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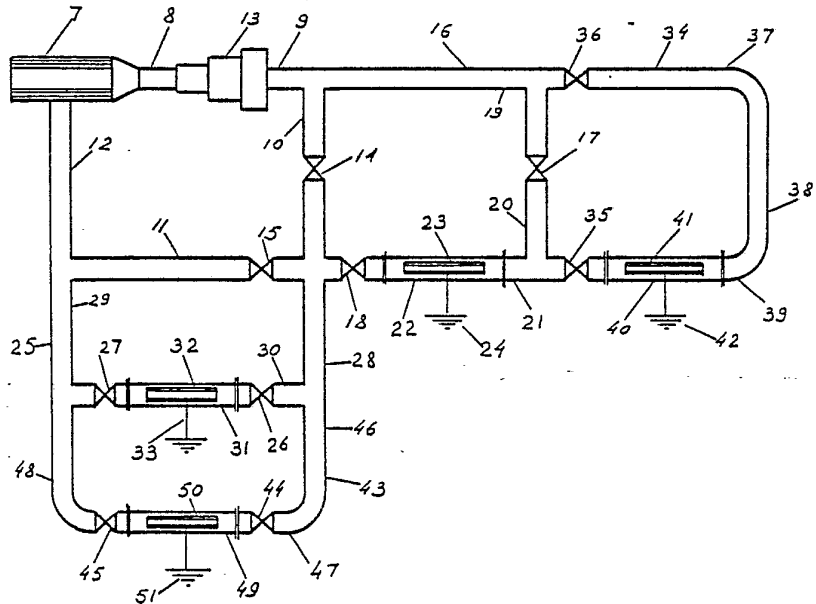
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/US79/00247 (22) International Filing Date: 19 April 1979 (19.04.79) (60) Parent Application or Grant (63) Related by Continuation US 741,893 (CIP) (71) Applicant; and (72) Inventor: ETLIN, Vladimir, N. [Stateless/US]; 7403 Lisle Avenue, Falls Church, VA 22043 (US). (81) Designated States: BR, CH (European patent), DE (European patent), FR (European patent), GB (European patent), JP, LU (European patent), SE (European patent), US.</p>		<p>Published With international search report</p>

(54) Title: MEANS AND METHOD FOR ELECTROSTATICALLY APPLYING POWDER COATING TO AN ARTICLE

(57) Abstract

The purpose of the invention is to provide a method and the required apparatus to coat articles of any shape and size with a layer of protective coating in an effective, energy-efficient, safe and economical way, omitting the use of electrostatic generators and avoiding contamination of the environment and loss in materials. The coating agent contemplated is powdered plastic which is introduced into a structure (See Figure 3) which is in the form of a main closed circuit loop (8) in which a blower (7) circulates air carrying coating agent until it has acquired substantial electrostatic charge, which can be increased by the addition in that loop of a section (13) of increasing diameter in the direction of the flow of powder. When the requisite electrostatic charge has been achieved, valves (17), (18), (26) and (27) are opened putting the main loop (8) into communication with branch circuits (16) and (25), which contain articles to be coated (23) and (32). The powder and air flow into those branch circuits



and the powder coats the articles (23) and (32) by adhering to them by electrostatic attraction. Any powder that is not used is then returned in the flow of circulating air for reuse. After removing articles (23) and (32) from communication with the loop (8) and heating these articles to melt said powder the process is completed.

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MEANS AND METHOD FOR ELECTROSTATICALLY APPLYING
POWDER COATING TO AN ARTICLE

Description

Technical Field

My invention relates to the coating of pipes and other articles with a layer of plastic to provide protection from rusting, salt deposition, paraffin deposition, corrosion by chemical agents, etc. and to create a smooth surface which in the case of pipes can minimize resistance from friction of substances being transported through them, and in the case of other articles can serve a variety of purposes, including aesthetic. In the field at this time, most of such coating is done either by applying liquid coating by spraying or dipping objects and then drying them, or by dry powder coating applied by the fluidized bed or electrostatic methods using high voltage electrostatic generators and spraying nozzles.

