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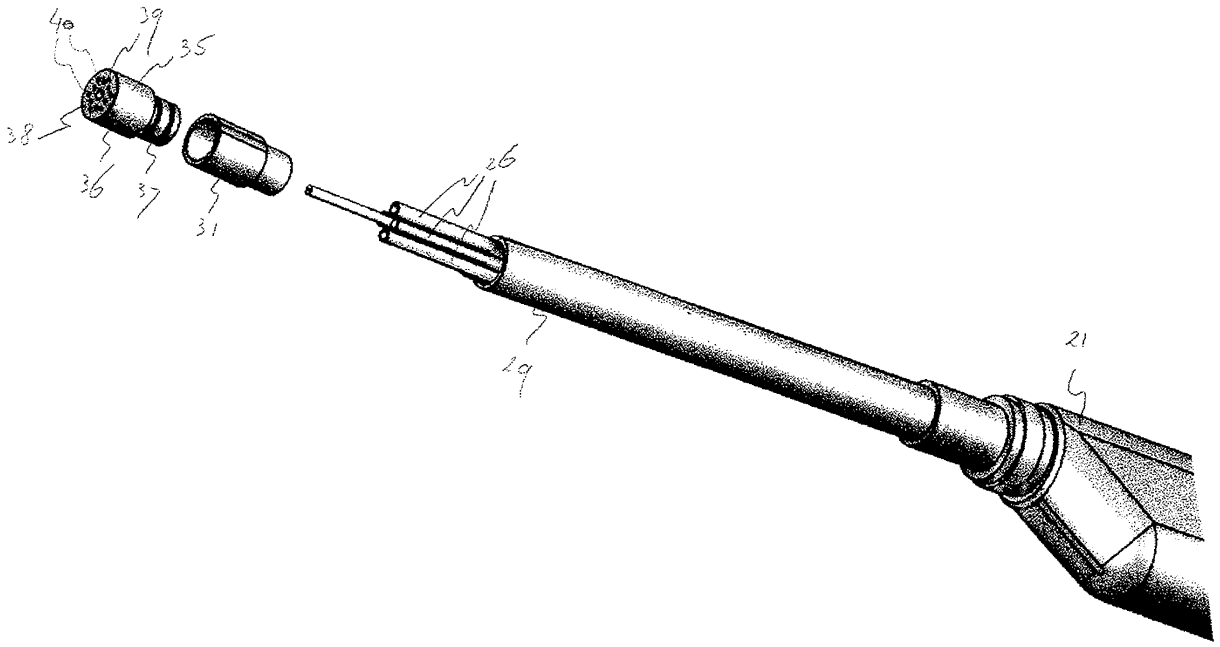
(54) Powder coating spraying apparatus

(57) Powder coating spray apparatus comprising an inlet connected to a powder feed line; an electric charger; one or more powder channels (26) leading from the inlet to a nozzle; and an electrode leading from the charging element to the nozzle. The electrode is arranged centrally in the nozzle and the powder channels (26) surround the electrode. The nozzle can for example comprise a diffuser element (35) located at a distance from the ends of the powder channels, e.g., a perforated wall (38) provided with a pattern of equally distributed apertures.

FIG. 3



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Description

[0001] The present invention is directed to a powder coating spray apparatus and to a method of spray application of a powder coating. More particularly, the invention is directed to a spray gun and application method that are particularly suitable for coating the inside walls of hollow metal products, such as aluminium containers, e.g., aluminium aerosol containers.

[0002] The two main powder coating application technologies are tribostatic spray application and electrostatic spray application. In tribostatic spray application, powder particles are charged by causing them to move along a specially designed and shaped surface. The frictionally charged particles will then be attracted to, and deposited onto the substrate. The extent of frictional charging is governed by the volume of powder delivered onto the charging surface and the speed it moves across the surface, both of which can be controlled by the tribostatic gun operator.

