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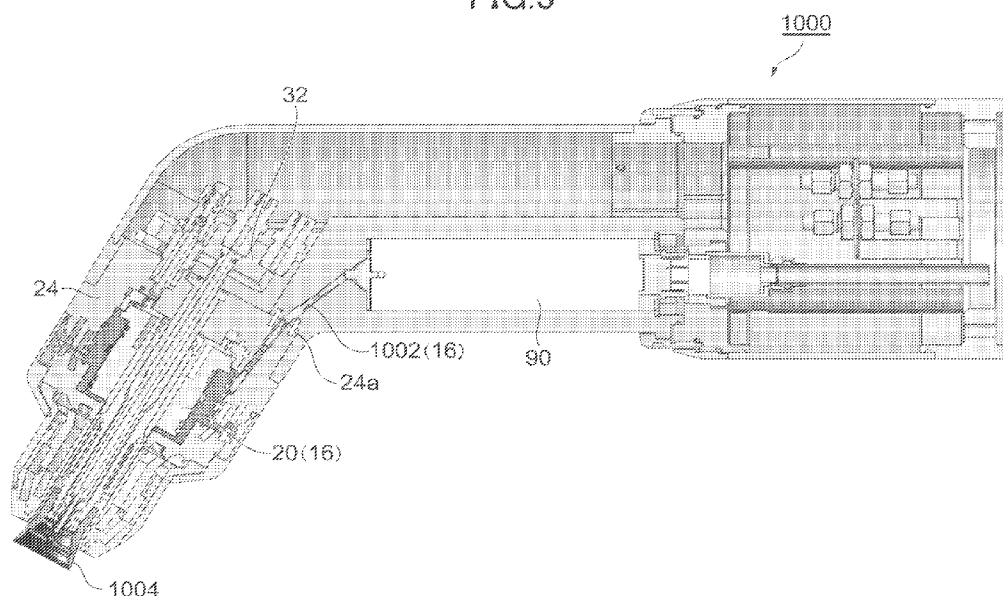
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(54) Title: ELECTROSTATIC ATOMIZER

FIG.3



(57) Abstract: An electrostatic atomizer can include a paint supply path configured to supply paint to a paint discharge section; and a high voltage supply path configured to supply a high voltage to a discharge electrode, wherein the discharge electrode comprises a semi-conductive material, and wherein the high voltage supply path includes a high resistance near the discharge electrode, and is electrically segregated from the paint supply path.

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ELECTROSTATIC ATOMIZER

CROSS-REFERENCES TO RELATED APPLICATIONS

The present application is a continuation and claims the benefit of the filing date of an application entitled, "Electrostatic Atomizer," U.S. provisional patent application Ser. No. 62/965,477, filed 24 JAN 2020, assigned to the assignee of the present application, and herein incorporated by reference.

BACKGROUND

An electrostatic coating material can comprise solvent borne metallics. As an electrically charged bell cup approaches the ground while painting with a solvent borne metallic paint, a spark can be generated to the grounded object. This spark can be the result of the bridging phenomenon, where metallics in a paint align sufficiently in order to form a bridge between a charged bell cup and the grounded object, and thereby be the conductor for a spark. What is needed is a safe electrostatic atomizer wherein sparking is prevented, even when using metallic paint and/or in close proximity painting.

Provided is an electrostatic atomizer, specifically, an electrostatic atomizer wherein the high voltage supply path includes a high resistance near the discharge electrode and is electrically independent of the paint supply path.

SUMMARY

An electrostatic atomizer can include a paint supply path configured to supply paint to a paint discharge section; and a high voltage supply path configured to supply a high voltage to a discharge electrode, wherein the discharge electrode comprises a semi-conductive material, and wherein the high voltage supply path includes a high resistance near the discharge electrode, and is electrically segregated from the paint supply path. This electrostatic atomizer can prevent the bridging phenomenon, even in close proximity painting with paints comprising metallic particles.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is an example, non-limiting view of an electrostatic atomizer of the embodiments described herein.

FIG. 2 is an example, non-limiting view of an electrostatic atomizer of the embodiments described herein.

5 FIG. 3 is an example, non-limiting view of an electrostatic atomizer of the embodiments described herein.

 FIG. 4 is an example, non-limiting view of a portion of an electrostatic atomizer of the embodiments described herein.

10 FIG. 5 is an example, non-limiting view of an electrostatic atomizer of the embodiments described herein.

 FIG. 6 is an example, non-limiting view of a portion of an electrostatic atomizer of the embodiments described herein.

 FIG. 7 is an example, non-limiting view of an electrostatic atomizer of the embodiments described herein.

15 FIG. 8 is an example non-limiting view of a portion of an electrostatic atomizer of the embodiments described herein.

DETAILED DESCRIPTION

Reference will now be made in detail to the embodiments consistent with the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same
20 reference numerals used throughout the drawings refer to the same or like parts.

Some preferable embodiments will be described in more detail with reference to the accompanying drawings, in which the preferable embodiments of the present disclosure have been illustrated. However, the present disclosure can be implemented in various manners, and thus should not be construed to be limited to the embodiments disclosed herein. On the
25 contrary, those embodiments are provided for the thorough and complete understanding of the present disclosure, and completely conveying the scope of the present disclosure to those skilled in the art. As will be appreciated by one skilled in the art, aspects of the claimed subject matter may be embodied as an apparatus, system, or method. Accordingly, aspects of the claimed subject matter may take the form of an entirely hardware embodiment or method
30 embodiment.

 FIG. 1 is an example, non-limiting view of an electrostatic atomizer (1000) of the embodiments described herein. As shown in Fig. 1, the high voltage cascade (90) can be located within the electrostatic atomizer 100.

35 According to the electrostatic atomizer of Fig. 1, an electrostatic atomizer (1000) can comprise a paint supply path (12) configured to supply paint to a paint discharge section (10);

5 and a high voltage supply path (16) configured to supply a high voltage to a discharge electrode (14), wherein the discharge electrode (14) comprises a semi-conductive material, and wherein the high voltage supply path (16) includes a high resistance (18) near the discharge electrode (14), and is electrically segregated from the paint supply path (12). According to certain
10 embodiments, the electrostatic atomizer (1000) can provide that the paint supply path (12) comprises an electrically insulating material. In some embodiments the electrostatic atomizer (1000) can provide that the discharge electrode (14) consists of a semi-conductive material, and the paint supply path consists of an electrically insulating material. In certain embodiments, the electrostatic atomizer (1000) can provide that the high voltage supply path (16) includes a
15 metal part (20) on an upstream side of the high resistance (18), and wherein the metal part (20) does not include a paint supply system part (32) forming a part of the paint supply path (12). According to some embodiments, the electrostatic atomizer (1000) according to can provide that the paint supply path (12) includes a feed tube (30) connected to the paint discharge section (10), and wherein the feed tube (30) is made of an electrically insulating material. In some
20 embodiments the electrostatic atomizer (1000) is configured such that the electrostatic atomizer (1000) is a rotary atomizing type electrostatic atomizer (1000), wherein the discharge electrode (14) is composed of a rotary atomizing head (1004) which is connected to an output shaft (1010) of an air motor (20) configured to drive the rotary atomizing head, and wherein the rotary atomizing head (1004) consists of a semi-conductive resin material. The electrostatic atomizer (1000) can provide that the air motor (20) is made of metal and
25 constitutes a part of the high-voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can provide that the output shaft (1010) of the air motor (20) is made of an electrically insulating material and is hollow, and wherein the feed tube (30) is coaxially arranged in the hollow output shaft (1010). In certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) includes a manifold (32)
30 communicated with the feed tube (30), wherein a paint supply pipe (36) communicated with a paint source (34) and a solvent supply pipe (40) communicated with a solvent source (38) are connected to the manifold (32), and wherein the paint supply pipe (36) and the solvent supply pipe (40) are grounded through a bracket (1006). In some embodiments, the electrostatic atomizer (1000) can be configured such that the manifold (32) consists of an electrically
35 insulating material. In some embodiments, the electrostatic atomizer (1000) can be arranged

5 such that the paint supply pipe (36) and the solvent supply pipe (40) consist of an electrically insulating material. According to certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) consists of an electrically insulating material. In some embodiments, electrostatic atomizer (1000) can provide that the high resistance (18) is supported by the hollow output shaft (1010). The electrostatic atomizer (1000) can further
10 include an electrically insulating motor holder (24) for supporting the air motor (20) and having a hole for receiving a high-voltage cable (1002) forming a part of the high voltage supply path (16), and a cylindrical and electrically insulating member provided at an entrance of the hole of the motor holder (24), wherein the motor holder (24) has a cylindrical and electrically
15 insulating member (24a) at an entrance of a hole for receiving a high-voltage cable (1002), wherein the hole forms a portion of the high voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can be configured such that the high resistance (18) has a resistance value (R2) of 120 M Ω to 180 M Ω .

FIG. 2 is an example, non-limiting view of an electrostatic atomizer (1000) of the embodiments described herein. As shown in Fig. 2, the high voltage cascade (90) can be
20 located within the electrostatic atomizer 110. In some embodiments, the high voltage cascade comprises a generator. As used herein, high voltage can be at least 60 kV. In some embodiments, high voltage can be at least 80 kV. In some embodiments, high voltage can be as high as 130 kV. In some embodiments, high voltage can range from about 60 kV to about
25 120 kV.