Background Art

Typically, pipes and articles which are to be so coated must receive even coating on all surfaces. If they are coated by the use of liquid plastic which is then dried, they are usually either dipped or sprayed with several layers which takes a lot of time, and neither of which methods yields uniform complete coating. If they are coated by a powder by the fluidized bed or electrostatic methods, the technical problem is how best to get an even layer of powder on all surfaces. To make this economically feasible, a process should consume as little energy as possible, coat as many articles as possible with one run, and waste as little of the coating agent as possible.



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The prior art includes several patents which achieved certain but not all of the desired results, and which were not as energy-efficient or versatile as my invention. Figure 1 among my drawings represents a generally known and commonly used embodiment of the prior art, although the various patents I cite as examples may not each incorporate all of its features. German Patent No. 1910487 uses dry powder to coat objects which are suspended in a working chamber and sprayed with powder by an electrostatic gun, the powder being transported from location to location by four blowers, with unused powder recovered by two precipitators. U.S. Patent No. 3918401 applies powder coating to pipes by charging the particles of powder by means of an electrostatic generator and then, by means of blowers, directing the charged particles at the object to be coated. This process is repeated from beginning to end for each object to be coated. If more than one object is to be coated, working parts must be duplicated for simultaneous operation to the extent that it would be just as practical to operate several apparatus, each coating one object at a time, side by side. U.S. Patent No. 3976031 also applies powder coating to objects by the electrostatic method. The powder is propelled into the vicinity of the object to be coated by a fan, and is at that point charged by a generator, so that it coats the part of the object exposed to the powder. U.S. Patent No. 3982050 teaches coating objects with powder, which must be used at high levels of concentration upon pre-heated objects. The possibilities of this patent are only for coating the inner surfaces of pipes of small diameter. U.S. Patent No. 3946125 is also a method of coating the inner surfaces of metal pipes, and is used for one pipe at a time per unit; this patent teaches heating the pipe, then introducing the powder so that it fuses to the surface it touches.

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Disclosure of Invention

In accordance with the present invention, I provide an apparatus comprising a main closed circuit which may have 5 branches in series or in parallel in which the articles to be coated are placed. Plastic powder is introduced into the main circuit and is circulated and accelerated to a high speed by a fan, whereby it acquires a high electrostatic charge. When the working chambers (the branches containing the articles 10 to be coated) are placed in communication with the main circuit by opening valves, the charged particles thereupon flow through the branch circuits and cling to the articles to be coated. When the desired thickness of coating has been achieved, the branches are cut off from the main circuit by 15 closing valves and the coated articles can then be heated to cure the coating. No static generator is used. My apparatus possesses the advantage over the prior art devices in that it eliminates the necessity for using costly electrostatic generators. And because the process can take place in an 20 enclosed structure, there need be no loss of the coating agent and no contamination of the surrounding atmosphere, which is a distinct improvement over certain prior art devices in which coating had to take place in a booth. Another advantage of my invention is that all surfaces of articles of 25 any size and shape may be evenly coated with a desired thickness of coating without rotating or moving those articles or repeating the process over and over.

Brief Description of the Drawings

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The details of my invention will be described in connection with the accompanying drawings.

Figure 1 is a schematic elevational view showing an example of the prior art apparatus for applying electrostatic- 35 ally charged particles of coating to an article. It does not



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represent any one of the cited prior art patents but rather a general design employing the art they teach.

Figure 2 is a schematic elevational view showing a first embodiment of the invention in which coating takes place in a booth or open space.

Figure 3 is a schematic plan showing a second embodiment of the invention in which coating takes place in closed branches.

Figure 4 is a schematic plan showing a third embodiment of the invention which provides a universal fixture to allow pipes of different diameters to be placed into circuit branches for coating of their inner surfaces.