[0003] In electrostatic spray application, a high voltage generator is used to charge an electrode at the tip of the powder gun. This creates an electrostatic field (or corona) between the gun and the substrate. Gas molecules in the air pick up electrons emitted from the corona. This negative charge is, in turn, transferred to the powder particles as they are propelled from the gun head towards the substrate. The target substrate is held at an electrical potential relative to the electrode, typically ground, and the charged powder particles are attracted to and readily adhere to the substrate.

[0004] An electrostatic spraying apparatus typically includes a spray nozzle through which powder is ejected toward a target surface or object to be coated with the powder. Powder is fed to the spray apparatus from a powder supply, typically a powder feed hopper that may include a fluidized powder bed. The powder is fluidized in the hopper by a flow of air through the floor of the hopper. One or more powder pumps may be used to pump the fluidized powder from the hopper to one or more spray guns through a corresponding number of powder feed hoses.

[0005] Thus, a typical electrostatic corona charging powder spray gun includes an electrical power input cable, a powder hose and may further include an air line for purge air, all connectable to the back end of the spray gun. A specific powder coating spray gun using corona charging is disclosed in US 6,796,519.

[0006] In the manufacture of metal packaging containers or cans, such as aerosol cans, the cans are coated with an internal protective coating. Aerosol cans are generally made from an aluminium-based alloy with an aluminium content of 99.7% in weight or more. To manufacture the aerosol cans, the alloy used is usually shaped into slugs of predetermined diameter. A strip is obtained by continuous casting, and then hot followed by cold rolling. The slugs are then cut out and thermally annealed. Then the aerosol cans are manufactured from the slugs, e.g., by means of a cold impact extrusion step. A layer of lacquer or varnish is then applied to the inside of the can. This layer of lacquer, for example a phenolic epoxy resin, is preferably applied by spraying followed by polymerization, at a temperature comprised between 200° C and 250° C for a period of time of less than 10 minutes. The can may then be subjected to an external printing step designed to form patterns on the outside wall of the can.

[0007] Liquid coating materials are nowadays used for the internal coating of aerosol cans. These materials give rise to numerous environmental problems as a result of their solvent content. This also applies to cases where aqueous coating materials are employed. It is therefore increasingly being attempted to replace these coating materials by solvent-free substitutes, in particular powder coatings.

[0008] So far, in prior art systems no satisfactory results have been achieved with using powder coating in aerosol interiors. These prior art systems use corona technology wherein the container is then rotated around the spray nozzle. Since the rotating container must be earthed to form a corona with the electrode, these systems require complicated earthing contacts. Due to the short distance between the electrode and the metal container, the sparks can occur. Electrostatically charged powder coatings particles have the tendency to coagulate. This effect is often referred to as the pofing effect. In prior art systems, it has been proposed to reduce this effect by continuously re-circulating the powder coating particles between the feed hopper and the spray gun. When the spray gun is activated, a flow of powder coatings particles is drawn off from the re-circulation flow to coat the substrate. This system is complicated and expensive since it requires a continuous flow of pressurized air.

[0009] The object of the invention is to provide a powder coating apparatus and a coating method which is particularly suitable for coating the interior of a can or container, such as an aluminium aerosol container, in an automated production cycle.

[0010] The object of the invention is achieved with a powder coating spray apparatus or spray gun comprising:

- an inlet connectable to a powder feed line;
- an electric charger;
- one or more powder channels leading from the inlet to a nozzle;
- an electrode leading from the charging element to the nozzle

wherein the electrode is arranged centrally in the nozzle and the powder channels surround the electrode.

[0011] It has been found that having the electrode centrally arranged in the nozzle results in a spraying cone with the powder coating being evenly distributed over the full 360°. The corona between the tip of the electrode and

the substrate shows rotational symmetry. The spray gun can be moved in and out of the target container while the electrode is moved along a line coinciding with the longitudinal axis of the container. During at least a part of the inward movement and/or of the outward movement powder coating material is sprayed on the container interior. This way, the interior of the cans can be coated with a even layer thickness without the need to rotate the container and the spray gun relative to each other. Moreover, in this configuration the distance between the electrode and the metal substrate is maximized resulting in a minimized risk of spark discharge. It was also found that the central arrangement of the electrode in the nozzle allows a spray gun construction with a deposition efficiency of more than 78 %.

