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(54) **ELECTRIC CABLE COLORING METHOD AND ELECTRIC CABLE COLORING DEVICE**

(57) The present invention is to provide a coloring method and an apparatus for forming a predetermined marking on an electric wire even when a moving speed

of the electric wire is changed. The coloring apparatus injects predetermined drops of a coloring material to an outer surface of the electric wire. The viscosity of the coloring material is 0.3mPa·s to 4.5mPa·s.

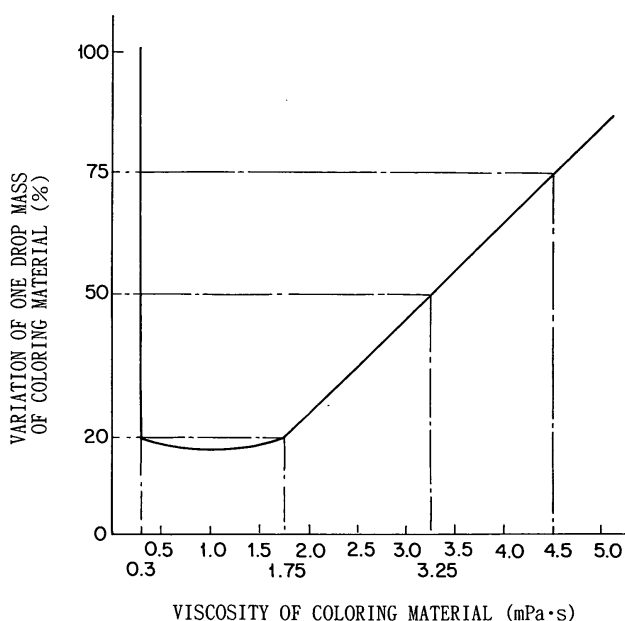


FIG. 5

Description

Technical Field

[0001] The present invention relates to a method and an apparatus for coloring an electric wire which includes a core wire and an insulating sheath covering the core wire.

Related Art

[0002] Various types of electronic units are mounted on a motor car as a moving body. The motor car includes wiring harnesses to provide electric power from a power source and control signals from a computer to the electronic units. The wiring harness includes a plurality of electric wires and a connector attached to ends of the electric wires.

[0003] The electric wire has a conductive core wire and a sheath made of an insulating synthetic resin for covering the core wire. The electric wire is a so-called sheathed wire. The connector has terminals and a connector housing to receive the terminals. The terminals made of a conductive metal sheet are fixed to the ends of the electric wires to be connected with the core wires of the electric wires. The connector housing is made of a synthetic resin and has a box shape. The electronic units are connected to the terminals in the connector housing through the electric wires in order to provide the electric powers and signals.

[0004] When assembling the wiring harness, the electric wires are cut into a predetermined length and the sheaths of the ends of the electric wires are removed and their ends are fixed to the terminals. The electric wires could be connected to each other if necessary. Then, the terminals are inserted into the connector housing. The wiring harness is assembled in this manner.

[0005] It is necessary to identify the electric wires of the wiring harness with respect to a size of the core wire, material of the sheath (the material may vary depending on presence of heat resisting property or so), an object for use. The object for use means, for example, a system of the motor car having the electric wires to provide the control signals for an air bag, an ABS (Antilock Brake System) and vehicle speed information, and the electric powers.

[0006] A coloring of the sheath of the electric wire is formed by extruding the synthetic resin, which consists a desired coloring material, around the core wire (for example, Patent Document 1 to 3). Whenever a color of an outer surface of the electric wire is changed, it is necessary to stop the operation of a sheath apparatus to extrude. It increases cost and time to produce the electric wires and reduces the productivity.

[0007] The coloring material contained in the synthetic resin is changed during the sheath extrusion of the apparatus. Hence, right after changing the color, the sheath of the electric wire has a mixed color of the preceding

and the changed coloring materials. It reduces a material yield of the electric wire.

[0008] In order to avoid the low productivity and low material yield of the electric wire, the applicant of the present invention proposed to produce a single color electric wire and color a desired color on an outer surface of the electric wire if necessary and assemble a wiring harness (Patent Document 4). The applicant of the present invention proposed an electric wire coloring apparatus which injects a certain amount of a desired liquid coloring material and makes a drop adhered to an outer surface of a single colored electric wire (Patent Document 5).

[0009] The related Patent Documents are Patent Document 1: JP,H05-111947,A, Patent Document 2: JP,H06-119833,A, Patent Document 3: JP,H09-92056,A, Patent Document 4: WO03019580, A1, and Patent Document 5: Patent Application Number 2003-193904.

[0010] A coloring material to be injected to an outer surface of an electric wire with predetermined drops is liquid material consisting of color material (organic substance for industrial use) which is dissolved or dispersed in water or other solvent. As the organic substance, the coloring material includes dyes and pigments which are generally composites of the organic substances. The dyes may be used as the pigments, or the pigments may be used as the dyes according to cases.

[0011] The electric wire coloring apparatus described in above can be attached to an electric wire forming apparatus such as an electric wire cutting apparatus which cuts a long electric wire into a predetermined length and attaches terminals to ends thereof. The electric wire forming apparatus provides several processes to the electric wires along the longitudinal direction by moving intermittently the wire. Therefore, the coloring apparatus is required to form a predetermined mark always even when the moving speed of the electric wire is changed (faster or slower). It is necessary to form the predetermined mark on the outer surface of the electric wire regardless of an interval of the injection of the coloring material drop.

Disclosure of the Invention

[0012] An object of the present invention is to provide a method and an apparatus for coloring an electric wire with a predetermined mark when a moving speed of the electric wire is varied.

[0013] According to a first aspect of the present invention, a method of coloring an electric wire includes the steps of injecting predetermined drops of a coloring material onto an outer surface of the electric wire and adhering the drop of the coloring material to the outer surface of the electric wire for coloring, whereby a viscosity of the coloring material is 0.3mPa·s to 4.5mPa·s.

[0014] According to a second aspect of the present invention, the viscosity of the coloring material is 0.3mPa·s to 3.25mPa·s.

[0015] According to a third aspect of the present in-

vention, the viscosity of the coloring material is 0.3mPa·s to 1.75mPa·s.

[0016] According to a fourth aspect of the present invention, an apparatus for coloring an electric wire has a coloring nozzle for injecting predetermined drops of a coloring material to be injected onto an outer surface of the electric wire and to be adhered to the outer surface of the electric wire for coloring, whereby said coloring material has a viscosity ranging from 0.3mPa·s to 4.5mPa·s.

[0017] According to a fifth aspect of the present invention, the coloring material has the viscosity ranging from 0.3mPa·s to 3.25mPa·s.

[0018] According to a sixth aspect of the present invention, the coloring material has the viscosity ranging from 0.3mPa·s to 1.75mPa·s.

[0019] According to claim 1, the coloring material of viscosity with from 0.3mPa·s to 4.5mPa·s can control a variation of one drop mass of the coloring material even when an injection interval time is changed (shorter or longer).

[0020] The coloring material is liquid material consisting of color material (organic substance for industrial purpose) which is dissolved or dispersed in water or other solvent. As the organic substance, the coloring material includes dyes and pigments which are generally composites of the organic substances. The dyes may be used as the pigments, or the pigments may be used as the dyes according to cases. As more specific examples, the coloring material in the claims means both coloring liquid and paint. The coloring liquid means the dye which is dissolved or dispersed in the solvent, while the paint means the pigment which is dispersed in dispersion liquid. Therefore, when the coloring liquid has been adhered to the outer surface of the sheath, the dye will be infiltrated into the sheath. On the other hand, when the paint has been adhered to the outer surface of the sheath, the pigment will not be infiltrated into the sheath, but simply adhered to the outer surface. Therefore, the method of coloring the outer surface of the electric wire includes both dyeing a part of the outer surface of the electric wire with the dye, and applying the pigment to the part of the outer surface of the electric wire.

[0021] Preferably, the solvent and dispersion liquid are compatible with the synthetic resin which forms the sheath. In this case, the dye can be reliably infiltrated into the sheath, and the pigment can be reliably adhered to the outer surface of the sheath.