Figure 5 is a schematic plan showing another type of universal fixture allowing pipes of different diameters and lengths to be placed into branch circuits for coating of their inner surfaces.

Best Mode for Carrying Out Invention

In accordance with Figure 2, air blower or fan 1 is stationed in a circuit which is the acceleration conduit 2. An optional wide section 3 is positioned in the path of particles being blown from the fan, and by its shape, to wit, tapered outwardly in the direction of the flow of particles, it increases the turbulence of particles in the flow of air and therefore builds higher electrostatic charge. A branch conduit 4 communicates with a combination valve and spray nozzle 5. During operation, a quantity of powder is introduced into the conduit 2 and with the valve 5 in closed position, the blower is operated to continuously cycle the powder at high velocity, whereby upon contacting the inner surface of the conduit 2 and among themselves the particles acquire a high electrostatic charge in the absence of any mechanical charging means. When sufficient charge has been accumulated, the valve 5 is opened and the powder is allowed to travel to the vicinity of the article 6. This



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structure eliminates the necessity of the presence of a powder tank with mechanical agitator and a costly electrostatic generator 78 (See Figure 1). As in the prior art device shown in Figure 1, my apparatus in Figure 2 is used
5 in conjunction with a spray booth or similar enclosure to reduce pollution and coating agent losses. Therefore my invention as demonstrated by this Figure 2 configuration teaches the basic invention of the main closed circuit providing a stream of electrostatically charged particles,
10 which have been charged merely circulating them by means of a blower, said stream of charged particles thereupon efficiently and thoroughly coating an article with an even layer of film.

To completely eliminate coating agent losses and
15 pollution of the surrounding area, a coated article is placed in a branch circuit conduit. Figure 3 is a schematic plan showing a plurality of such branch circuit conduits. This embodiment includes a blower element 7, a main conduit element 8 including members 9, 10, 11 and
20 12; an optional wide section 13 tapering outwardly in the direction of flow of the particles to increase turbulence and cause the electrostatic charge to build up more readily. The main conduit 8 also includes valves 14 and 15 for flexibility in putting branch circuits into communication
25 with the main circuit and regulation of gas flow in the branch circuits. The conduit 8 selectively communicates with a first branch circuit 16 including valves 17 and 18 and members 19, 20 and 21. Member 21 includes a selectively openable chamber 22 retaining an article to be
30 coated 23, said article having an optional suitable grounding connection 24. A second branch 25 selectively communicates with the main conduit 8 and branch circuits, and includes two valves 26 and 27 and members 28, 29 and 30. Member 30 has an openable chamber 31 enclosing a second article to be
35 coated 32, said article having an optional ground connection 33. A third branch 34 selectively communicates with the main



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conduit 8 and branch circuits, includes two valves 35 and 36 and members 37, 38 and 39. Member 39 has an openable chamber 40 enclosing an article or articles 41 for coating, the article(s) having an optional grounding connection 42. A
5 fourth branch circuit 43 selectively communicates with the main conduit 8, and branch circuits, and includes two valves 44 and 45 and members 46, 47 and 48. Member 47 has an openable chamber 49 enclosing an article or articles 50 for coating, the article(s) having an optional grounding connection 51. In the operation of this embodiment, the branch
10 circuits 16, 25, 34 and 43 are used selectively either in series or in parallel, or in combination, depending on different conditions and the coating quality requirements.

15 Operation in Series

After sufficient charge in the plastic powder has built up in the main conduit 8 while valves 14 and 15 are open and the other valves are closed, due to the powder's circulation by the blower 7, the valves 36, 35 and 18 are opened and remain
20 open until the articles 41 and 23 have acquired coating of the desired thickness. By throttling valves 36 and 14, the required powder concentration is obtained. The valves 36 and 18 are then closed and the articles 41 and 23 are heated to effect curing of the powder deposited, using suitable means
25 (not shown) such as inductive heater or the like.

