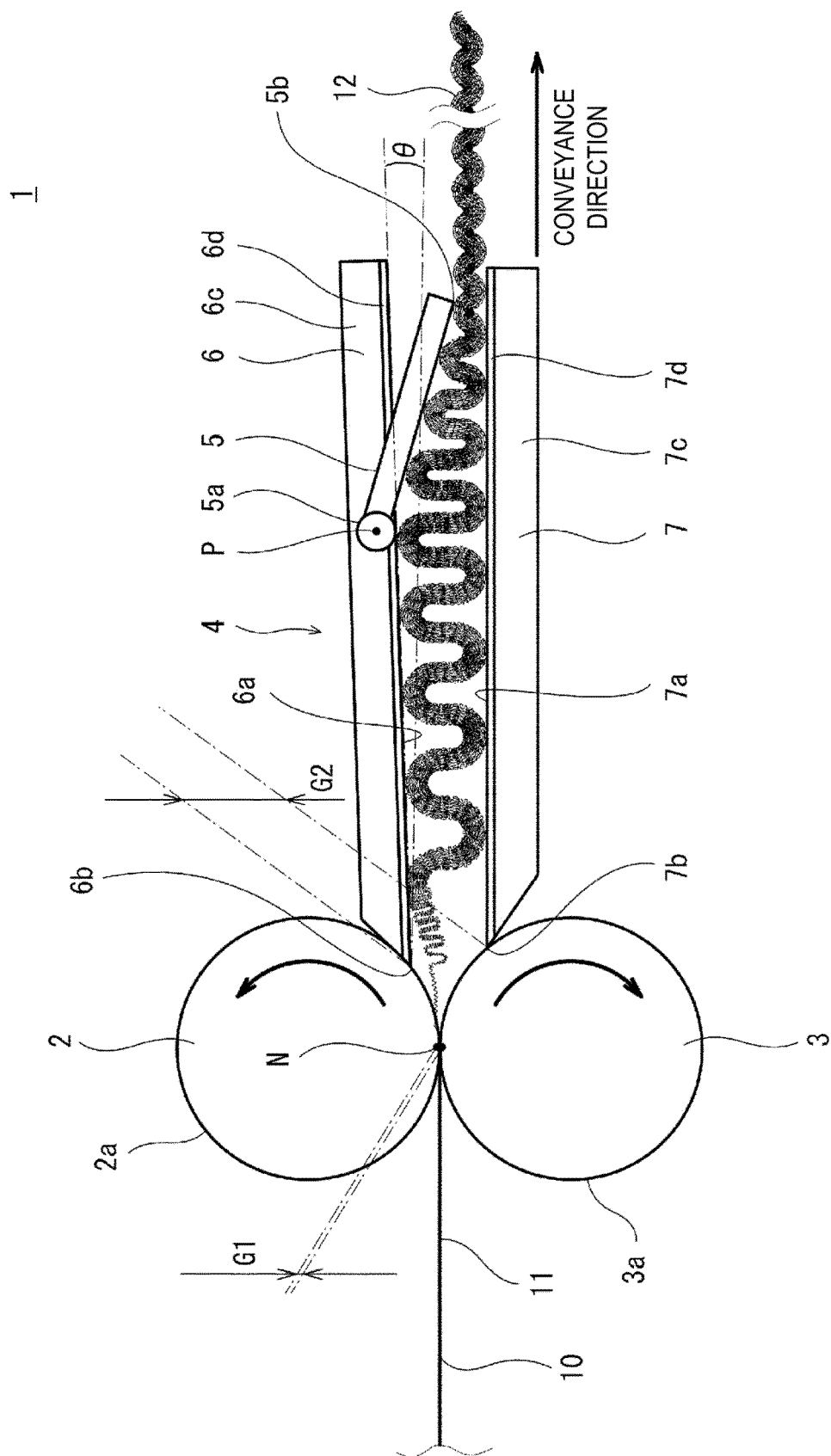


FIG. 1

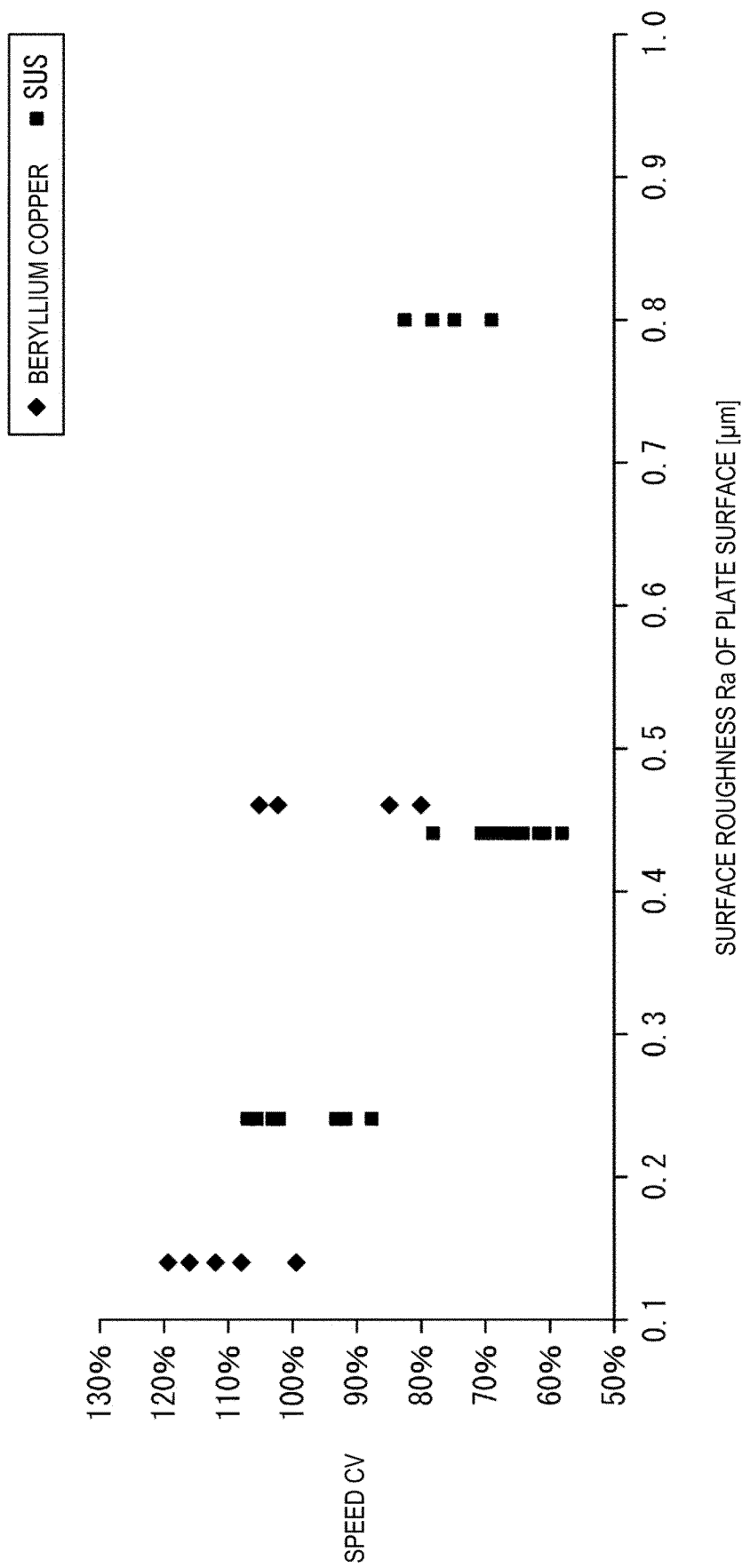


FIG. 2

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/044633

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. D02G1/12 (2006.01) i

FI: D02G1/12

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)

Int.Cl. D02G1/00-3/48, D02J1/00-13/00

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 1971-2021

Registered utility model specifications of Japan 1996-2021

Published registered utility model applications of Japan 1994-2021

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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

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Date of the actual completion of the international search
28 January 2021Date of mailing of the international search report
16 February 2021Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/044633

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

10

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 148758/1981 (Laid-open No. 56081/1983) (TEIJIN LTD.) 15 April 1983 (1983-04-15)	1-16

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