[0012] The powder channel surrounding the electrode can for example be an annular channel around the electrode, or it can for example comprise at least three, four or more powder channels equidistantially arranged in a circular array around the electrode. To obtain turbulence in the powder coating material stream, the powder channels can be spiraled along the electrode. It has been found that more turbulence in the powder channels reduces coagulation of the powder coating material particles and the pofing effect. The channels can for instance be made of flexible hoses or the like.

[0013] Further it has been found that pofing of powder coating material can effectively be reduced by using a diffuser element located at a distance downstream the nozzle. In this respect, use of the word "downstream" refers the flow direction of the powder coating material during spraying. The diffuser can for instance have a perforated wall provided with a pattern of equally distributed apertures, the wall being disposed under right angles with the flow direction of the sprayed powder coating material. Particularly good effects are obtained if the perforated wall of the diffuser element is concave.

[0014] The object of the present invention is also achieved with a method of coating the interior of a container having a longitudinal axis characterized in that a powder coating material is sprayed evenly distributed as a spraying cone via a spray nozzle which is moved along the longitudinal axis of the container. While the nozzle is moved along the longitudinal axis of the container, a coating of even thickness is obtained. The container and the spray nozzle do not need to be rotated relative to each other.

[0015] The spraying cone of powder coating material can be formed around a central electrode with a tip end arranged centrally in the nozzle. This way, the electrode does not disturb the formation of a spray cone. Moreover, since the nozzle, and thus the electrode, is moved along the longitudinal axis of the container, the distance between the substrate and the electrode is substantially equal and a corona is obtained showing rotational symmetry.

[0016] Optionally, a short pulse of pressurized air is blown through the powder channels before the powder coating is sprayed. This purges and cleans the powder channels from coating material left from an earlier cycle. Moreover, it creates a corona of pre-ionized air already before the powder is sprayed, unexpectedly resulting in a high surface quality of the applied coating.

[0017] The method according to the invention is particularly suitable for aluminium containers, such as an aerosol container having a cylindrical or mainly cylindrical shape, e.g. a shouldered and/or waisted cylinder.

[0018] The present invention will be elucidated with reference to the figures wherein:

Figure 1: shows a powder coating spraying apparatus according to the present invention;
Figure 2 shows a cross section of the spray gun of the apparatus shown in Figure 1;
Figure 3: shows in exploded view the nozzle end of the spray gun of Figure 1;
Figure 4: shows a longitudinal cross section of the tip the spray gun shown in Figure 1.

[0019] Figure 1 shows a powder coating spraying apparatus 1 comprising a spray gun 2 connected to a feed hopper 3 via a powder supply line 4. In front of the spray gun 2 a trigger sensor 5 serves to detect the presence of an aluminium aerosol container 6 when the container is in line with the longitudinal axis of the spray gun 2. An earthing member 7 is brought into contact with the aluminium container. The spray gun 2, the container 6, the trigger sensor 5 and the earthing member 7 are shown in cross section in Figure 2. In Figure 2, dotted lines A indicate the outline of a spray cone of sprayed powder coating material.

[0020] The spray gun 2 comprises a body 21 encasing a charger element (see Figure 2) connected to a power supply 8. An insert pipe 23 is inserted in a bore 24 running through the body 21. The insert pipe 23 is connected to the powder feed line 4. The insert pipe 23 ends in a splitter 25 splitting the powder supply channel into four powder supply channels 26, as can be seen in more detail in Figure 3. The charger element 22 comprises an extension 27 inclined towards the splitter 25 where it contacts an electrode 28. A lance 29 is connected to the body 21 in line with the bore 23. The electrode 28 is disposed coaxially in the lance 29 along the lances longitudinal axis. The four powder supply channels 26 are flexible hoses spiraled along the electrode 28. The outer ends of the electrode 29 and the four powder channels 26 are hold in a nozzle element 30, shown in detail in Figures 4 and 5. The nozzle element 30 comprises a cylindrical skirt 31 closely fitting into the lance 29, and a plug part 32 comprising a central opening 33 and four spray openings 34 arranged around the central opening 33 at even distance from each other. The spray openings 34 are shouldered to receive the ends of the powder channel lines 26 in a clamping manner.