Operation in Parallel

While the branch circuits 16 and 34 are cut off from the main conduit 8, valves 26, 27, 44 and 45 are opened, and
30 without discontinuing operation of the blower 7, the articles 32 and 50 may be coated and the deposited powder cured in a similar manner after the valves 26, 27, 44 and 45 are closed.



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Operation in Combination

While plastic powder is circulating inside the main circuit 8, all valves are opened and all articles are coated simultaneously, some in the parallel working chambers and others in those in series. By throttling certain valves, each article can be coated at the optimum flow rate and powder concentration.

Referring to Figure 4, a universal fixture constructed in accordance with my invention allows pipes of different diameters to be placed into branch circuits for coating their inner surfaces. This embodiment includes a blower element 54, a main circuit element 55 including members 56, 57, 58 and 59. The circuit 55 also includes a valve 60. The branch circuit 61 communicates with the main circuit 55 and includes valves 62 and 63 and members 64, 65, 66 and 67, which are rigid. The universal fixture which comprises two funnel-like members 52 and 53 which are slidably adjustable on the segments of members 66 and 67, two springs 68 and 69 and two flanges which are permanently attached to the members 66 and 67. As seen in Figure 4, a wide variety of diameters of pipes can be accommodated by sliding the funnel-like members 52 and 53 away from each other for purposes of loading, and sliding them together to engage members 52 and 53 with the article 72 prior to commencement of the coating operation. The springs 68 and 69 insure air-tight connection between the members 52 and 53 and the article 72.

Referring to Figure 5, another type of universal fixture is shown which allows pipes of different diameters and different lengths to be placed into branch circuits for coating of their inner surfaces. The universal fixture includes two funnel-like members 73 and 74 and two or more

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hinged bolts 75 and 76 with nuts which are attached to a member 74. Because the universal fixture is attached to members of a branch circuit which are flexible, a wide variety of pipes, in length and diameter, can be accommodated by moving members 73 and 74 away from each other for purposes of loading, and bringing them together to engage them with the article 77 to be coated, prior to commencement of the coating operation. The hinged bolts and nuts 75 and 76 provide air tight connection between the members 73 and 74 and the article 77.



CLAIMS

1. Apparatus for electrostatically applying synthetic powder to an object which is to be coated with a film over its entire surface, comprising: a main
5 hollow pipe-like closed circuit conduit; a blower positioned in said conduit whereby to create and maintain high speed circulation of the powder coating agent through said conduit to develop high electrostatic charge in the
10 circulating powder; means for introducing the powdered coating agent into said conduit in the vicinity of the blower; a branch conduit which can be put into or removed from communication with said main closed conduit by means of a valve, said branch conduit communicating with
15 the object to be coated.

2. Apparatus in accordance with Claim 1, wherein said branch conduit forms a separate closed circuit loop which includes an openable chamber containing
20 at least one article to be coated, said branch conduit communicating with said main closed conduit by at least two valve means.

3. Apparatus in accordance with Claim 2 wherein a
25 plurality of said article-containing branch conduits are provided, each such branch conduit being in selective communication with said main closed conduit whereby in use at least one article-containing branch conduit may be
30 utilized in a coating operation while an additional step in the overall operation of the system is performed in the at least one other article-containing branch conduit.

4. Apparatus in accordance with Claim 1 further characterized by said branch conduit composed of valve
35 means, flexible members and universal fixture; and forming a separate closed circuit when said universal fixture



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communicates with a pipe to be coated; said universal
fixture being composed of two funnel-like members which
are attached to said flexible branch conduit members
and two or more hinged bolts with nuts in combination
5 with said funnel-like members, and said funnel-like
members having their wider ends toward each other and
their inner surfaces laminated with rubber-like material;
said universal fixture serving to engage said branch
conduit and said pipe of variable sizes for purposes of
10 coating the inside surface of said pipe; said pipe's
maximum ultimate diameter defined by the widest diameter
of the said funnel-like members and said pipe's minimum
ultimate diameter defined by the diameter of the hollow
flexible members of the said branch conduit.