[0022] An injection means, in this specification, that the coloring material is energized from a coloring nozzle and injected onto the outer surface of the electric wire with a drop.

[0023] According to claim 2, the coloring material of viscosity with from 0.3mPa·s to 3.25mPa·s can further control the variation of the one drop mass of the coloring material even when the injection interval time is changed (shorter or longer).

[0024] According to claim 3, the coloring material of

viscosity with from 0.3mPa·s to 1.75mPa·s can further control the variation of the one drop mass of the coloring material even when the injection interval time is changed (shorter or longer).

5 [0025] According to claim 4, a coloring material of viscosity with from 0.3mPa·s to 4.5mPa·s can control a variation of one drop mass of the coloring material even when an injection interval time is changed (shorter or longer).

10 [0026] According to claim 5, the coloring material of viscosity with from 0.3mPa·s to 3.25mPa·s can further control the variation of the one drop mass of the coloring material even when the injection interval time is changed (shorter or longer).

15 [0027] According to claim 6, the coloring material of viscosity with from 0.3mPa·s to 1.75mPa·s can further control the variation of the one drop mass of the coloring material even when the injection interval time is changed (shorter or longer).

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Brief Description of the Drawings

[0028]

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FIG. 1 is a side view of an electric wire coloring apparatus of an embodiment of the present invention; FIG. 2 is a sectional view of a coloring unit of the coloring apparatus taken along a line II-II in FIG. 1; FIG. 3 is an illustration showing an arrangement of each coloring nozzle and an electric wire in the coloring unit of FIG. 2;

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FIG. 4A is a perspective view of the electric wire colored by the coloring apparatus of FIG. 1;

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FIG. 4B is a plan view of the electric wire of FIG. 4A; FIG. 5 is an illustration showing a variation of one drop mass of a coloring material injected by the coloring apparatus shown in FIG. 1 with different viscosity; and

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FIG. 6 is an illustration showing the variation of the one drop mass of the coloring material A, B, and C injected by the coloring apparatus shown in FIG. 1.

Best Mode for Carrying out the Invention

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[0029] An apparatus for coloring an electric wire (simply referred to "coloring apparatus" hereafter) according to a first embodiment of the present invention is described referring to FIGS. 1 to 6. The coloring apparatus 1 is employed for forming a mark 6 on a part of an outer surface 3a of an electric wire 3 after cutting the electric wire 3 into a predetermined length. In short, the coloring apparatus 1 colors (marks) the outer surface 3a of the electric wire 3.

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[0030] The electric wire 3 is one component of a wiring harness to be arranged in a motor car as a moving body. The electric wire 3 includes, as shown in FIG. 4A, a conductive core wire 4 and an insulating sheath 5. The core wire 4 is formed of a plurality of wires twisted together.

The wires composing the core wire 4 are made of electrically conductive metal. The core wire 4 can be a single wire. The sheath 5 is formed of, for example, a synthetic resin such as polyvinyl chloride (PVC). Since the sheath 5 covers the core wire 4, the outer surface 3a of the sheath 5 becomes the outer surface of the electric wire 3.

[0031] The sheath 5 has a single color P. In order to give the single color P to the outer surface 3a of the electric wire 3, a coloring material having a desired color may be admixed to the synthetic resin which forms the sheath 5, or the synthetic resin may not be mixed with the coloring material so that the color of the synthetic resin itself may constitute the single color P. In case where the color of the synthetic resin itself is the single color P with no coloring material mixed to the synthetic resin forming the sheath 5, the outer surface 3a of the sheath 5, that is, the outer surface of the electric wire 3 is called as non-coloring. In this manner, the term "non-coloring" means that the outer surface 3a of the electric wire 3 has the color of the synthetic resin itself without mixing the coloring material into the synthetic resin. The outer surface 3a of the electric wire 3 can be non-coloring or a single color such as white.

[0032] The mark 6 with a plurality of dots 7 is formed on the outer surface 3a of the electric wire 3. The dots 7 have a color of B (shown by parallel diagonal lines in FIG. 4). The color B is different from the single color P. A planar shape of the dots 7 is round as shown in FIG. 4B. The plurality of the dots 7 are arranged in a longitudinal direction of the electric wire 3 with a predetermined pattern. The dots 7 are equally separated along the longitudinal direction of the electric wire 3. The distance between the centers of the adjacent dots 7 is predetermined.

[0033] A plurality of the electric wires 3 are bundled and ends of the electric wires are connected to connectors to form the wiring harness. The connectors are coupled to connectors of electronic units of various types in a motor car, and the wiring harness, that is, the group of the electric wires 3 provides various signals or electric power to the electronic units.

[0034] Each color B of the dots 7 in the mark 6 is changed to identify the electric wires 3 each other. FIGS. 4A and 4B show all dots 7 having the same color B, but each dot 7 may have a different color if necessary. The color B of each dot 7 of the mark 6 is utilized to identify kinds and systems of the electric wires 3 of the wiring harness.

[0035] The coloring apparatus 1 is attached to the cutter 18 as shown in FIG. 1.

[0036] The cutter 18 is disposed to a downstream side of the rotors 47 of the encoder 17 in the moving direction K. The cutter 18 has a pair of cutting blades 48 and 49. The pair of the cutting blades 48 and 49 are arranged vertically, and approach or depart from each other in the vertical direction. The pair of the cutting blades 48 and 49 approach each other and sandwich to cut the electric wire 3 moved by a pair of take-up rolls 12. After cutting, the cutting blades 48 and 49 depart from each other.

[0037] The coloring apparatus 1 includes, as shown in FIG. 1, a frame 10 (a main body), a guide roll 11, the take-rolls 12 to take-up the electric wire, a straighten unit 13 to straighten the electric wire, a slack absorbing unit 14 to absorb a slack of the electric wire, a coloring unit 15, a duct 16, an encoder 17 for measuring means, and a controller 19.

[0038] The frame 10 is installed on a floor of a factory and extends into a horizontal direction. The guide roll 11 is rotatably attached to one end of the frame 10. The guide roll 11 winds the long electric wire 3 with no mark 6 and sends the electric wire 3 to the straighten unit 13, the slack absorbing unit 14, the coloring unit 15, the duct 16, the encoder 17, and the cutter 18 in order.

[0039] The take-up rolls 12 are disposed in the other end of the frame 10. The pair of take-up rolls 12 are rotatably supported by the frame 10 and arranged vertically each other. The take-up rolls 12 are driven by a motor (not shown) and rotate in opposite direction each other with a same rotation number. The pair of take-up rolls 12 sandwich the electric wire 3 between them and pull out the electric wire 3 from the guide roll 11 along the longitudinal direction of the electric wire 3.

[0040] The take-up rolls 12 stretch and move the electric wire 3 along the longitudinal direction thereof. Thus, the take-up rolls 12 move the electric wire 3 relative to coloring nozzles 31 of the coloring unit 15 along the longitudinal direction thereof. The electric wire 3 is moved from the guide roll 11 to the take-up rolls 12 along an arrow K in FIG. 1, which is a moving direction of the electric wire 3.

[0041] The straighten unit 13 is disposed between the guide roll 11 and the take-up rolls 12. The straighten unit 13 is disposed in a downstream of the guide roll 11 and in a upstream of the take-up rolls 12 of the moving direction K. The straighten unit 13 includes a unit main body 20 with a plate shape, a plurality of first rolls 21, and a plurality of second rolls 22. The unit main body 20 is fixed to the frame 10.

[0042] The first and second rolls 21 and 22 are rotatably supported on the unit main body 20. The plurality of the first rolls 21 are arranged horizontally (along the moving direction K) and disposed above the electric wire 3. The plurality of the second rolls 22 are arranged horizontally (along the moving direction K) and disposed below the electric wire 3. The first rolls 21 and the second rolls 22 each are arranged in zigzag as shown in FIG. 1.