[0021] Further to the outer end of the lance 29, is a diffuser element 35 comprising a first cylindrical section

36, closely fitting into lance 29, and a second cylindrical section 37 with a smaller diameter closely fitting into skirt 31 of the nozzle element 30. The first cylindrical section 36 is capped with a concave end wall 38 with a central opening 39 and diffuser openings 40. The electrode 28 passes through the central opening 33 in the nozzle element 30 and the central opening 39 in the diffuser element 35 and projects out of the open end of the lance 29. The diffuser openings 40 have a smaller diameter than the outlet openings of the powder channels. However, the total summed-up through-flow of all diffuser openings 40 should not be less than the total through-flow via the outlet openings of the powder supply channels 26.

[0022] In the feed hopper 3 air is blown through the stored powder coating material to create a fluidized bed. A pneumatic control 50 is used to activate a first valve 51 to pass a pulse of pressurized air via the powder feed hopper 3 and feed line 4 to the spray gun 2, exactly dosing the required amount of powder coating material needed to coat the interior of the aerosol container 6. Powder coating material is transported only during spraying and no continuous re-circulation is required..

[0023] Just before initiating the pulse of powder coating material, a pulse of clean air is blown for about 10 - 20 milliseconds via an additional air feed line 52 through the spray gun 2 by activating a second valve 53 by means of pneumatic control 50. This way, the feed lines and powder channels 26 are purged and cleaned and a corona is already generated between the electrode 28 and the substrate 6 before the flow of powder coating material passes the nozzle.

Claims

1. Powder coating spray apparatus (1) comprising:

- an inlet connected to a powder feed line (4);
- an electric charger (22);
- one or more powder channels (26) leading from the inlet to a nozzle;
- an electrode (28) leading from the electric charger (22) to the nozzle **characterized in that** the electrode (28) is arranged centrally in the nozzle and the powder channels (26) surround the electrode (28).

2. Powder coating spray apparatus according to claim 1 **characterized in that** the apparatus comprises at least three powder channels (26) equidistantly arranged in a circular array around the electrode (28).

3. Powder coating spray apparatus according to claim 1 or 2 **characterized in that** the nozzle comprises a diffuser element (35) located at a distance from the ends of the powder channels (26) and **in that** the diffuser (35) has a perforated wall (38) provided with a pattern of equally distributed apertures, the wall being disposed under right angles with the powder channels (26).

4. Powder coating spray apparatus according to claim 3 **characterized in that** the perforated wall (38) of the diffuser element is concave.

5. Powder coating spray apparatus according to any one of the preceding claims **characterized in that** the powder channels (26) are spiraled along the electrode (28).

6. Method of coating the interior of a container having a longitudinal axis **characterized in that** powder coating material is sprayed evenly distributed as a spraying cone via a spray nozzle moving along the longitudinal axis of the container (6).

7. Method according to claim 6 **characterized in that** the container (6) and the spray nozzle are not rotated relative to each other.

8. Method according to claim 6 or 7 **characterized in that** a pulse of pressurized air is blown through the powder channels before the powder coating material is sprayed.

9. Method according to any one of claims 6 - 8 **characterized in that** the container is a cylindrical aluminium container, such as an aerosol container.