15

5. Apparatus in accordance with Claim 1 further
characterized by said branch conduit composed of valve
means, rigid members and universal fixture, and forming
a separate closed circuit when said universal fixture
20 communicates with a pipe of variable length and diameter;
said universal fixture being composed of two funnel-like
members positioned with their wider ends toward each other
and being slidably adjustable on the segments of said
branch conduit and their inner surfaces laminated with a
25 rubber-like material, and two flanges which are permanent-
ly attached to the segments of said branch conduit, and
two springs located between said flanges and said funnel-
like members; said universal fixture serving to engage
said branch conduit and said pipe of variable size for
30 purposes of coating the inside surface of said pipe; said
pipe's widest ultimate diameter defined by the widest
diameter of the said funnel-like members and said pipe's
smallest ultimate diameter defined by the diameter of the
hollow rigid members of the said branch conduit.

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6. Apparatus in accordance with Claim 1 further characterized by a slanting conical or telescoping segmented section, increasing in diameter in the direction of flow of the particles, located in the main closed
5 circuit loop for the purpose of increasing turbulence in the powder particles and thereby increasing the intensity of electrostatic charge imparted to said powder particles.

7. Apparatus as in Claim 1 further characterized
10 by means to electrically ground said article to be coated.

8. Apparatus as in Claim 2 further characterized by means, in combination with the branch conduit, to electrically ground said article to be coated.
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9. Apparatus as in Claim 3 further characterized by means, in combination with the branch conduits, to electrically ground said articles to be coated.

10. Apparatus as in Claim 4 further characterized
20 by means to electrically ground said pipe to be coated.

11. Apparatus as in Claim 5 further characterized by means to electrically ground said pipe to be
25 coated.

12. Apparatus as in Claim 2 further characterized by heater means, in combination with said branch conduit, to heat said article in order to cure said coating after
30 application.

13. Apparatus as in Claim 3 further characterized by heater means, in combination with said branch conduits, to heat said articles in order to cure said coatings
35 after application.



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14. Apparatus as in Claim 4 further characterized by heater means to heat said pipe in order to cure said coating after application.

5 15. Apparatus as in Claim 5 further characterized by heater means to heat said pipe in order to cure said coating after application.

10 16. Apparatus as in Claim 2 wherein said openable chamber is maintained in a generally horizontal orientation during the coating process.

15 17. Apparatus as in Claim 3 wherein said openable chambers are maintained in a generally horizontal orientation during the coating process.

20 18. Apparatus as in Claim 4 wherein said pipe is maintained in a generally horizontal orientation while being coated.

 19. Apparatus as in Claim 5 wherein said pipe is maintained in a generally horizontal orientation while being coated.

25 20. Method for coating an article with a film of powdered coating agent comprising:

 a. Introducing a supply of the desired synthetic powdered coating agent into a closed circuit conduit which is communicating with a branch conduit by means of a valve, said closed circuit conduit containing a blower;

 b. Positioning an article to be coated in front of said branch conduit;

30 c. Isolating said closed circuit conduit from said branch conduit by means of said valve;

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5 d. Imparting electrostatic charge to said synthetic powdered coating agent by circulating said powder within said closed circuit conduit by means of the blower for a period of time and at such velocity so as to impart to the said powdered coating agent the optimum electrostatic charge;

10 e. Placing said branch conduit in communication with said closed circuit conduit by means of opening said valve while said powdered coating agent continues to circulate inside said closed circuit conduit, and directing part of the flow of said electrostatically charged agent toward said object;

15 f. Removing said branch conduit from communication with said closed circuit conduit by means of said valve after said object has acquired a film of the powdered agent in the requisite thickness;

20 g. Applying sufficient heat to said object to melt said powder and thereby cure the film coating.

25 21. Method in accordance with Claim 20 wherein said object to be coated is positioned inside of an openable chamber which is part of a closed loop branch conduit; said branch conduit communicating with the main closed circuit conduit by means of at least two valves.