[0043] The straighten unit 13 sandwiches the electric wire 3, which is moved from the guide roll 11 by the take-up rolls 12, between the first rolls 21 and the second rolls 22. Hence, the straighten unit 13 straightens the electric wire 3 and provides a friction to the electric wire 3 by sandwiching the wire with the first and second rolls 21 and 22. Consequently, the straighten unit 13 provides a biasing force H1 in a direction opposite to a stretching direction (the moving direction K) to which the take-up rolls 12 pull out the electric wire 3. The first biasing force H1 is weaker than the tension pulled by the take-up rolls

12. Then, the straighten unit 13 provides the tension to the electric wire 3 in the longitudinal direction.

[0044] The slack absorbing unit 14 is disposed on the take-up rolls 12 side of the straighten unit 13. The slack absorbing unit 14 is disposed in a downstream of the straighten unit 13 and in the upstream of the take-up rolls 12 in the moving direction K of the electric wire 3. The slack absorbing unit 14 is disposed between the straighten unit 13 and the coloring nozzles 31 described below.

[0045] The slack absorbing unit 14 includes, as shown in FIG. 1, a pair of guide roll support frames 23, a pair of guide rolls 24, a transfer roll support frame 25, a transfer roll 26, and an air cylinder 27 for biasing means. The guide roll support frames 23 are fixed to the frame 10 and extend upwardly from the frame 10. Each guide roll support frame 23 is separated each other along the moving direction K of the electric wire 3.

[0046] The pair of the guide rolls 24 are rotatably supported by the guide roll support frames 23 and disposed at under the electric wire 3 to make an outer circumferential surface in contact to the electric wire 3. It results that the guide rolls 24 guide the electric wire 3 not to escape from the moving direction K.

[0047] The transfer roll support frame 25 is fixed to the frame 10 and extends upwardly from the frame 10 and is disposed at between the pair of the guide roll support frames 23.

[0048] The transfer roll 26 is rotatably supported by the transfer roll support frame 25 and movable vertically. The transfer roll 26 is disposed above the electric wire 3 and movable in a direction perpendicular to the moving direction K of the electric wire 3. The transfer roll 26 is disposed at the middle position between the guide rolls 24.

[0049] The air cylinder 27 has a cylinder 28 and an extendable rod 29 in the cylinder 28. The cylinder 28 is fixed to the transfer roll support frame 25 and disposed above the electric wire 3. The extendable rod 29 extends downwardly from the cylinder 28 and approaches to the electric wire 3.

[0050] The transfer roll 26 is attached to the extendable rod 29. When a pressurized gas is supplied to inside the cylinder 28, the air cylinder 27 moves the extendable rod 29 downwardly, that is, the transfer roll 26 with a second biasing force H2 (shown in FIG. 1) in a direction perpendicular to the moving direction K. The air cylinder 27 biases the transfer roll 26 to the electric wire 3 with the second biasing force H2 which is weaker than the first biasing force H1.

[0051] When the pair of cutting blades 48 and 49 of the cutter 18 cut the electric wire 3, the electric wire 3 is once stopped. It causes a slack of the electric wire 3 between the pair of the guide rolls 24 due to the movement inertia of the electric wire 3 in the moving direction K. On this occasion, since the air cylinder 27 biases the transfer roll 26 with the second biasing force H2 in the slack absorbing unit 14, the extendable rod 29 in the air cylinder 27 extends and displaces the transfer roll 26 to

the position shown by a dashed double-dotted line in FIG. 1.

[0052] The coloring unit 15 is disposed between the slack absorbing unit 14 and the take-up rolls 12. The coloring unit 15 is disposed in a downstream side of the slack absorbing unit 14 and the upstream side of the take-up rolls 12 of the moving direction K of the electric wire 3. The coloring unit 15, that is, the coloring nozzles 31 are arranged between the take-up rolls 12 and the straighten unit 13.

[0053] The coloring unit 15 includes, as shown in FIG. 2, a main body 30, the plurality of the coloring nozzles 31, a plurality of coloring material supply sources 32 (one source is shown in FIG. 2 and the others are omitted), and pressurized air supply sources 33. The main body 30 is fixed to the frame 10 and supports the plurality of the coloring nozzles 31.

[0054] Each coloring nozzle 31 has a nozzle member 50 as shown in FIG. 3. The nozzle member 50 is formed in a cylindrical shape and made of Polyetheretherketone (PEEK) or Polyetherimide (PEI). The coloring material is supplied to the coloring nozzle 31 from the coloring material supply source 32.

[0055] The coloring nozzle 31 injects the coloring material from the nozzle member 50. The coloring nozzle 31 injects a predetermined amount of the coloring material to the outer surface 3a of the electric wire 3 according to an order of the controller 19.

[0056] The coloring nozzles 31 each inject a predetermined amount of the liquid coloring material from the coloring material supply source 32 to the outer surface 3a of the electric wire 3. The injected drops of the coloring material from the coloring nozzles 31 are adhered to the outer surface 3a of the electric wire 3 and color (mark) a part of the outer surface 3a.

[0057] The coloring nozzles 31 are attached to the main body 30. The plurality of the coloring nozzles 31 are arranged in the moving direction K and around the electric wire 3. In the example of FIG. 1, the main body 30 has five coloring nozzles 31 along the moving direction K and three coloring nozzles 31 around the center of the electric wire 3.

[0058] As shown in FIG. 3, each coloring nozzle 31 is supported by the main body 30 so as that an axis R of the nozzle member 50, shown by a dashed dotted line in FIG. 3, extends to an uppermost position 3b of the electric wire 3. Each coloring nozzle 31 injects the predetermined amount of the coloring material to the uppermost position 3b of the electric wire 3 along the axis R.

[0059] Each coloring material supply source 32 receives the coloring material and supplies the coloring material to an inlet tube 36 of the corresponding coloring nozzle 31. The colors B supplied to the coloring nozzles 31 by the coloring material supply sources 32 can be different from each other or same.

[0060] Each pressurized air supply source 33 supplies the pressurized air to the color material supply source 32 so that a valve 44 described below is separated from a

base end 37a of the nozzle member 50 and the coloring material in a flow path 39 is injected from the nozzle member 50.

[0061] The coloring unit 15 injects to the electric wire 3 the predetermined amount of the coloring material from any coloring nozzle 31 responding to an order from the controller 19.

[0062] A viscosity of the coloring material utilized in this specification ranges from 0.3mPa·s (millipascal second) to 4.5mPa·s. The coloring material supply source 32 and coloring nozzle 31 utilize this coloring material.

[0063] The coloring material is liquid material consisting of color material (organic substance for industrial purpose) dissolved or dispersed in water or other solvent. As the organic substance, the coloring material includes dyes and pigments which are generally composites of the organic substances. The dyes may be used as the pigments, or the pigments may be used as the dyes according to cases. More specifically, the coloring material is in a form of coloring liquid or paint.

[0064] The coloring liquid means the dye dissolved or dispersed in the solvent, while the paint means the pigment dispersed in dispersion liquid. Therefore, when the coloring liquid is adhered to the outer surface 3a of the electric wire 3, the dye is infiltrated into the sheath 5. On the other hand, when the paint is adhered to the outer surface 3a of the electric wire 3, the pigment is not infiltrated into the sheath 5, but simply adhered to the outer surface 3a. In other words, the coloring unit 15 serves to dye the part of the outer surface 3a of the electric wire 3 with the dye, or alternatively, to apply the pigment to the part of the outer surface 3a of the electric wire 3. Therefore, a method of marking the outer surface 3a of the electric wire 3 includes both dyeing the part of the outer surface 3a of the electric wire with the dye, and applying the pigment to the part of the outer surface 3a of the electric wire 3.

[0065] Preferably, the solvent and dispersion liquid are compatible with the synthetic resin which forms the sheath 5. In this case, the dye can be reliably infiltrated into the sheath 5, and the pigment can be reliably adhered to the outer surface 3a of the sheath 5.

[0066] The injection described means that the liquid coloring material is energized to be injected to the outer surface 3a of the electric wire 3 with the liquid drop, that is, drop from the each coloring nozzle 31.