According to the electrostatic atomizer of Fig. 2, the electrostatic atomizer (1000) can comprise a paint supply path (12) configured to supply paint to a paint discharge section (10); and a high voltage supply path (16) configured to supply a high voltage to a discharge electrode (14), wherein the discharge electrode (14) comprises a semi-conductive material, and wherein
30 the high voltage supply path (16) includes a high resistance (18) near the discharge electrode (14), and is electrically segregated from the paint supply path (12). According to certain embodiments, the electrostatic atomizer (1000) can provide that the paint supply path (12) comprises an electrically insulating material. In some embodiments, the cascade 90 can incorporate a resistance R1. The high voltage generated by the cascade (90) can be supplied to the multiple electrostatic coating devices (1000). The first resistance value R1 of the cascade is
35 typically at least 60 M Ω , and can be between 80 M Ω and 100 M Ω . In some embodiments the

5 electrostatic atomizer (1000) can provide that the discharge electrode (14) consists of a semi-conductive material, and the paint supply path consists of an electrically insulating material. In certain embodiments, the electrostatic atomizer (1000) can provide that the high voltage supply path (16) includes a metal part (20) on an upstream side of the high resistance (18), and wherein the metal part (20) does not include a paint supply system part (32) forming a part of
10 the paint supply path (12). According to some embodiments, the electrostatic atomizer (1000) according to can provide that the paint supply path (12) includes a feed tube (30) connected to the paint discharge section (10), and wherein the feed tube (30) is made of an electrically insulating material. In some embodiments the electrostatic atomizer (1000) is configured such that the electrostatic atomizer (1000) is a rotary atomizing type electrostatic atomizer (1000) ,
15 wherein the discharge electrode (14) is composed of a rotary atomizing head (1004) which is connected to an output shaft (1010) of an air motor (20) configured to drive the rotary atomizing head, and wherein the rotary atomizing head (1004) consists of a semi-conductive resin material. The electrostatic atomizer (1000) can provide that the air motor (20) is made of metal and constitutes a part of the high-voltage supply path (16). In some embodiments, the
20 electrostatic atomizer (1000) can provide that the output shaft (1010) of the air motor (20) is made of an electrically insulating material and is hollow, and wherein the feed tube (30) is coaxially arranged in the hollow output shaft (1010). In certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) includes a manifold (32) communicated with the feed tube (30), wherein a paint supply pipe (36) communicated with a
25 paint source (34) and a solvent supply pipe (40) communicated with a solvent source (38) are connected to the manifold (32), and wherein the paint supply pipe (36) and the solvent supply pipe (40) are grounded through a bracket (1006). In some embodiments, the electrostatic atomizer (1000) can be configured such that the manifold (32) consists of an electrically insulating material. In some embodiments, the electrostatic atomizer (1000) can be arranged
30 such that the paint supply pipe (36) and the solvent supply pipe (40) consist of an electrically insulating material. According to certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) consists of an electrically insulating material. In some embodiments, electrostatic atomizer (1000) can provide that the high resistance (18) is supported by the hollow output shaft (1010). The electrostatic atomizer (1000) can further
35 include an electrically insulating motor holder (24) for supporting the air motor (20) and having

5 a hole for receiving a high-voltage cable (1002) forming a part of the high voltage supply path (16), and a cylindrical and electrically insulating member provided at an entrance of the hole of the motor holder (24), wherein the motor holder (24) has a cylindrical and electrically insulating member (24a) at an entrance of a hole for receiving a high-voltage cable (1002), wherein the hole forms a portion of the high voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can be configured such that the high resistance (18) has a resistance value (R2) of 120 MΩ to 180 MΩ.

FIG. 3 is an example, non-limiting view of an electrostatic atomizer (1000) of the embodiments described herein. As shown in Fig. 3, the paint supply path (12) can be a polytetrafluoroethylene tube. Further, the solvent supply pipe (40) can be a polytetrafluoroethylene tube.

According to the electrostatic atomizer of Fig. 3, an electrostatic atomizer (1000) can comprise a paint supply path (12) configured to supply paint to a paint discharge section (10); and a high voltage supply path (16) configured to supply a high voltage to a discharge electrode (14), wherein the discharge electrode (14) comprises a semi-conductive material, and wherein the high voltage supply path (16) includes a high resistance (18) near the discharge electrode (14), and is electrically segregated from the paint supply path (12). According to certain embodiments, the electrostatic atomizer (1000) can provide that the paint supply path (12) comprises an electrically insulating material. In some embodiments the electrostatic atomizer (1000) can provide that the discharge electrode (14) consists of a semi-conductive material, and the paint supply path consists of an electrically insulating material. In certain embodiments, the electrostatic atomizer (1000) can provide that the high voltage supply path (16) includes a metal part (20) on an upstream side of the high resistance (18), and wherein the metal part (20) does not include a paint supply system part (32) forming a part of the paint supply path (12). According to some embodiments, the electrostatic atomizer (1000) according to can provide that the paint supply path (12) includes a feed tube (30) connected to the paint discharge section (10), and wherein the feed tube (30) is made of an electrically insulating material. In some embodiments the electrostatic atomizer (1000) is configured such that the electrostatic atomizer (1000) is a rotary atomizing type electrostatic atomizer (1000), wherein the discharge electrode (14) is composed of a rotary atomizing head (1004) which is connected to an output shaft (1010) of an air motor (20) configured to drive the rotary atomizing head, and

5 wherein the rotary atomizing head (1004) consists of a semi-conductive resin material. The electrostatic atomizer (1000) can provide that the air motor (20) is made of metal and constitutes a part of the high-voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can provide that the output shaft (1010) of the air motor (20) is made of an electrically insulating material and is hollow, and wherein the feed tube (30) is coaxially
10 arranged in the hollow output shaft (1010). In certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) includes a manifold (32) communicated with the feed tube (30), wherein a paint supply pipe (36) communicated with a paint source (34) and a solvent supply pipe (40) communicated with a solvent source (38) are connected to the manifold (32), and wherein the paint supply pipe (36) and the solvent supply
15 pipe (40) are grounded through a bracket (1006). In some embodiments, the electrostatic atomizer (1000) can be configured such that the manifold (32) consists of an electrically insulating material. In some embodiments, the electrostatic atomizer (1000) can be arranged such that the paint supply pipe (36) and the solvent supply pipe (40) consist of an electrically insulating material. According to certain embodiments, the electrostatic atomizer (1000) can be
20 configured such that the paint supply path (12) consists of an electrically insulating material. In some embodiments, electrostatic atomizer (1000) can provide that the high resistance (18) is supported by the hollow output shaft (1010). The electrostatic atomizer (1000) can further include an electrically insulating motor holder (24) for supporting the air motor (20) and having a hole for receiving a high-voltage cable (1002) forming a part of the high voltage supply path
25 (16), and a cylindrical and electrically insulating member provided at an entrance of the hole of the motor holder (24), wherein the motor holder (24) has a cylindrical and electrically insulating member (24a) at an entrance of a hole for receiving a high-voltage cable (1002), wherein the hole forms a portion of the high voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can be configured such that the high resistance (18) has a
30 resistance value (R2) of 120 M Ω to 180 M Ω .

FIG. 4 is an example, non-limiting view of a portion of an electrostatic atomizer of the embodiments described herein. As shown in Fig. 4, a contact (1002a) of the high voltage cable (1002) can be held under pressure by a spring. An electrostatic atomizer (1000) can comprise a paint supply path (12) configured to supply paint to a paint discharge section (10); and a high
35 voltage supply path (16) configured to supply a high voltage to a discharge electrode (14),

5 wherein the discharge electrode (14) comprises a semi-conductive material, and wherein the high voltage supply path (16) includes a high resistance (18) near the discharge electrode (14), and is electrically segregated from the paint supply path (12).

According to certain embodiments, the electrostatic atomizer (1000) can provide that the paint supply path (12) comprises an electrically insulating material. In some embodiments
10 the electrostatic atomizer (1000) can provide that the discharge electrode (14) consists of a semi-conductive material, and the paint supply path consists of an electrically insulating material. In certain embodiments, the electrostatic atomizer (1000) can provide that the high voltage supply path (16) includes a metal part (20) on an upstream side of the high resistance (18), and wherein the metal part (20) does not include a paint supply system part (32) forming a
15 part of the paint supply path (12). According to some embodiments, the electrostatic atomizer (1000) according to can provide that the paint supply path (12) includes a feed tube (30) connected to the paint discharge section (10), and wherein the feed tube (30) is made of an electrically insulating material. In some embodiments the electrostatic atomizer (1000) is configured such that the electrostatic atomizer (1000) is a rotary atomizing type electrostatic
20 atomizer (1000), wherein the discharge electrode (14) is composed of a rotary atomizing head (1004) which is connected to an output shaft (1010) of an air motor (20) configured to drive the rotary atomizing head, and wherein the rotary atomizing head (1004) consists of a semi-conductive resin material. The electrostatic atomizer (1000) can provide that the air motor (20) is made of metal and constitutes a part of the high-voltage supply path (16). In some
25 embodiments, the electrostatic atomizer (1000) can provide that the output shaft (1010) of the air motor (20) is made of an electrically insulating material and is hollow, and wherein the feed tube (30) is coaxially arranged in the hollow output shaft (1010). In certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) includes a manifold (32) communicated with the feed tube (30), wherein a paint supply pipe (36)
30 communicated with a paint source (34) and a solvent supply pipe (40) communicated with a solvent source (38) are connected to the manifold (32), and wherein the paint supply pipe (36) and the solvent supply pipe (40) are grounded through a bracket (1006). In some embodiments, the electrostatic atomizer (1000) can be configured such that the manifold (32) consists of an electrically insulating material. In some embodiments, the electrostatic atomizer (1000) can be
35 arranged such that the paint supply pipe (36) and the solvent supply pipe (40) consist of an

5 electrically insulating material. According to certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) consists of an electrically insulating material. In some embodiments, electrostatic atomizer (1000) can provide that the high resistance (18) is supported by the hollow output shaft (1010). The electrostatic atomizer (1000) can further include an electrically insulating motor holder (24) for supporting the air
10 motor (20) and having a hole for receiving a high-voltage cable (1002) forming a part of the high voltage supply path (16), and a cylindrical and electrically insulating member provided at an entrance of the hole of the motor holder (24), wherein the motor holder (24) has a cylindrical and electrically insulating member (24a) at an entrance of a hole for receiving a high-voltage cable (1002), wherein the hole forms a portion of the high voltage supply path (16). In some
15 embodiments, the electrostatic atomizer (1000) can be configured such that the high resistance (18) has a resistance value (R2) of 120 M Ω to 180 M Ω .