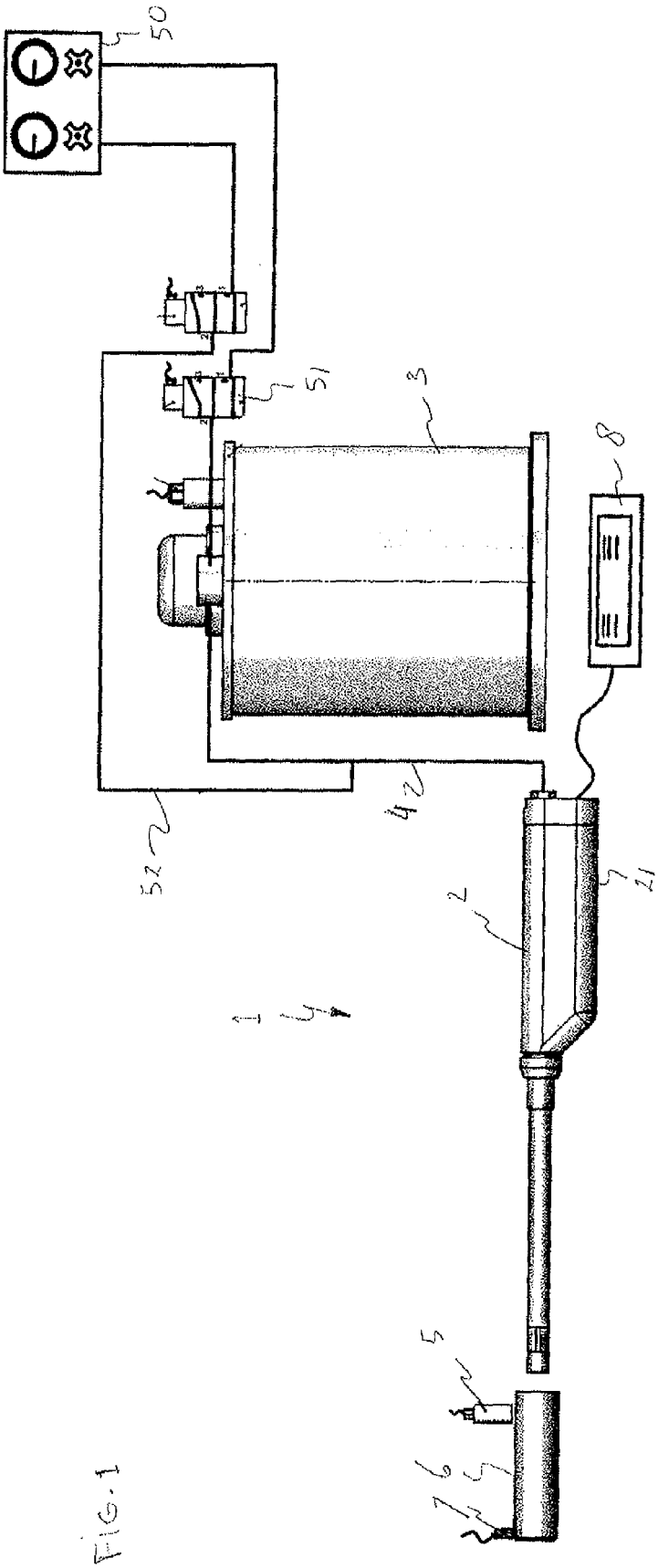

FIG. 1

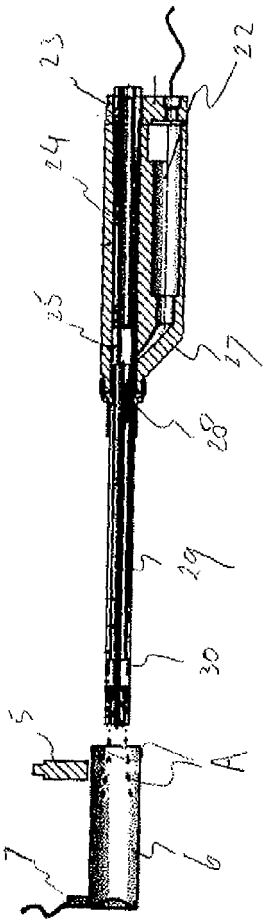

FIG. 2

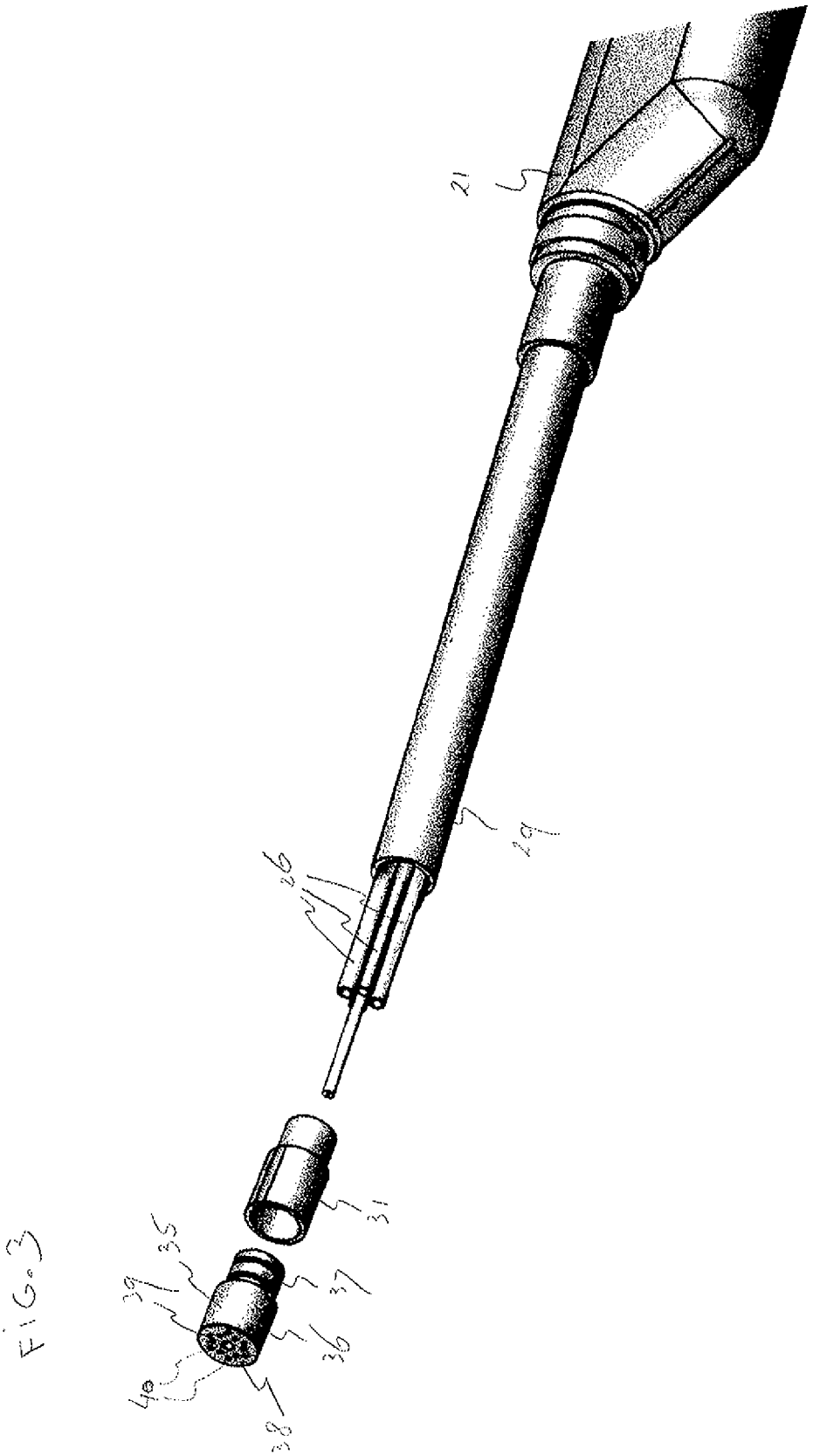

FIG. 3

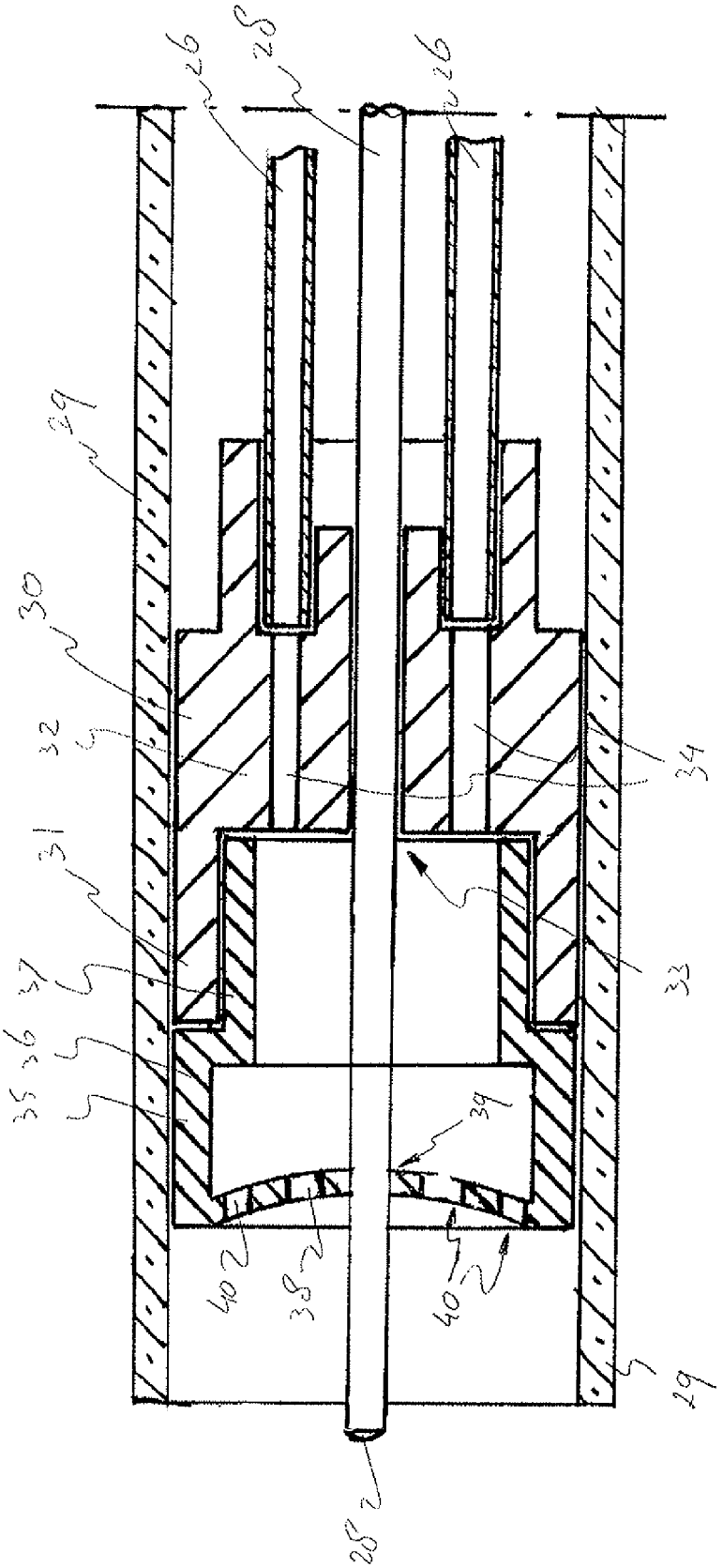

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 07 11 8895

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	12 March 2008	Brito, Fernando

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

Application Number
EP 07 11 8895

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-5

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

European Patent Office

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 07 11 8895

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-5

A powder coating spray apparatus with one or more powder channels surrounding a centrally located electrode, thereby reducing the problem of coagulation of the powder.

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2. claims: 6-9

A method of coating the interior of a container comprising spraying material as a spraying cone via a nozzle moving along a longitudinal axis of said container, thereby simplifying the coating process without the need of rotating the container and/or the nozzle.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 07 11 8895

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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