[0067] The duct 16 is disposed to the take-up rolls side of the coloring unit 15, and between the coloring unit 15 and the take-up rolls 12. The duct 16 is disposed to a downstream side of the coloring unit 15 in the moving direction K of the electric wire 3 and the upstream side of the take-up rolls 12. The duct 16 is formed in a tubular shape and the electric wire 3 passes therein. Evacuating means (not shown) is connected to the duct 16. The evacuating means evacuates the gas in the duct 16 to prevent the solvent and dispersion liquid in the coloring material from being filled outside the coloring unit 1.

[0068] The encoder 17 is disposed to a downstream

side of the take-up rolls 12 in the moving direction K of the electric wire 3. The encoder 17 has a pair of rotors 47 as shown in FIG. 1. Each rotor 47 can rotate around an axis of rotation. An outer circumferential face of each rotor 47 is in contact with the outer face 3a of the electric wire 3 sandwiched by the pair of the take-up rolls 12. When the core wire 4, that is, the electric wire 3 runs (moves) in the direction of the arrow K, the rotors 47 rotate. In short, the rotors 47 each rotate around the axis with the running (moving) of the core wire 4, that is, the electric wire 3 along the direction of the arrow K. It is apparent that a number of the rotation of each rotor 43 is proportional to the moving distance of the electric wire 3 along the direction of the arrow K.

[0069] The encoder 17 is connected to the controller 19. When the rotors 43 rotate by a predetermined angle, the encoder 17 outputs pulse signals to the controller 19. More specifically, the encoder 17 outputs information corresponding to the moving velocity of the electric wire 3 along the direction of the arrow K. In this manner, the encoder 17 measures the information corresponding to the moving velocity of the electric wire 3, and outputs the information to the controller 19. Usually, the encoder 17 outputs the pulse signals according to the moving distance of the electric wire 3 by friction between the electric wire 3 and the rotors 47 of the encoder 17. However, in case where the moving distance is inconsistent with the number of the pulse signals, depending on condition of the outer face 3a of the electric wire 3, it would be possible to obtain the information of the moving velocity in other places, and to feedback the information for comparative calculation.

[0070] The controller 19 is a computer having known RAM, ROM, CPU, and so on. The controller 19 is connected to the take-up rolls 12, encoder 17, cutter 18, and coloring nozzles 31 to control their operations and thereby controls all the operations of the coloring unit 1.

[0071] The controller 19 stores a predetermined pattern of the mark 6. When the information of the pulse signals, that is, the amount of the moving distance of the electric wire 3, is input from the encoder 17 to the controller 19, the predetermined amount of the coloring material is injected to the electric wire 3 from the predetermined coloring nozzle 31. The controller 19 can make the injection time of the coloring material from the coloring nozzles 31 shorter or longer depending on the moving speed of the electric wire 3 with being higher or slower, respectively according to the pattern of the mark 6 stored in the controller 19. Hence, the controller 19 colors the electric wire 3 according to the stored pattern. The controller 19 controls the coloring nozzles 31 to inject the predetermined amount of the coloring material drop according to the moving distance of the electric wire 3 measured by the encoder 17.

[0072] When the controller 19 judges the predetermined amount of the moving distance of the electric wire 3 from the information of the encoder 17, the controller 19 stops the operation of the take-up rolls 12 and brings

the pair of the cutting blades 48 and 49 close together to cut the electric wire 3.

[0073] In order to color the outer surface 3a of the electric wire 3 with the mark 6 by utilizing the coloring apparatus 1, the guide roll 11 is attached to the frame 10. The pair of the cutting blades 48 and 49 are set separated each other. The electric wire 3 wound on the guide roll 11 is passed thorough the straighten unit 13, the slack absorbing unit 14, the coloring unit 15, and the duct 16 in order, and sandwiched between the pair of the take-up rolls 12. The coloring nozzles 31 are attached to a predetermined position of the unit main body 30 of the coloring unit 15 and each coloring nozzle 31 is connected to the coloring material supply source 32. Each coloring material supply source 33 is connected to the corresponding pressurized air supply source 33 and the evacuating means is connected to the duct 16.

[0074] The take-up rolls 12 are driven to pull out the electric wire 3 from the guide roll 11 and moves the electric wire 3 along the longitudinal direction. The friction as the first biasing force H1 is provided to the electric wire 3 by the straighten unit 13 to pull out the electric wire 3. The air cylinder 27 biases the transfer roll 26, that is, the electric wire 3 with the second biasing force H2.

[0075] When the predetermined pulse signals are input to the controller 19 from the encoder 17, the controller 19 injects the predetermined amount of the coloring material to the outer surface 3a of the electric wire 3 from the predetermined coloring nozzles 31.

[0076] The solvent or dispersion liquid evaporates from the coloring material adhered to the outer surface 3a of the electric wire 3 and the outer surface 3a of the electric wire 3 is dyed with the dye or painted with the pigment. The evaporated solvent or dispersion liquid is evacuated by the evacuating means from the duct 16. Thereby, the outer surface 3a of the electric wire 3 is colored.

[0077] When the predetermined length of the electric wire 3 is moved, the controller 19 judges it from the information of the encoder 17 and stops the take-up rolls 12. It causes the slack of the electric wire 3 especially between the pair of the guide rolls 24 of the slack absorbing unit 14, and the transfer roll 26 biased with the second biasing force H2 is displaced to a position shown by the dashed double-dotted line in FIG. 1. The extendable rod 29 of the air cylinder 27 of the slack absorbing unit 14 extends and absorbs the slack of the electric wire 3.

[0078] The pair of the cutting blades 48 and 49 come close to each other and sandwich the electric wire 3 between them to cut. Thereby, the electric wire 3 marked with the mark 6 on the outer face 3a thereof is obtained as shown in FIG. 4A and 4B.

[0079] According to the embodiment, the viscosity from 0.3mPa·s to 4.5mPa·s of the coloring material can control a variation of one drop mass of the coloring material even when an injection interval time from the coloring nozzle 31 is varied (shorter or longer). Thus, it can keep the colored points (dots 7) to the desired area (size)

and form a predetermined marking on the electric wire 3 even when the injection interval time or the moving speed of the electric wire 3 is varied.

[0080] While the electric wire 3 is moving relative to the coloring nozzles 31, the coloring nozzles 31 inject the predetermined amount of the coloring materials to the electric wire 3. Therefore, it is not necessary to stop the electric wire 3 to color the electric wire 3, then resulting in that the working efficiency is not reduced. Since the predetermined amount of the coloring material is injected to the electric wire 3 moving relatively to the coloring nozzles 31, the coloring can be made on any positions or continuously on the electric wire 3.

[0081] The encoder 17 measures the moving distance of the electric wire 3 and the controller 19 controls the coloring nozzles 31 responding to the moving distance. The interval time of the coloring material injection becomes shorter or longer with the moving speed of the electric wire 3 faster or slower, respectively. Then, the distance between the adjacent dots adhered to the outer surface 3a of the electric wire 3 can be kept constant even when the moving speed of the electric wire 3 varies.

[0082] The predetermined pattern is adhered to, that is, colored to the outer surface 3a of the electric wire 3 with the coloring material even when the moving speed of the electric wire 3 varies.

[0083] The applicant measured the variation of the one drop mass of the coloring material with different viscosity when they are injected from the coloring nozzle 31. FIG. 5 shows the result. The coloring materials of viscosity ranging from less than 0.3mPa·s to more than 5.0mPa·s were injected from the coloring nozzle 31 having the nozzle member 50 of an inner diameter 100μm. Each coloring material of the different viscosity was injected with a frequency from 500Hz to 3000Hz. The coloring materials were injected 500 to 3000 times in one second.

[0084] In FIG. 5, the abscissa axis is the viscosity of the coloring material measured. The ordinate axis is the maximum variation of the ratio of the injected one drop mass with the different frequencies to that of 500Hz. In FIG. 5, the value 20% of the ordinate axis means that an injected drop mass of a frequency ranged from 80% to 120% of the drop mass of 500Hz.