30 22. Method in accordance with Claim 21 employing a plurality of closed loop branch conduits selectively communicating either in series or in parallel or in combination by means of valves with said closed circuit conduit, placing at least one article to be
35 coated in each of said closed loop branch conduits and

whereby in use at least one said article-containing
branch conduit may be utilized in a coating operation
while an additional step in the overall operation of
the system is performed in the at least one other said
5 article-containing branch conduit; said branch conduits
each comprising its own openable working chamber.

23. Method in accordance with Claim 21 wherein
at least one pipe to be coated is utilized as a part of
10 said branch conduit which has been adapted to communi-
cate with said pipe to form a closed loop conduit during
the coating process.

24. Method in accordance with Claim 20 while
15 electrically grounding said article to be coated.

25. Method in accordance with Claim 21 while
electrically grounding said article to be coated.

20 26. Method in accordance with Claim 22 while
electrically grounding said articles to be coated.

27. Method in accordance with Claim 23 while
25 electrically grounding said pipe to be coated.

28. Method in accordance with Claim 21 wherein
said article is heated to cure said coating after
application, by heater means in combination with said
branch conduit.

30 29. Method in accordance with Claim 22 wherein
said articles are heated to cure said coatings after
application, by heater means in combination with said
branch conduits.

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30. Method in accordance with Claim 23 wherein said pipe is heated to cure said coating after application.

5 31. Method in accordance with Claim 21 wherein said openable working chamber is maintained in a generally horizontal orientation while the coating process takes place.