FIG. 5 is an example, non-limiting view of an electrostatic atomizer of the embodiments described herein. As shown in Fig. 5, the electrostatic atomizer (1000) can be arranged such that the output shaft (1010) of the air motor (20) is made of an electrically insulating material
20 and is hollow, and wherein the feed tube (30) is coaxially arranged in the hollow output shaft (1010). The electrostatic atomizer (1000) can be used to electrostatically coat a workpiece W, wherein the workpiece W is grounded. The workpiece W can be coated with a paint. The paint can comprise solvent borne metalics. In some embodiments, the electrostatic atomizer (1000) will avoid bridging with a solvent borne metallic paint at less than 50 mm from the workpiece
25 W. In some embodiments, the electrostatic atomizer (1000) will avoid bridging at less than 40 mm between the bell cup (1004) and workpiece W. In some embodiments, the electrostatic atomizer (1000) will avoid bridging at less than 30 mm between the bell cup (1004) and workpiece W. An electrostatic atomizer (1000) can comprise a paint supply path (12) configured to supply paint to a paint discharge section (10); and a high voltage supply path (16)
30 configured to supply a high voltage to a discharge electrode (14), wherein the discharge electrode (14) comprises a semi-conductive material, and wherein the high voltage supply path (16) includes a high resistance (18) near the discharge electrode (14), and is electrically segregated from the paint supply path (12). According to certain embodiments, the electrostatic atomizer (1000) can provide that the paint supply path (12) comprises an electrically insulating
35 material. In some embodiments the electrostatic atomizer (1000) can provide that the discharge

5 electrode (14) consists of a semi-conductive material, and the paint supply path consists of an electrically insulating material. In certain embodiments, the electrostatic atomizer (1000) can provide that the high voltage supply path (16) includes a metal part (20) on an upstream side of the high resistance (18), and wherein the metal part (20) does not include a paint supply system
10 part (32) forming a part of the paint supply path (12). According to some embodiments, the electrostatic atomizer (1000) according to can provide that the paint supply path (12) includes a feed tube (30) connected to the paint discharge section (10), and wherein the feed tube (30) is made of an electrically insulating material.

In some embodiments the electrostatic atomizer (1000) is configured such that the electrostatic atomizer (1000) is a rotary atomizing type electrostatic atomizer (1000), wherein
15 the discharge electrode (14) is composed of a rotary atomizing head (1004) which is connected to an output shaft (1010) of an air motor (20) configured to drive the rotary atomizing head, and wherein the rotary atomizing head (1004) consists of a semi-conductive resin material. The electrostatic atomizer (1000) can provide that the air motor (20) is made of metal and constitutes a part of the high-voltage supply path (16). In some embodiments, the electrostatic
20 atomizer (1000) can provide that the output shaft (1010) of the air motor (20) is made of an electrically insulating material and is hollow, and wherein the feed tube (30) is coaxially arranged in the hollow output shaft (1010). In certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) includes a manifold (32) communicated with the feed tube (30), wherein a paint supply pipe (36) communicated with a
25 paint source (34) and a solvent supply pipe (40) communicated with a solvent source (38) are connected to the manifold (32), and wherein the paint supply pipe (36) and the solvent supply pipe (40) are grounded through a bracket (1006). In some embodiments, the electrostatic atomizer (1000) can be configured such that the manifold (32) consists of an electrically insulating material. In some embodiments, the electrostatic atomizer (1000) can be arranged
30 such that the paint supply pipe (36) and the solvent supply pipe (40) consist of an electrically insulating material. According to certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) consists of an electrically insulating material. In some embodiments, electrostatic atomizer (1000) can provide that the high resistance (18) is supported by the hollow output shaft (1010). The electrostatic atomizer (1000) can further
35 include an electrically insulating motor holder (24) for supporting the air motor (20) and having

5 a hole for receiving a high-voltage cable (1002) forming a part of the high voltage supply path (16), and a cylindrical and electrically insulating member provided at an entrance of the hole of the motor holder (24), wherein the motor holder (24) has a cylindrical and electrically insulating member (24a) at an entrance of a hole for receiving a high-voltage cable (1002), wherein the hole forms a portion of the high voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can be configured such that the high resistance (18) has a resistance value (R2) of 120 MΩ to 180 MΩ.

FIG. 6 is an example, non-limiting view of a portion of an electrostatic atomizer of the embodiments described herein. The high resistance (R2) (18) can comprise, consist essentially of, or consist of a plurality of plate-shaped resistance elements (1100) connected in series with each other. The resistance elements (1100) can be supported by the output shaft (1010) of the air motor (20). A first plate-shaped resistor (1100) can be connected to the metal air motor (20) by the input lead wire (1012). The plurality of plate-shaped resistors (1100) are connected in series by conductive wires (1014). The last plate-shaped resistor (1100) can be connected to the rotary atomizing head, which can be a bell cup (1004) by an output lead wire (1016). An electrostatic atomizer (1000) can comprise a paint supply path (12) configured to supply paint to a paint discharge section (10); and a high voltage supply path (16) configured to supply a high voltage to a discharge electrode (14), wherein the discharge electrode (14) comprises a semi-conductive material, and wherein the high voltage supply path (16) includes a high resistance (18) near the discharge electrode (14), and is electrically segregated from the paint supply path (12).

According to certain embodiments, the electrostatic atomizer (1000) can provide that the paint supply path (12) comprises an electrically insulating material. In some embodiments the electrostatic atomizer (1000) can provide that the discharge electrode (14) consists of a semi-conductive material, and the paint supply path consists of an electrically insulating material. In certain embodiments, the electrostatic atomizer (1000) can provide that the high voltage supply path (16) includes a metal part (20) on an upstream side of the high resistance (18), and wherein the metal part (20) does not include a paint supply system part (32) forming a part of the paint supply path (12). According to some embodiments, the electrostatic atomizer (1000) according to can provide that the paint supply path (12) includes a feed tube (30) connected to the paint discharge section (10), and wherein the feed tube (30) is made of an

5 electrically insulating material. In some embodiments the electrostatic atomizer (1000) is configured such that the electrostatic atomizer (1000) is a rotary atomizing type electrostatic atomizer (1000), wherein the discharge electrode (14) is composed of a rotary atomizing head (1004) which is connected to an output shaft (1010) of an air motor (20) configured to drive the rotary atomizing head, and wherein the rotary atomizing head (1004) consists of a semi-
10 conductive resin material. The electrostatic atomizer (1000) can provide that the air motor (20) is made of metal and constitutes a part of the high-voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can provide that the output shaft (1010) of the air motor (20) is made of an electrically insulating material and is hollow, and wherein the feed tube (30) is coaxially arranged in the hollow output shaft (1010). In certain embodiments, the
15 electrostatic atomizer (1000) can be configured such that the paint supply path (12) includes a manifold (32) communicated with the feed tube (30), wherein a paint supply pipe (36) communicated with a paint source (34) and a solvent supply pipe (40) communicated with a solvent source (38) are connected to the manifold (32), and wherein the paint supply pipe (36) and the solvent supply pipe (40) are grounded through a bracket (1006). In some embodiments,
20 the electrostatic atomizer (1000) can be configured such that the manifold (32) consists of an electrically insulating material. In some embodiments, the electrostatic atomizer (1000) can be arranged such that the paint supply pipe (36) and the solvent supply pipe (40) consist of an electrically insulating material. According to certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) consists of an electrically
25 insulating material. In some embodiments, electrostatic atomizer (1000) can provide that the high resistance (18) is supported by the hollow output shaft (1010). The electrostatic atomizer (1000) can further include an electrically insulating motor holder (24) for supporting the air motor (20) and having a hole for receiving a high-voltage cable (1002) forming a part of the high voltage supply path (16), and a cylindrical and electrically insulating member provided at
30 an entrance of the hole of the motor holder (24), wherein the motor holder (24) has a cylindrical and electrically insulating member (24a) at an entrance of a hole for receiving a high-voltage cable (1002), wherein the hole forms a portion of the high voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can be configured such that the high resistance (18) has a resistance value (R2) of 120 M Ω to 180 M Ω .

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FIG. 7 is an example, non-limiting view of a portion of an electrostatic atomizer of the
embodiments described herein. The high resistance (R2) 18 can comprise, consist essentially
of, or consist of a plurality of plate-shaped resistance elements (1100) connected in series with
each other. The resistance elements (1100) can be supported by the output shaft (1010) of the
air motor (20). A first plate-shaped resistor (1100) can be connected to the metal air motor (20)
10 by the input lead wire (1012). The plurality of plate-shaped resistors (1100) are connected in
series by conductive wires 1014.