[0085] When the viscosity of the coloring material is less than 0.3mPa·s, the maximum variation of the one drop mass at the frequencies is very large. The low viscosity of the coloring material causes the large variation of the one drop mass with the injection intervals, or frequencies. The decreased interval time, or the increased frequency resulted in the increased one drop mass of the coloring material.

[0086] FIG. 5 shows that the viscosity of 0.3mPa·s to 1.75mPa·s gives the variation of 20% or less, which is a very small variation. In this range of the viscosity, the one drop mass can be controlled to form the predetermined size of mark 6 (dots 7) even when the interval time or frequency of the injection varies.

[0087] FIG. 5 shows that the variation of the one drop

mass increases gradually from 1.75mPa·s. The variation of the one drop mass is 75% or less at the viscosity of 4.5mPa·s or less. It is found that the one drop mass can be controlled to form the predetermined size of mark 6 (dots 7) even when the interval time or frequency of the injection varies.

[0088] It is assumed that the mass of the coloring material injected is proportional to the size of the mark 6 or dot 7. It is found that the diameter of the dot 7 at 500Hz can be controlled from half to about 1.3 times size at the mass variation of 75% or less. The viscosity of the coloring material of 4.5mPa·s or less can control the one drop mass and form the predetermined size of the mark 6 (dots 7) under the varying injection interval times or frequencies.

[0089] As shown in FIG. 5, the viscosity above 4.5mPa·s causes the variation of the drop mass above 75%, which is a large value. The high viscosity of the coloring material causes the large variation of the one drop mass with the change of the injection interval time or frequency. The shorter interval time or high frequency decreases the one drop mass of the coloring material.

[0090] As clearly seen from FIG. 5, the viscosity of from 0.3mPa·s to 4.5mPa·s of the coloring material can control the one drop mass to form the predetermined size of the mark 6 (dots 7) and the predetermined marking on the outer surface 3a of the electric wire 3 even that the injection interval time or the moving speed of the electric wire is changed.

[0091] The viscosity of from 0.3mPa·s to 3.25mPa·s can control further the one drop mass within the variation of 50% even the injection interval time is changed (shorter or longer). Then, it can assuredly keep the colored points (dots 7) to the desired area (size) with the change of the injection interval time. It can form the predetermined size of the mark (dots 7) and the predetermined marking on the electric wire 3 even the injection interval time or the moving speed of the electric wire 3 is changed.

[0092] As clearly seen in FIG. 5, the viscosity of from 0.3mPa·s to 1.75mPa·s can control furthermore the one drop mass within the variation of 20% even the injection interval time is changed (shorter or longer). Then, it can more assuredly keep the colored points (dots 7) to the desired area (size) with the change of the injection interval time. It can more assuredly form the predetermined size of the mark (dots 7) and the predetermined marking on the electric wire 3 even the injection interval time or the moving speed of the electric wire 3 is changed.

[0093] FIG. 6 shows the variation of the one drop mass of the coloring material injected from the coloring nozzle 31 described above for the viscosity of 0.3mPa·s (present invention A shown by a solid line), 1.5mPa·s (present invention B shown by a dashed dotted line), and 4.5mPa·s (present invention C shown by a dashed double-dotted line). The result of FIG. 6 was obtained utilizing the nozzle member 50 with the inner diameter of 100 μ m in the coloring nozzle 31. The coloring materials of A, B, and C were injected with the frequencies from 500Hz to

3000Hz. The coloring material of each viscosity was injected from 500 times to 3000 times in one second.

[0094] FIG. 6 shows that the abscissa axis is the frequency, or the interval time of the injection and the ordinate axis is the variation of the injected one drop mass of the present invention A, B, and C. The ordinate axis is the ratio of the injected one drop mass at each frequency to that of 500Hz. The value 20% of the ordinate axis means that the injected one drop mass at a frequency is 80% or 120% of the one drop mass injected at 500Hz.

[0095] As shown in FIG. 6, the variations of the one drop mass of all the present inventions A, B, and C were within -75% and 20% for the frequency range from 500Hz to 3000Hz. The present invention A, B, and C can control the one drop mass of the coloring material and form the predetermined size of the mark (dots 7) and the predetermined marking on the electric wire 3 even the injection interval time or the moving speed of the electric wire 3 is changed.

[0096] The viscosity of the coloring material is selected from 0.3mPa·s to 4.5mPa·s and also from 0.3mPa·s to 3.25mPa·s. As shown in FIG. 5, the variation of the one drop mass is further controlled with the change of the injection interval time (shorter or longer). It is possible to keep the colored points (dots 7) to the desired area (size) and form the predetermined marking on the electric wire 3 even the injection interval time or the moving speed of the electric wire 3 is changed.

[0097] The viscosity of the coloring material can be from 0.3mPa·s to 1.75mPa·s. As clearly seen in FIG. 5, the variation of the one drop mass is furthermore controlled with the change of the injection interval time (shorter or longer). It is possible to keep the colored points (dots 7) to the desired area (size) and form the predetermined marking on the electric wire 3 even the injection interval time or the moving speed of the electric wire 3 is changed.

[0098] In the present invention, acrylic paint, ink (dye or pigment), and UV ink can be utilized as the coloring liquid and paint.

[0099] The embodiments disclose the electric wire 3 of the wiring harness arranged in the motor cars. The present invention can also be adapted to electronics devices such as portable computers or electric machines.

[0100] The embodiments described above show only the representatives of the present invention and are not limited to them. Modifications of the present invention are made possible without departing from the scope of the present invention.

Industrial Applicability

[0101] The present invention of claim 1 can control a variation of one drop mass of a coloring material and keep a colored point to a desired area (size) even when an injection interval time is changed. It can form a predetermined marking onto an electric wire even when the

injection interval time or a moving speed of the electric wire is changed.

[0102] The present invention of claim 2 can further control the variation of the one drop mass of the coloring material and keep the colored point to the desired area (size) even when the injection interval time is changed. It can form assuredly the predetermined marking onto the electric wire even when the injection interval time or the moving speed of the electric wire is changed.

[0103] The present invention of claim 3 can furthermore control the variation of the one drop mass of the coloring material and keep the colored point to the desired area (size) even when the injection interval time is changed. It can form more assuredly the predetermined marking onto the electric wire even when the injection interval time or the moving speed of the electric wire is changed.

[0104] The present invention of claim 4 can control a variation of one drop mass of a coloring material and keep a colored point to a desired area (size) even when an injection interval time is changed. It can form a predetermined marking onto an electric wire even when the injection interval time or a moving speed of the electric wire is changed.

[0105] The present invention of claim 5 can furthermore control the variation of the one drop mass of the coloring material and keep the colored point to the desired area (size) even when the injection interval time is changed. It can form assuredly the predetermined marking onto the electric wire even when the injection interval time or the moving speed of the electric wire is changed.

[0106] The present invention of claim 6 can furthermore control the variation of the one drop mass of the coloring material and keep the colored point to the desired area (size) even when the injection interval time is changed. It can form more assuredly the predetermined marking onto the electric wire even when the injection interval time or the moving speed of the electric wire is changed.

3. The method as claimed in claim 1, wherein said viscosity of the coloring material is 0.3mPa·s to 1.75mPa·s.

5 4. An apparatus for coloring an electric wire comprising a coloring nozzle for injecting predetermined drops of a coloring material onto the outer surface of the electric wire and for adhering thereon, said coloring material having a viscosity of 0.3mPa·s to 4.5mPa·s.

10 5. The apparatus as claimed in claim 4, wherein said coloring material to be injected has the viscosity of 0.3mPa·s to 3.25mPa·s.

15 6. The apparatus as claimed in claim 4, wherein said coloring material to be injected has the viscosity of 0.3mPa·s to 1.75mPa·s.

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Claims

1. A method of coloring an electric wire comprising the steps of:

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injecting predetermined drops of a coloring material onto an outer surface of the electric wire; and

adhering the drops of the coloring material to the outer surface of the electric wire, whereby said coloring material has a viscosity of 0.3mPa·s to 4.5mPa·s.