The last plate-shaped resistor (1100) can be connected to the rotary atomizing head,
which can be a bell cup (1004) by an output lead wire (1016). An electrostatic atomizer (1000)
can comprise a paint supply path (12) configured to supply paint to a paint discharge section
15 (10); and a high voltage supply path (16) configured to supply a high voltage to a discharge
electrode (14), wherein the discharge electrode (14) comprises a semi-conductive material, and
wherein the high voltage supply path (16) includes a high resistance (18) near the discharge
electrode (14), and is electrically segregated from the paint supply path (12). According to
certain embodiments, the electrostatic atomizer (1000) can provide that the paint supply path
20 (12) comprises an electrically insulating material. In some embodiments the electrostatic
atomizer (1000) can provide that the discharge electrode (14) consists of a semi-conductive
material, and the paint supply path consists of an electrically insulating material. In certain
embodiments, the electrostatic atomizer (1000) can provide that the high voltage supply path
25 (16) includes a metal part (20) on an upstream side of the high resistance (18), and wherein the
metal part (20) does not include a paint supply system part (32) forming a part of the paint
supply path (12). According to some embodiments, the electrostatic atomizer (1000)
according to can provide that the paint supply path (12) includes a feed tube (30) connected to
the paint discharge section (10), and wherein the feed tube (30) is made of an electrically
30 insulating material. In some embodiments the electrostatic atomizer (1000) is configured such
that the electrostatic atomizer (1000) is a rotary atomizing type electrostatic atomizer (1000) ,
wherein the discharge electrode (14) is composed of a rotary atomizing head (1004) which is
connected to an output shaft (1010) of an air motor (20) configured to drive the rotary
atomizing head, and wherein the rotary atomizing head (1004) consists of a semi-conductive
resin material. The electrostatic atomizer (1000) can provide that the air motor (20) is made of
35 metal and constitutes a part of the high-voltage supply path (16). In some embodiments, the

5 electrostatic atomizer (1000) can provide that the output shaft (1010) of the air motor (20) is made of an electrically insulating material and is hollow, and wherein the feed tube (30) is coaxially arranged in the hollow output shaft (1010). In certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) includes a manifold (32) communicated with the feed tube (30), wherein a paint supply pipe (36) communicated with a
10 paint source (34) and a solvent supply pipe (40) communicated with a solvent source (38) are connected to the manifold (32), and wherein the paint supply pipe (36) and the solvent supply pipe (40) are grounded through a bracket (1006).

In some embodiments, the electrostatic atomizer (1000) can be configured such that the manifold (32) consists of an electrically insulating material. In some embodiments, the
15 electrostatic atomizer (1000) can be arranged such that the paint supply pipe (36) and the solvent supply pipe (40) consist of an electrically insulating material. According to certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) consists of an electrically insulating material. In some embodiments, electrostatic atomizer (1000) can provide that the high resistance (18) is supported by the hollow output
20 shaft (1010). The electrostatic atomizer (1000) can further include an electrically insulating motor holder (24) for supporting the air motor (20) and having a hole for receiving a high-voltage cable (1002) forming a part of the high voltage supply path (16), and a cylindrical and electrically insulating member provided at an entrance of the hole of the motor holder (24), wherein the motor holder (24) has a cylindrical and electrically insulating member (24a) at an
25 entrance of a hole for receiving a high-voltage cable (1002), wherein the hole forms a portion of the high voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can be configured such that the high resistance (18) has a resistance value (R2) of 120 M Ω to 180 M Ω .

FIG. 8 is an example, non-limiting view of a portion of an electrostatic atomizer of the
30 embodiments described herein. The high resistance (R2) 18 can comprise, consist essentially of, or consist of a plurality of plate-shaped resistance elements (1100) connected in series with each other. The resistance elements (1100) can be supported by the output shaft (1010) of the air motor (20). A first plate-shaped resistor (1100) can be connected to the metal air motor (20) by the input lead wire (1012). The plurality of plate-shaped resistors (1100) are connected in
35 series by conductive wires 1014. The last plate-shaped resistor (1100) can be connected to the

5 rotary atomizing head, which can be a bell cup (1004) by an output lead wire (1016). An electrostatic atomizer (1000) can comprise a paint supply path (12) configured to supply paint to a paint discharge section (10); and a high voltage supply path (16) configured to supply a high voltage to a discharge electrode (14), wherein the discharge electrode (14) comprises a semi-conductive material, and wherein the high voltage supply path (16) includes a high
10 resistance (18) near the discharge electrode (14), and is electrically segregated from the paint supply path (12). According to certain embodiments, the electrostatic atomizer (1000) can provide that the paint supply path (12) comprises an electrically insulating material. In some embodiments the electrostatic atomizer (1000) can provide that the discharge electrode (14) consists of a semi-conductive material, and the paint supply path consists of an electrically
15 insulating material. In certain embodiments, the electrostatic atomizer (1000) can provide that the high voltage supply path (16) includes a metal part (20) on an upstream side of the high resistance (18), and wherein the metal part (20) does not include a paint supply system part (32) forming a part of the paint supply path (12). According to some embodiments, the electrostatic atomizer (1000) according to can provide that the paint supply path (12) includes a feed tube
20 (30) connected to the paint discharge section (10), and wherein the feed tube (30) is made of an electrically insulating material. In some embodiments the electrostatic atomizer (1000) is configured such that the electrostatic atomizer (1000) is a rotary atomizing type electrostatic atomizer (1000), wherein the discharge electrode (14) is composed of a rotary atomizing head (1004) which is connected to an output shaft (1010) of an air motor (20) configured to drive the
25 rotary atomizing head, and wherein the rotary atomizing head (1004) consists of a semi-conductive resin material. The electrostatic atomizer (1000) can provide that the air motor (20) is made of metal and constitutes a part of the high-voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can provide that the output shaft (1010) of the air motor (20) is made of an electrically insulating material and is hollow, and wherein the feed
30 tube (30) is coaxially arranged in the hollow output shaft (1010). In certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) includes a manifold (32) communicated with the feed tube (30), wherein a paint supply pipe (36) communicated with a paint source (34) and a solvent supply pipe (40) communicated with a solvent source (38) are connected to the manifold (32), and wherein the paint supply pipe (36)
35 and the solvent supply pipe (40) are grounded through a bracket (1006). In some embodiments,

5 the electrostatic atomizer (1000) can be configured such that the manifold (32) consists of an electrically insulating material. In some embodiments, the electrostatic atomizer (1000) can be arranged such that the paint supply pipe (36) and the solvent supply pipe (40) consist of an electrically insulating material. According to certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) consists of an electrically
10 insulating material. In some embodiments, electrostatic atomizer (1000) can provide that the high resistance (18) is supported by the hollow output shaft (1010). The electrostatic atomizer (1000) can further include an electrically insulating motor holder (24) for supporting the air motor (20) and having a hole for receiving a high-voltage cable (1002) forming a part of the high voltage supply path (16), and a cylindrical and electrically insulating member provided at
15 an entrance of the hole of the motor holder (24), wherein the motor holder (24) has a cylindrical and electrically insulating member (24a) at an entrance of a hole for receiving a high-voltage cable (1002), wherein the hole forms a portion of the high voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can be configured such that the high resistance (18) has a resistance value (R2) of 120 MΩ to 180 MΩ.

20 An electrostatic atomizer (1000) can comprise a paint supply path (12) configured to supply paint to a paint discharge section (10); and a high voltage supply path (16) configured to supply a high voltage to a discharge electrode (14), wherein the discharge electrode comprises a semi-conductive material, and wherein the high voltage supply path (16) includes a high
25 resistance (18) near the discharge electrode (14), and is electrically segregated from the paint supply path (12). According to certain embodiments, the electrostatic atomizer (1000) can provide that the paint supply path (12) comprises an electrically insulating material. In some embodiments the electrostatic atomizer can provide that the discharge electrode consists of a semi-conductive material, and the paint supply path consists of an electrically insulating
30 material. In certain embodiments, the electrostatic atomizer (1000) can provide that the high voltage supply path (16) includes a metal part (20) on an upstream side of the high resistance (18), and wherein the metal part (20) does not include a paint supply system part (32) forming a part of the paint supply path (12). According to some embodiments, the electrostatic atomizer (1000) according to can provide that the paint supply path (12) includes a feed tube (30)
35 connected to the paint discharge section (10), and wherein the feed tube (30) is made of an electrically insulating material. In some embodiments the electrostatic atomizer (1000) is

5 configured such that the electrostatic atomizer is a rotary atomizing type electrostatic atomizer, wherein the discharge electrode (14) is composed of a rotary atomizing head (1004) which is connected to an output shaft (1010) of an air motor (20) configured to drive the rotary atomizing head, and wherein the rotary atomizing head (1004) consists of a semi-conductive resin material. The electrostatic atomizer (1000) can provide that the air motor (20) is made of
10 metal and constitutes a part of the high-voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can provide that the output shaft (1010) of the air motor (20) is made of an electrically insulating material and is hollow, and wherein the feed tube (30) is coaxially arranged in the hollow output shaft (1010). In certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) includes a manifold (32)
15 communicated with the feed tube (30), wherein a paint supply pipe (36) communicated with a paint source (34) and a solvent supply pipe (40) communicated with a solvent source (38) are connected to the manifold (32), and wherein the paint supply pipe (36) and the solvent supply pipe (40) are grounded through a bracket (1006). In some embodiments, the electrostatic atomizer (1000) can be configured such that the manifold (32) consists of an electrically
20 insulating material. In some embodiments, the electrostatic atomizer (1000) can be arranged such that the paint supply pipe (36) and the solvent supply pipe (40) consist of an electrically insulating material. According to certain embodiments, the electrostatic atomizer (1000) can be configured such that the paint supply path (12) consists of an electrically insulating material. In some embodiments, electrostatic atomizer can provide that the high resistance (18) is supported
25 by the hollow output shaft (1010). The electrostatic atomizer (1000) can further include an electrically insulating motor holder (24) for supporting the air motor (20) and having a hole for receiving a high-voltage cable (1002) forming a part of the high voltage supply path (16), and a cylindrical and electrically insulating member provided at an entrance of the hole of the motor holder (24), wherein the motor holder (24) has a cylindrical and electrically insulating member
30 (24a) at an entrance of a hole for receiving a high-voltage cable (1002), wherein the hole forms a portion of the high voltage supply path (16). In some embodiments, the electrostatic atomizer (1000) can be configured such that the high resistance (18) has a resistance value (R2) of 120 MΩ to 180 MΩ.