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2. The method as claimed in claim 1, wherein said viscosity of the coloring material is 0.3mPa·s to 3.25mPa·s.

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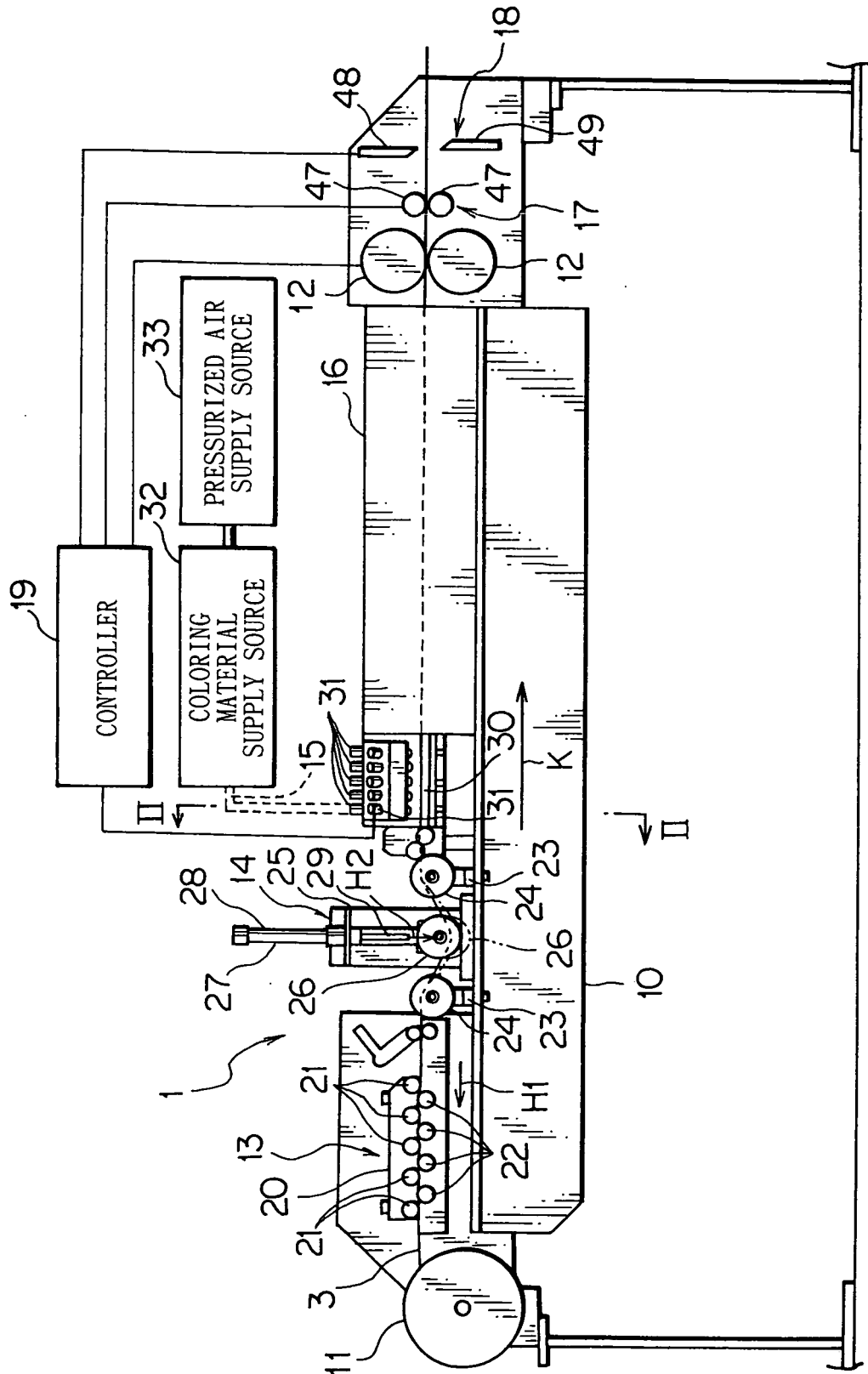