35 The high voltage supply path 16 can have the following configuration: beginning at the cascade (90), directly to the high voltage cable (1002), directly to the air motor (20), wherein

5 the air motor (20) consists of metal, directly to the input lead wire (1012), directly to the plate shaped resistance elements (1100), directly to the output lead wire (1016), directly to the rotating atomizing head (1004), which can be a bell.

10 The metal air motor (20) can be held by the motor holder (24), which can comprise, consist essentially of, or consist of an electrically insulating resin. The motor holder (24) can have a hole for receiving the high-voltage cable (1002), and at the entrance of the hole, a tubular and electrically insulating member (24a) can be provided. The tubular member (24a) can cause a creepage distance of insulation to be extended.

15 The rotary atomizing head (1004) can comprise or consist of a semi-conductive resin. The air motor (20) can comprise or consist of any electrically conductive metal. The motor holder (24) can comprise or consist of an electrically insulating resin. The output shaft (1010), which can be hollow, can comprise or consist of polyether ether ketone (PEEK) resin. The manifold (32) can comprise or consist of an electrically insulating resin. Pipes (36, 40) can comprise or consist of an electrically insulating resin tube. The feed tube (112) can comprise or consist of an electrically insulating resin. The resistance provided by R2 (18) can be
20 between 120 MΩ to 180 MΩ.

EMBODIMENTS

25 In a first embodiment, provided is an electrostatic atomizer comprising a paint supply path configured to supply paint to a paint discharge section; and a high voltage supply path configured to supply a high voltage to a discharge electrode, wherein the discharge electrode comprises a semi-conductive material, and wherein the high voltage supply path includes a high resistance near the discharge electrode and is electrically segregated from the paint supply path.

30 The first or any subsequent embodiments may further provide that the paint supply path comprises an electrically insulating material.

The first or any previous or subsequent embodiments may further provide that the discharge electrode consists of a semi-conductive material, and wherein the paint supply path consists of an electrically insulating material.

The first or any previous or subsequent embodiments may further provide that the high voltage supply path includes a metal part on an upstream side of the high resistance, and

5 wherein the metal part does not include a paint supply system part forming a part of the paint supply path.

The first or any previous or subsequent embodiments may further provide that the paint supply path includes a feed tube connected to the paint discharge section, and wherein the feed tube consists of an electrically insulating material.

10 The first or any previous or subsequent embodiments may further provide that the electrostatic atomizer is a rotary atomizing type electrostatic atomizer, wherein the discharge electrode is composed of a rotary atomizing head which is connected to an output shaft of an air motor configured to drive the rotary atomizing head, and wherein the rotary atomizing head consists of a semi-conductive resin material.

15 The first or any previous or subsequent embodiments may further provide that the air motor consists of metal and constitutes a part of the high-voltage supply path.

The first or any previous or subsequent embodiments may further provide that the output shaft of the air motor consists of an electrically insulating material and is hollow, and wherein the feed tube is coaxially arranged in the hollow output shaft.

20 The first or any previous or subsequent embodiments may further provide that the paint supply path includes a manifold communicated with the feed tube, wherein a paint supply pipe communicated with a paint source and a solvent supply pipe communicated with a solvent source are connected to the manifold, and wherein the paint supply pipe and the solvent supply pipe are grounded through a bracket.

25 The first or any previous or subsequent embodiments may further provide that the manifold consists of an electrically insulating material.

The first or any previous or subsequent embodiments may further provide that the paint supply pipe and the solvent supply pipe consist of an electrically insulating material.

30 The first or any previous or subsequent embodiments may further provide that the paint supply path consists of an electrically insulating material.

The first or any previous or subsequent embodiments may further provide that the high resistance is supported by the hollow output shaft.

35 The first or any previous or subsequent embodiments may further provide that the electrostatic atomizer comprises an electrically insulating motor holder for supporting the air motor and having a hole for receiving a high-voltage cable forming a part of the high voltage

5 supply path, and a cylindrical and electrically insulating member provided at an entrance of the hole of the motor holder, wherein the motor holder has a cylindrical and electrically insulating member at an entrance of a hole for receiving a high-voltage cable, wherein the hole forms a portion of the high voltage supply path.

10 The first or any previous or subsequent embodiments may further provide that the high resistance has a resistance value of 120 M Ω to 180 M Ω .

15 While the invention has been described with reference to various exemplary embodiments, it will be understood by those skilled in the art that various changes, omissions and/or additions may be made and equivalents may be substituted for elements thereof without departing from the spirit and scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims. Moreover, unless specifically stated any use of the terms first, second, etc. do
20 not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another.

5

CLAIMS

We Claim:

10

1. An electrostatic atomizer comprising:
a paint supply path configured to supply paint to a paint discharge section; and
a high voltage supply path configured to supply a high voltage to a discharge
electrode, wherein the discharge electrode comprises a semi-conductive material, and
wherein the high voltage supply path includes a high resistance near the
15 discharge electrode and is electrically segregated from the paint supply path.

15

2. The electrostatic atomizer according to claim 1, wherein the paint supply path
comprises an electrically insulating material.

20

3. The electrostatic atomizer of claim 2, wherein the discharge electrode consists of
a semi-conductive material, and wherein the paint supply path consists of an electrically
insulating material.

25

4. The electrostatic atomizer according to claim 1, wherein the high voltage supply
path includes a metal part on an upstream side of the high resistance, and wherein the metal
part does not include a paint supply system part forming a part of the paint supply path.

30

5. An electrostatic coater according to claim 4, wherein the paint supply path
includes a feed tube connected to the paint discharge section, and wherein the feed tube
consists of an electrically insulating material.

35

6. The electrostatic atomizer according to claim 1, wherein the electrostatic
atomizer is a rotary atomizing type electrostatic atomizer,
wherein the discharge electrode is composed of a rotary atomizing head which is
connected to an output shaft of an air motor configured to drive the rotary atomizing head, and

5 wherein the rotary atomizing head consists of a semi-conductive resin material.

7. The electrostatic atomizer according to claim 6, wherein the air motor consists of metal and constitutes a part of the high-voltage supply path.

10 8. The electrostatic atomizer according to claim 7, wherein the output shaft of the air motor consists of an electrically insulating material and is hollow (Fig. 5 attached here), and wherein the feed tube is coaxially arranged in the hollow output shaft.

15 9. The electrostatic atomizer according to claim 8, wherein the paint supply path includes a manifold communicated with the feed tube, wherein a paint supply pipe communicated with a paint source and a solvent supply pipe communicated with a solvent source are connected to the manifold, and wherein the paint supply pipe and the solvent supply pipe are grounded through a bracket.

20 10. The electrostatic atomizer according to claim 9, wherein the manifold consists of an electrically insulating material.

25 11. The electrostatic atomizer according to claim 10, wherein the paint supply pipe and the solvent supply pipe consist of an electrically insulating material.

12. The electrostatic atomizer according to claim 8, wherein the paint supply path consists of an electrically insulating material.

30 13. The electrostatic atomizer according to claim 8, wherein the high resistance is supported by the hollow output shaft.

14. The electrostatic atomizer according to claim 8, further comprising an electrically insulating motor holder for supporting the air motor and having a hole for receiving a high-voltage cable forming a part of the high voltage supply path, and

5

a cylindrical and electrically insulating member provided at an entrance of the hole of the motor holder, wherein the motor holder has a cylindrical and electrically insulating member at an entrance of a hole for receiving a high-voltage cable, wherein the hole forms a portion of the high voltage supply path.

10

14. The electrostatic atomizer according to claim 1, wherein the high resistance has a resistance value of 120 M Ω to 180 M Ω .

FIG.1

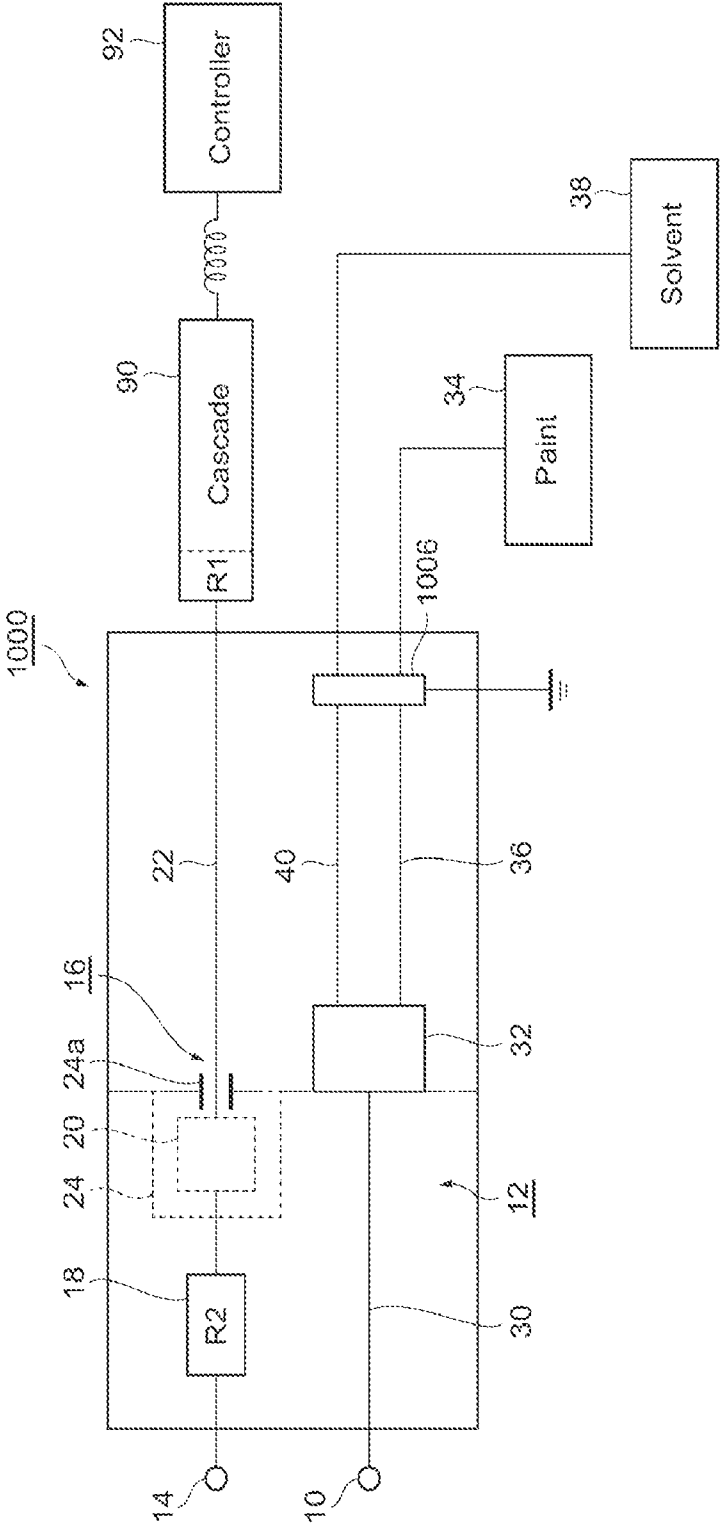


FIG.2

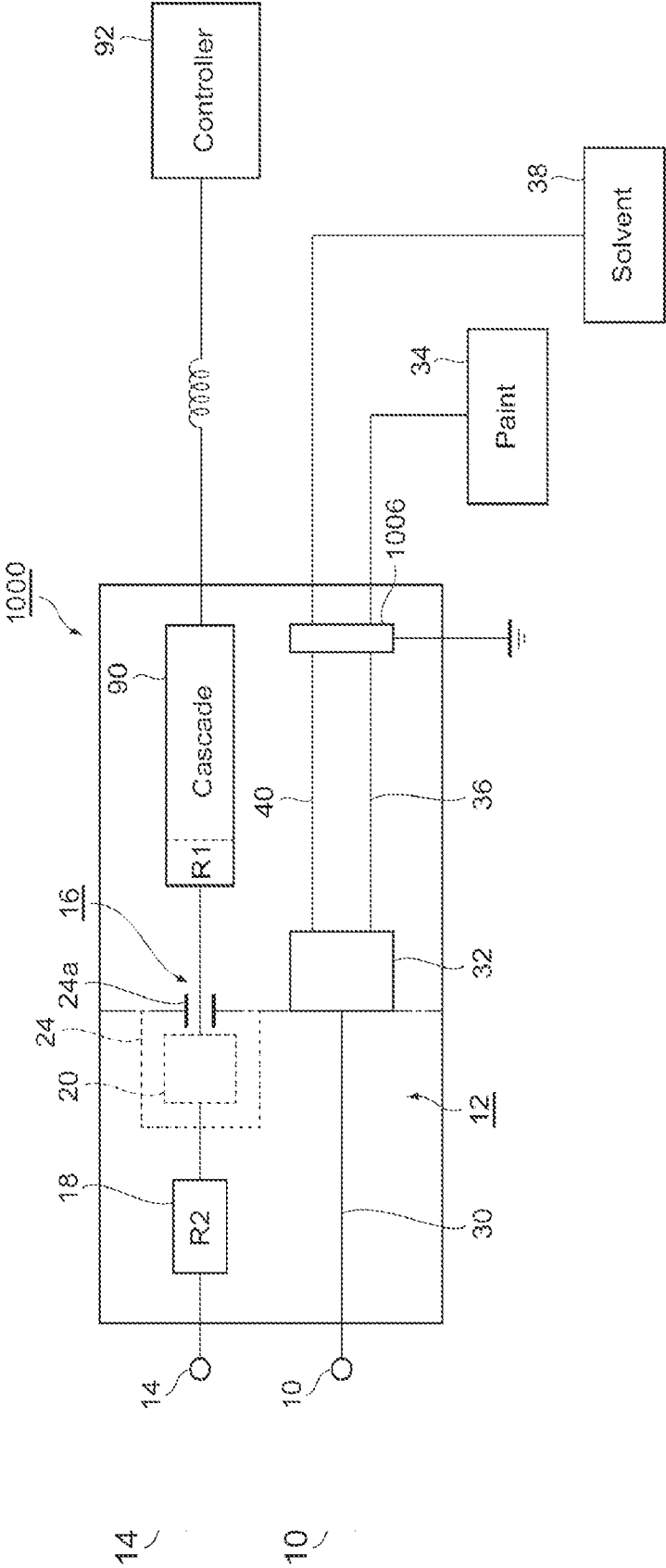


FIG.3

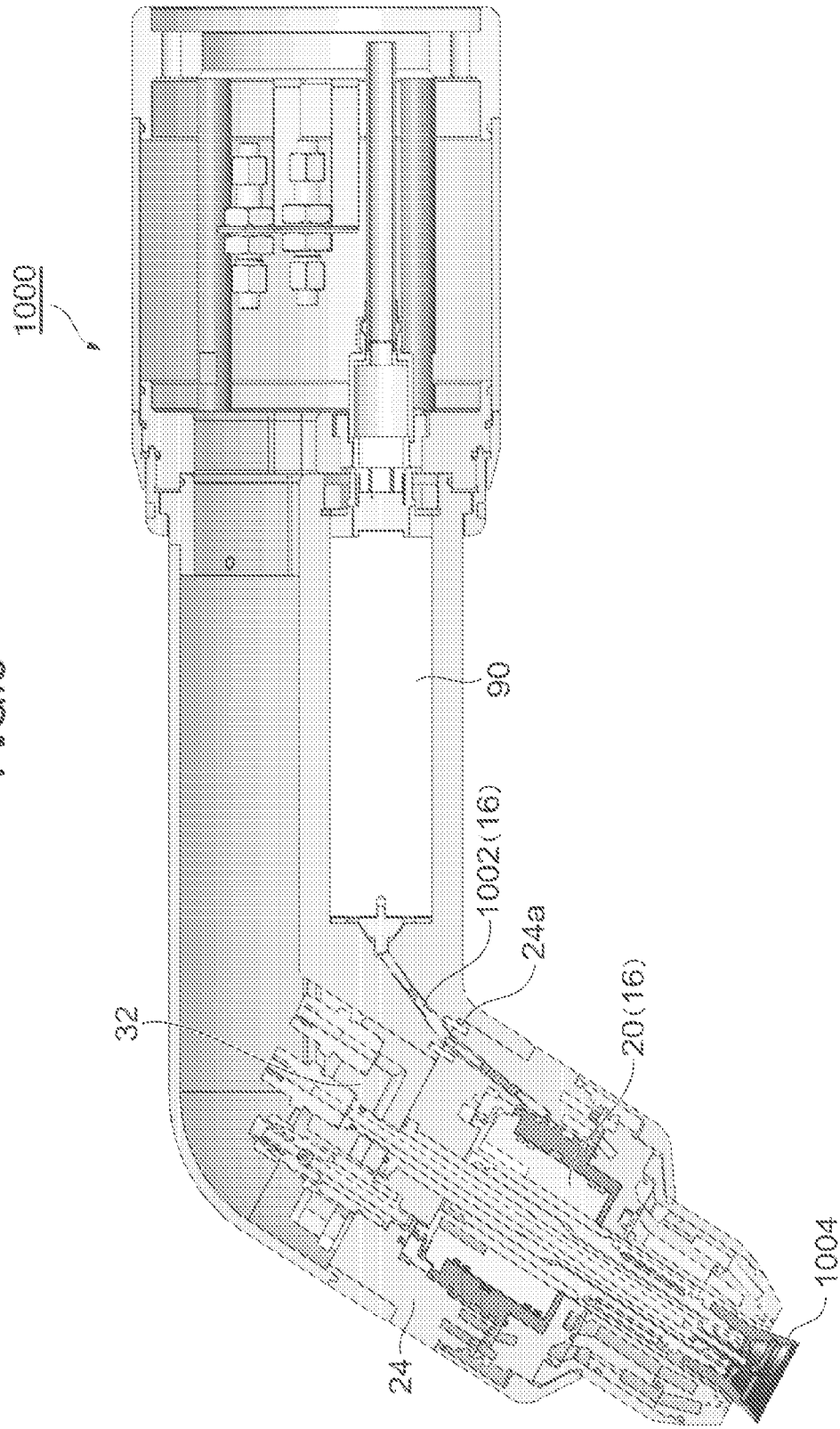
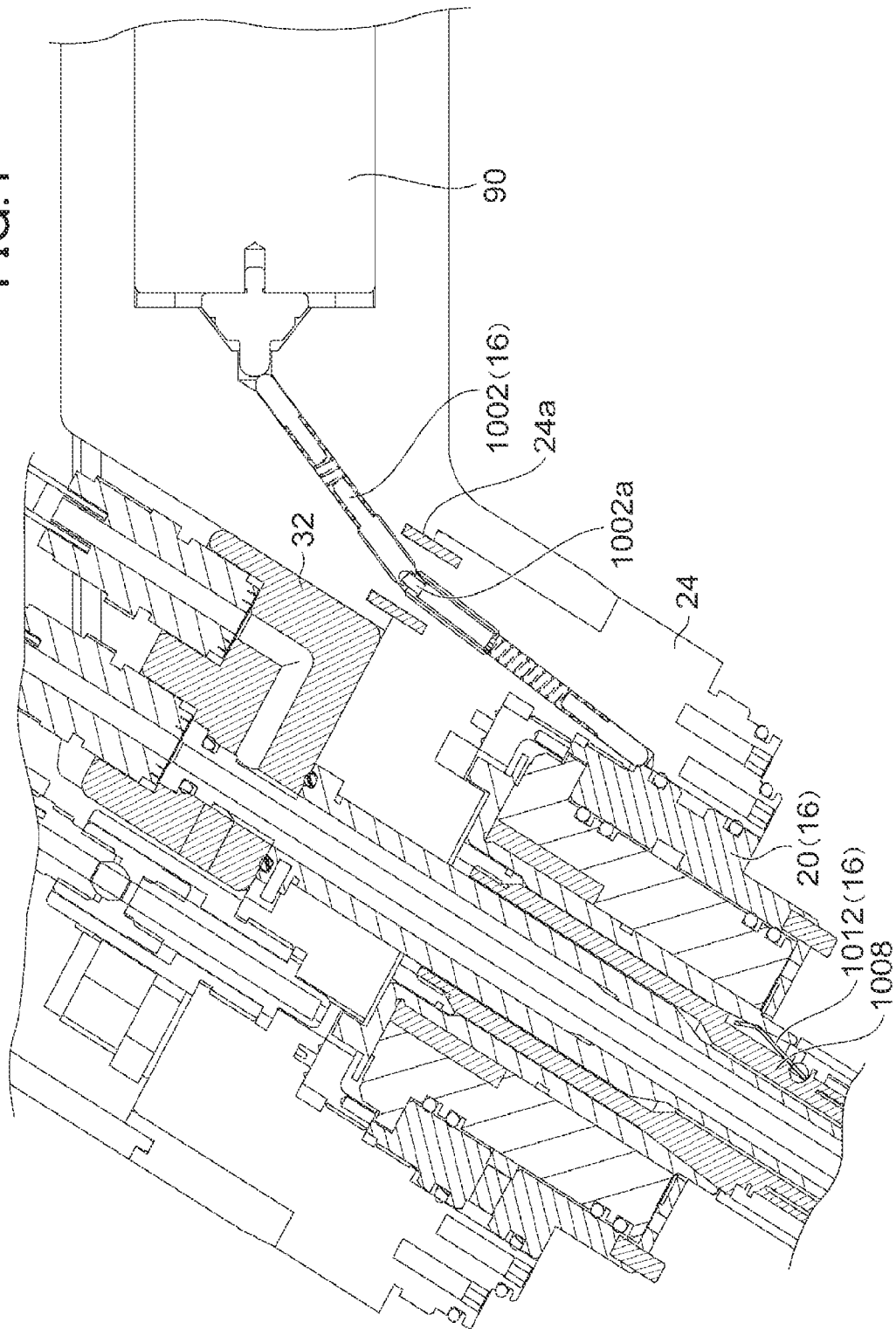