FIG. 1

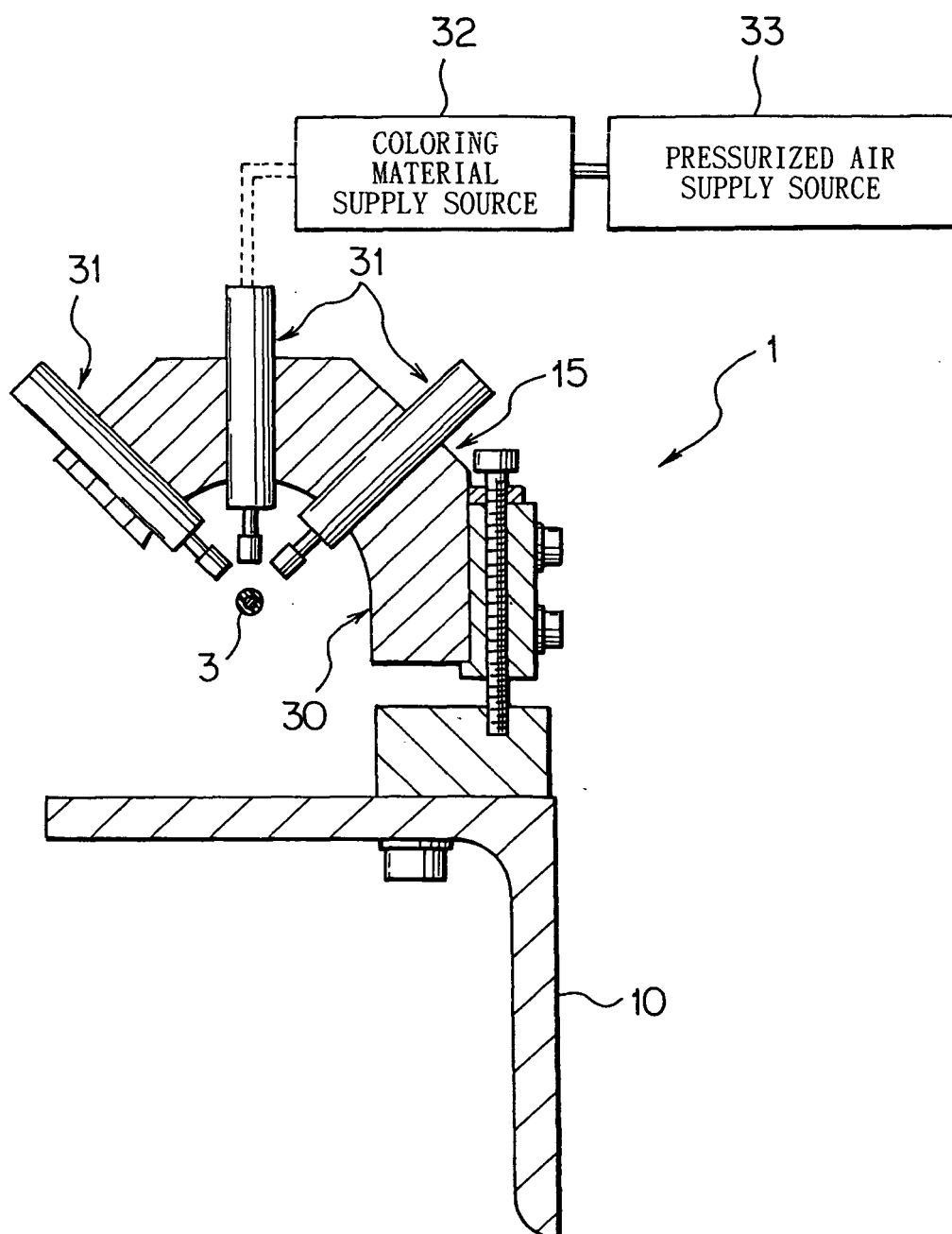


FIG. 2

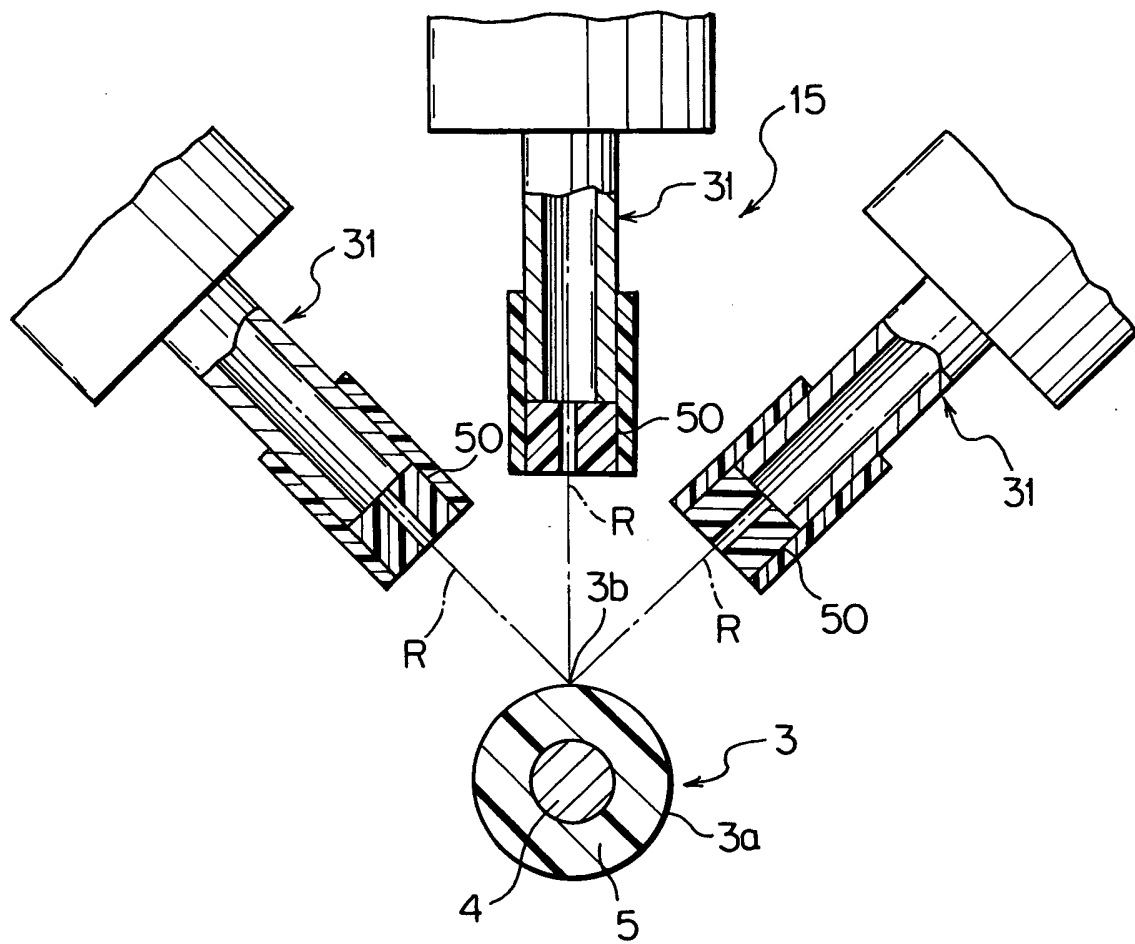


FIG. 3

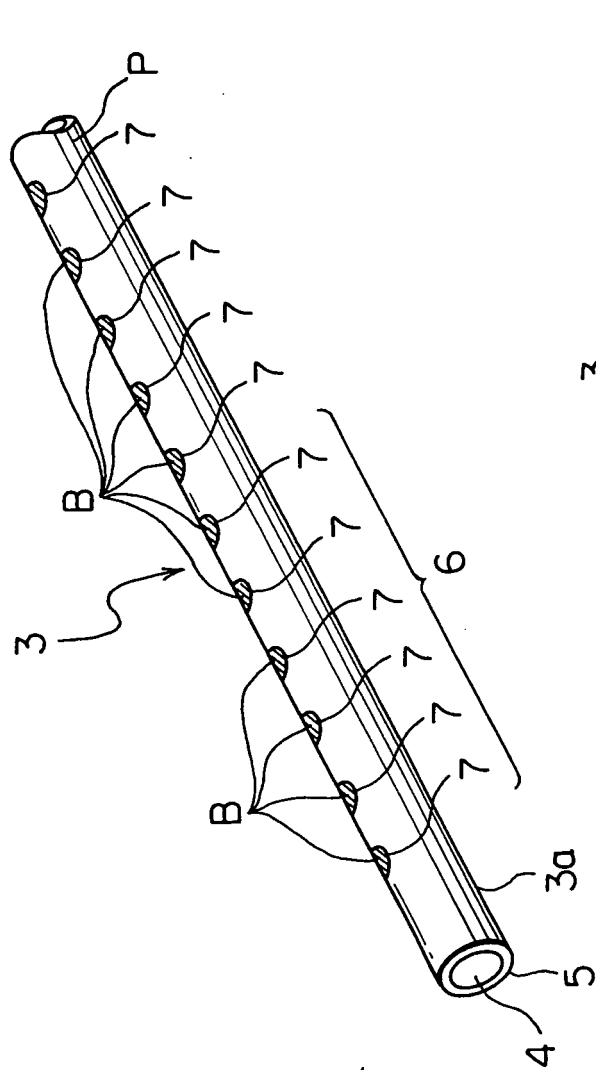


FIG. 4A

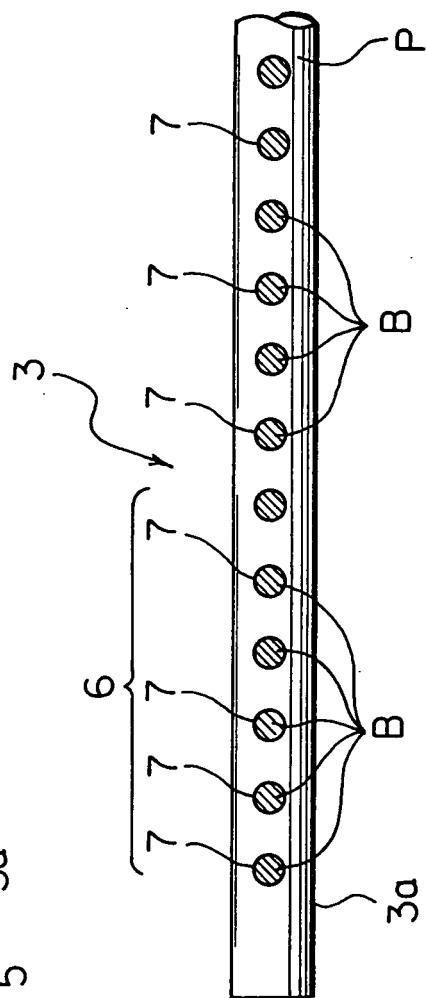


FIG. 4B

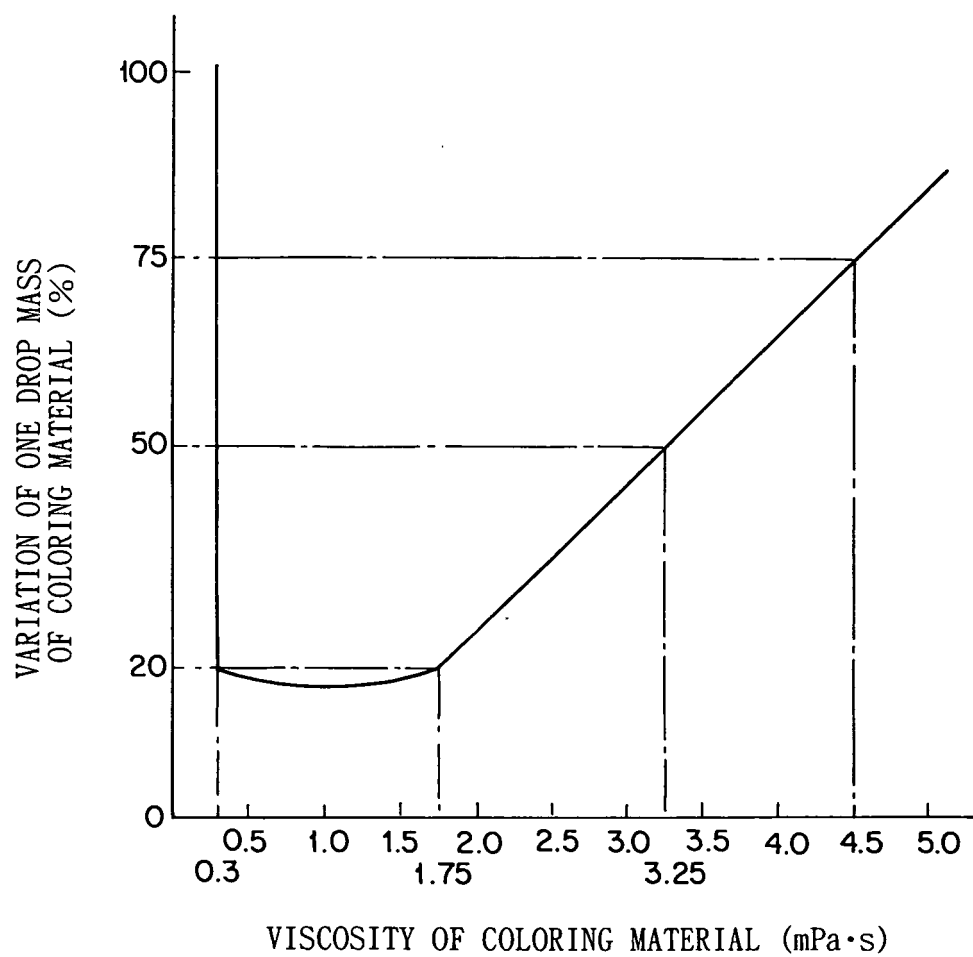


FIG. 5

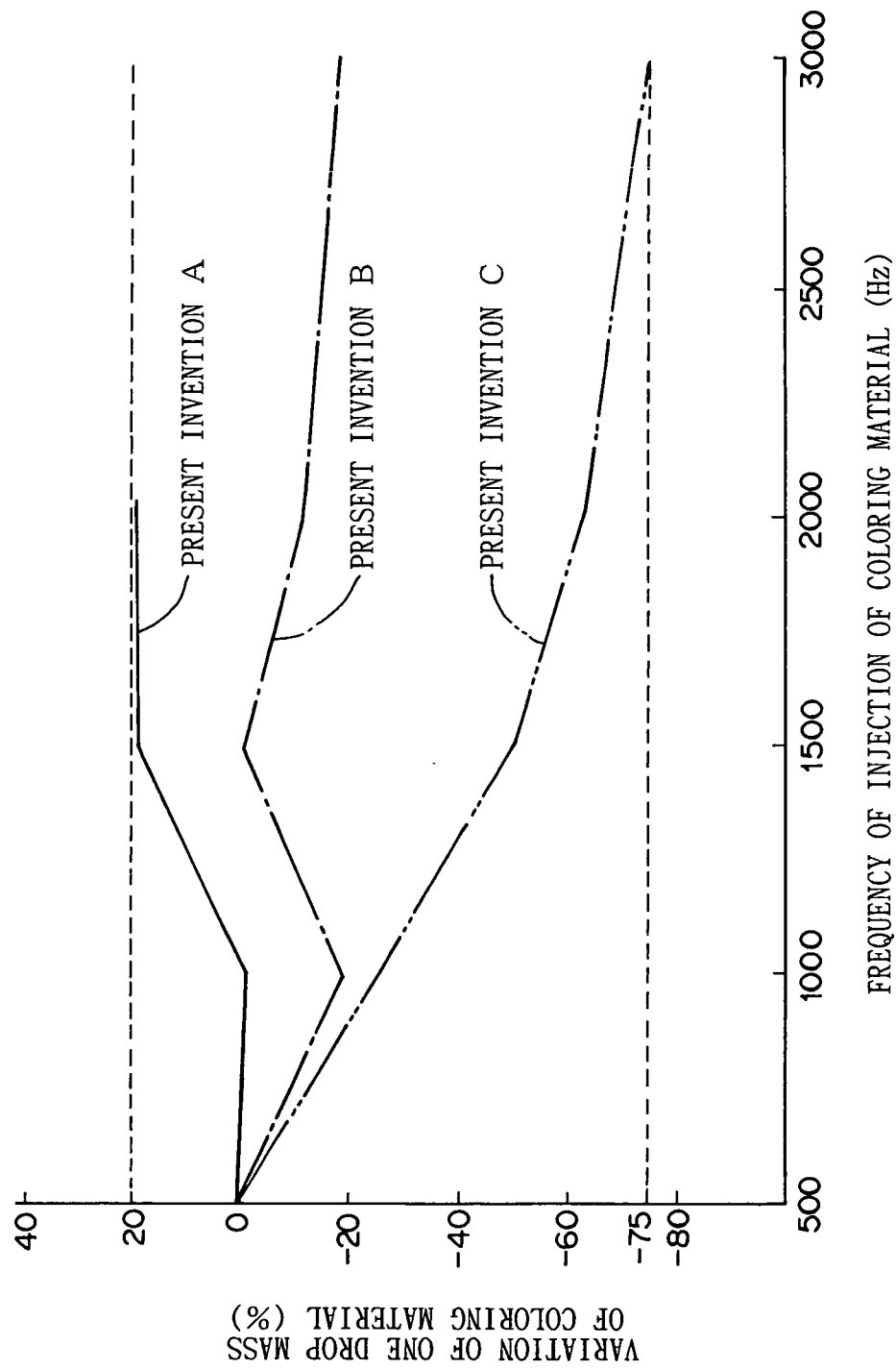


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/011627

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.⁷ H01B13/00

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.⁷ H01B13/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2005
Kokai Jitsuyo Shinan Koho	1971-2005	Toroku Jitsuyo Shinan Koho	1994-2005

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 2002-301837 A (Hitachi Cable, Ltd.), 15 October, 2002 (15.10.02), Claims 1 to 5; mode of the invention (Family: none)	1-6
Y	JP 2001-88280 A (Tatsuta Electric Wire & Cable Co., Ltd.), 03 April, 2001 (03.04.01), Claims 1 to 7; mode of the invention (Family: none)	1-6
Y	JP 9-171726 A (Sumitomo Electric Industries, Ltd.), 30 June, 1997 (30.06.97), Claims 1 to 4; mode of the invention (Family: none)	1-6

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

* Special categories of cited documents:

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"&" document member of the same patent family

Date of the actual completion of the international search
08 September, 2005 (08.09.05)Date of mailing of the international search report
27 September, 2005 (27.09.05)Name and mailing address of the ISA/
Japanese Patent Office

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/011627

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	JP 4-36908 A (Nippon Koku Kabushiki Kaisha), 06 February, 1992 (06.02.92), Claims 1 to 9; detailed explanation of the invention as a whole & WO 91/19299 A1 & EP 491955 A1	1-6
Y	JP 2002-113938 A (Fuji Xerox Co., Ltd.), 16 April, 2002 (16.04.02), Claims 1 to 5; Par. Nos. [0033], [0034]; examples (Family: none)	1-6
Y	JP 2004-122574 A (Konica Minolta Holdings Kabushiki Kaisha), 22 April, 2004 (22.04.04), Claims 1 to 15; Par. No. [0067]; examples & US 2004/119797 A1	1-6
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Y	JP 61-36381 A (Nippon Telegraph And Telephone Corp.), 21 February, 1986 (21.02.86), Concrete Explanation of the Invention; examples (Family: none)	1-6

Form PCT/ISA/210 (continuation of second sheet) (January 2004)

REFERENCES CITED IN THE DESCRIPTION

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