FIG.4



LOTE

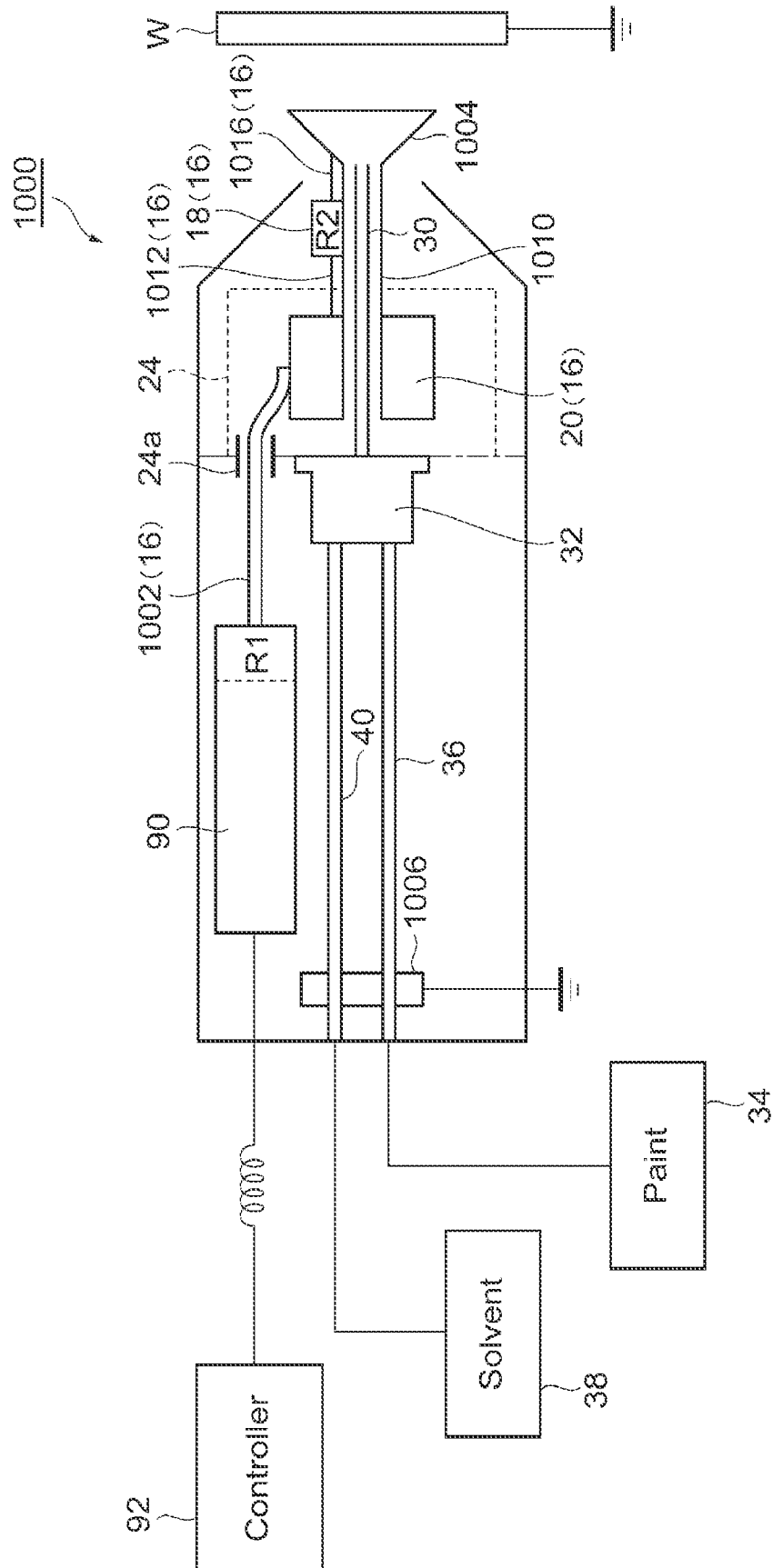
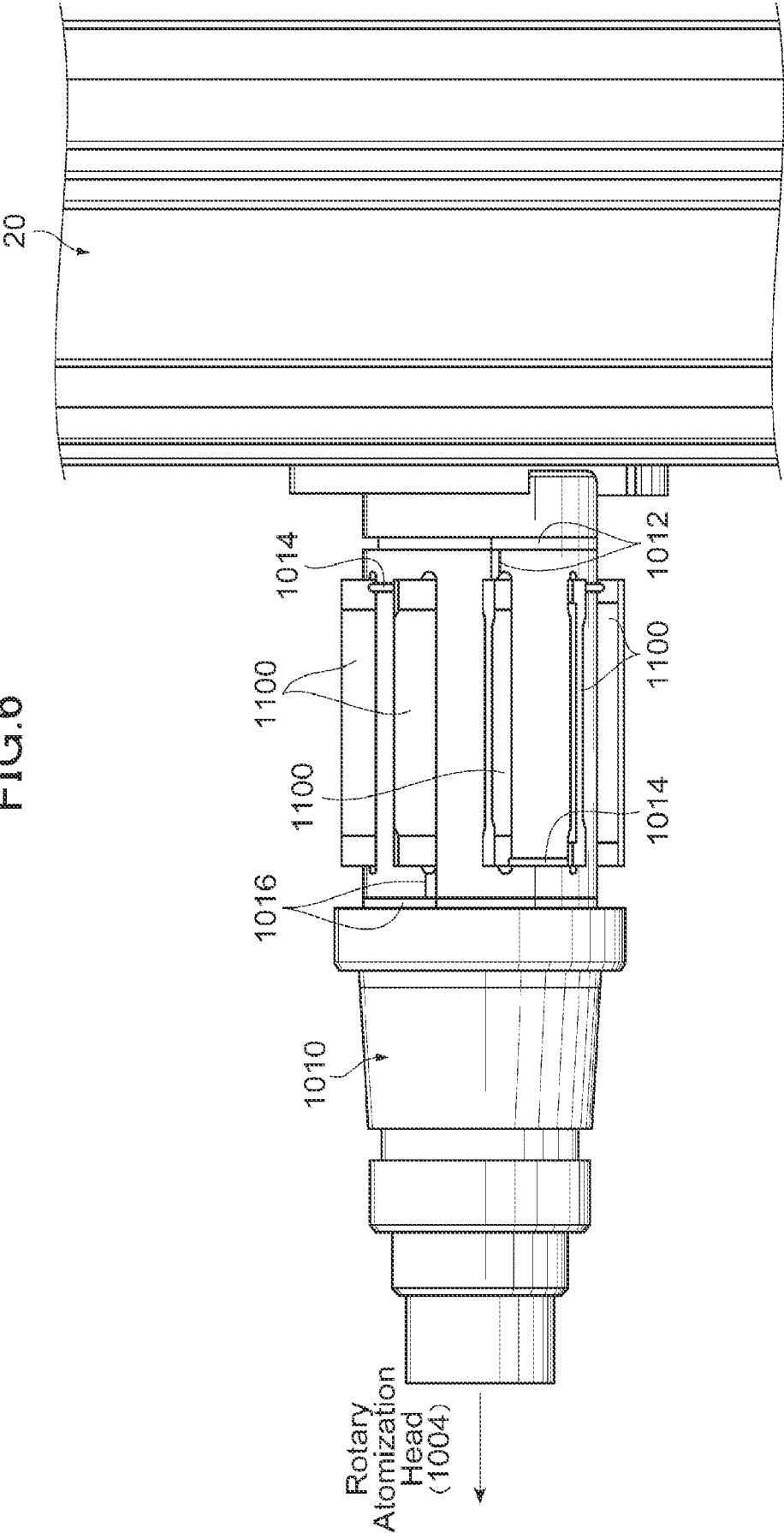


FIG.6



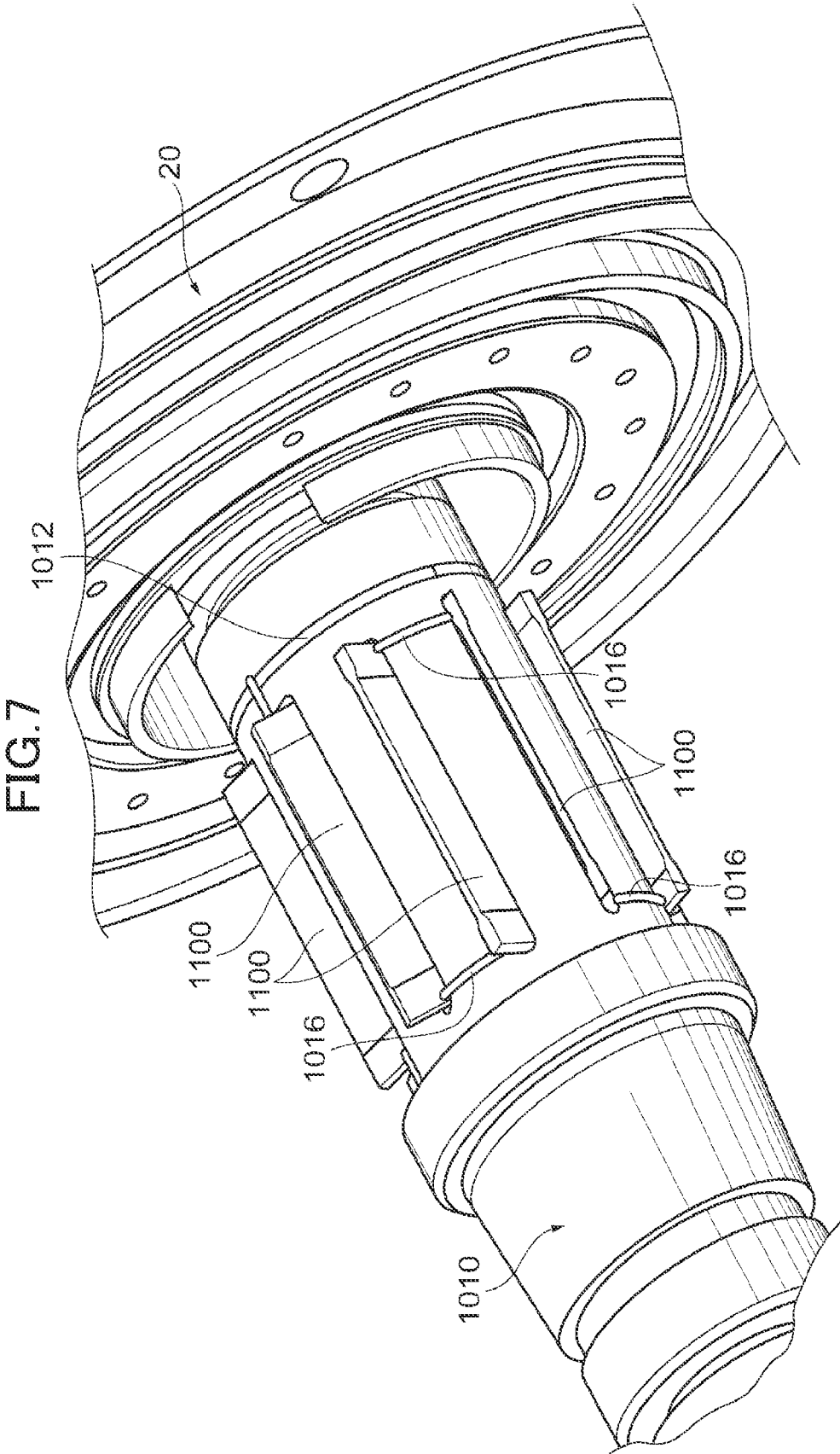
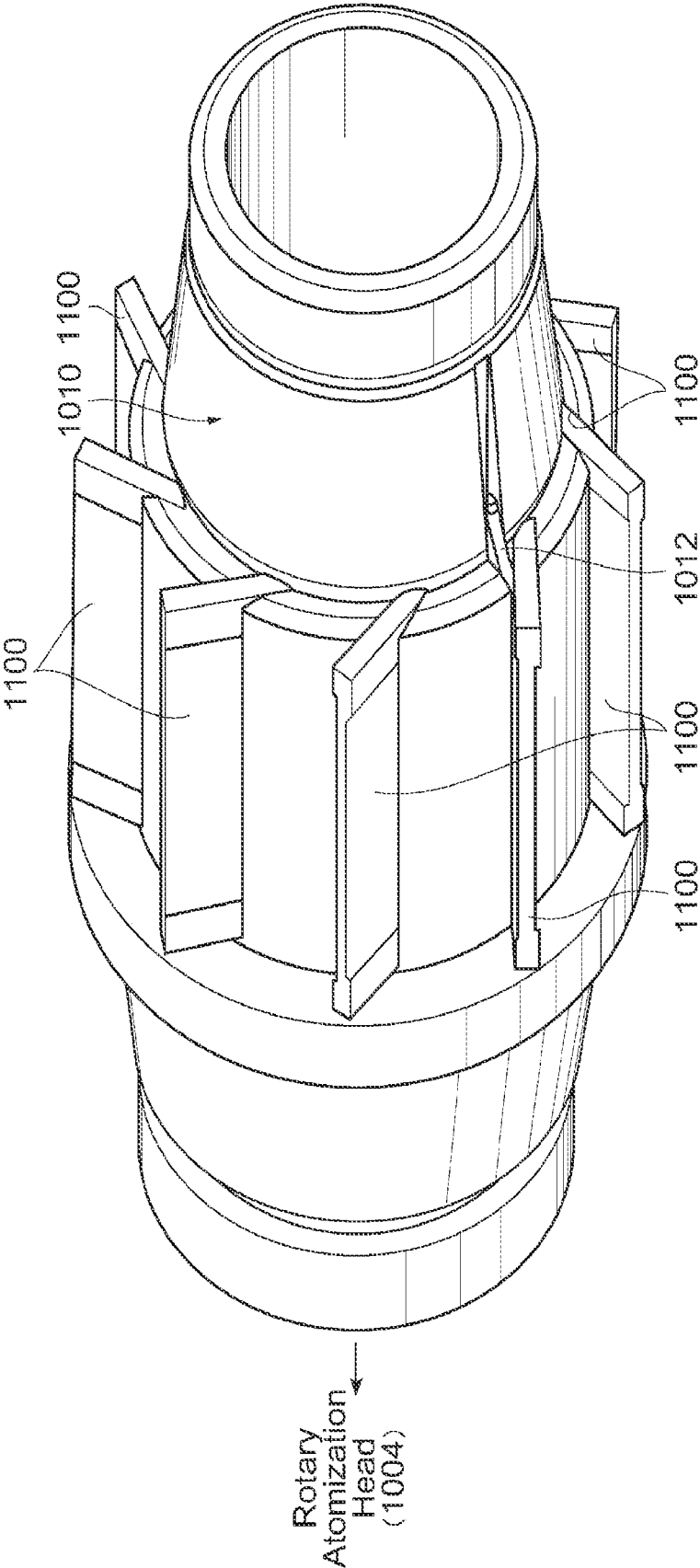


FIG.8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 21/14813

A. CLASSIFICATION OF SUBJECT MATTER

IPC - B05B 5/053, 5/025, 5/08 (2021.01)

CPC - B05B 5/0533, 5/088, 5/0255, 5/025, 5/087

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)

See Search History document

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

See Search History document

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

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2017/0001206 A1 (RANSBURG INDUSTRIAL FINISHING K.K.) 05 January 2017	1-8, 12, 13, 14a, 14b
---	(05.01.2017) entire document, especially Fig. 5, para [0011], [0021]-[0023], [0050], [0054]-[0059]	-----
Y		9-11
Y	US 5,102,046 A (DIANA) 07 April 1992 (07.04.1992) entire document, especially Fig. 1, col 3, 54-64; col 4, ln 1-4, ln 44-52; col 5, ln 1-12, ln 16-20	9-11

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

* Special categories of cited documents:

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

12 April 2021

Date of mailing of the international search report

APR 29 2021

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