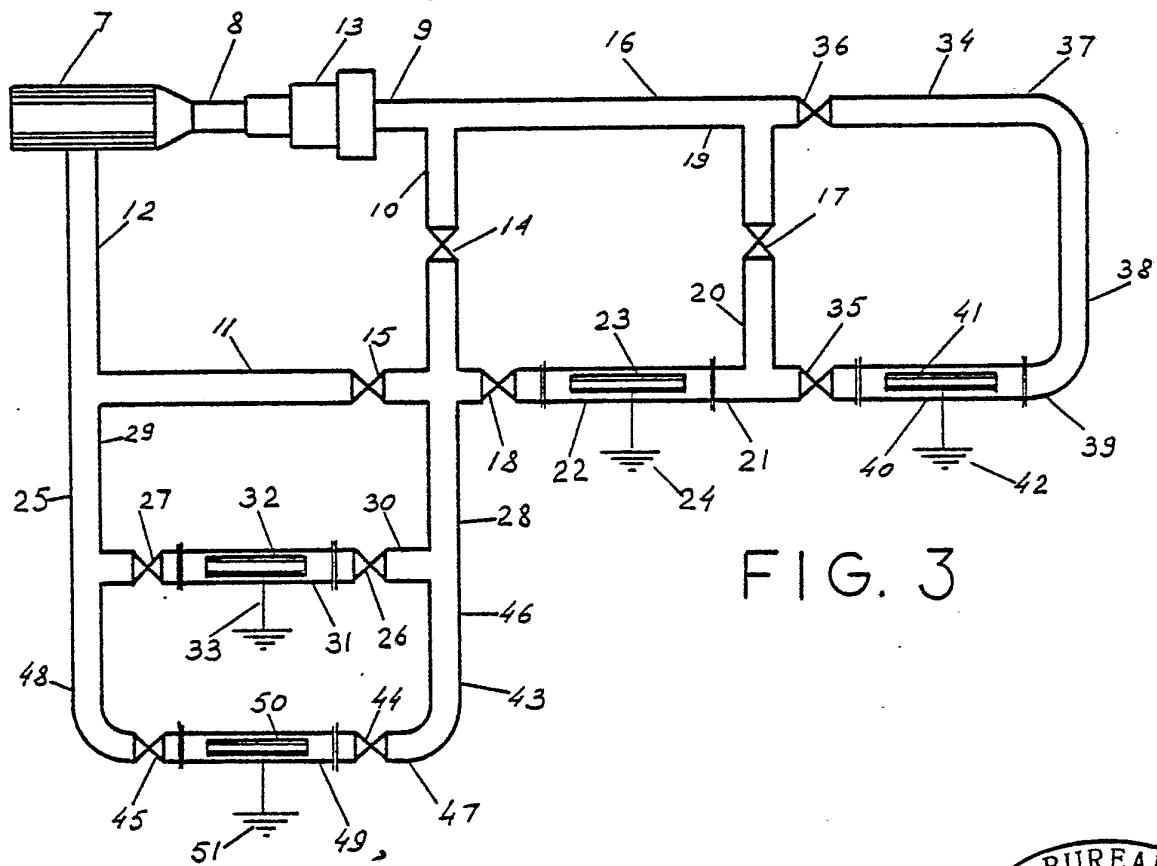
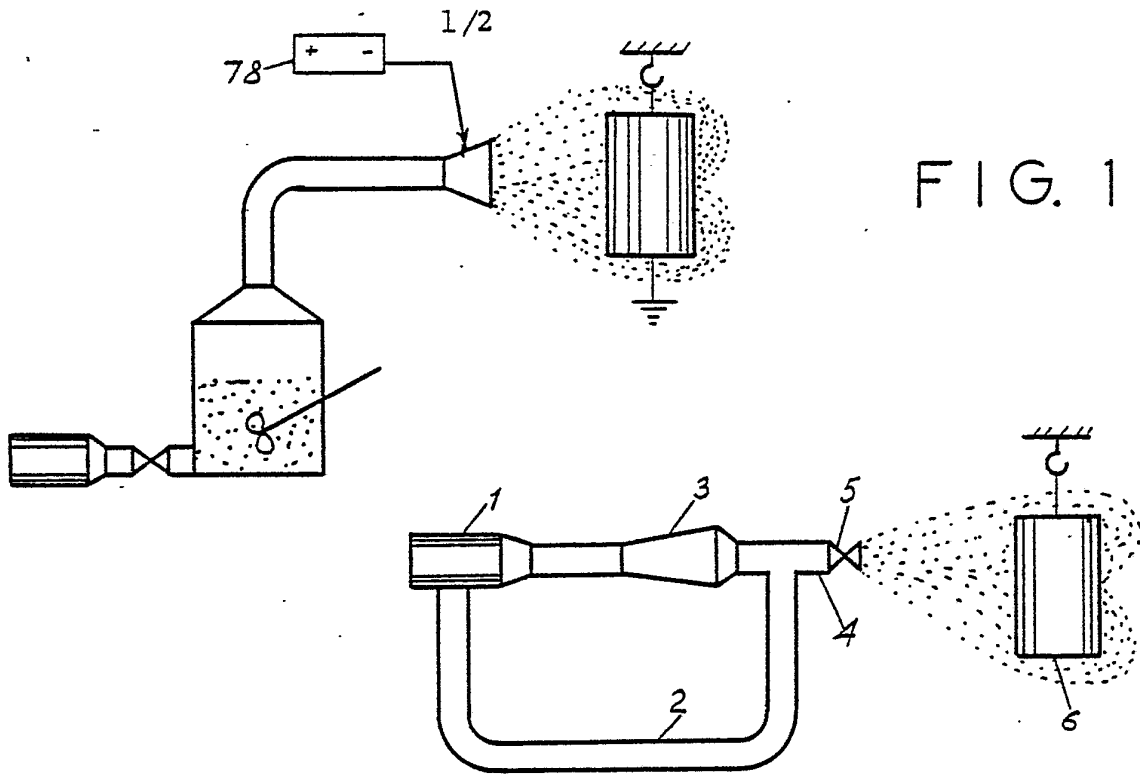
10 32. Method in accordance with Claim 22 wherein said openable working chambers are maintained in a generally horizontal orientation while the coating process takes place.

15 33. Method in accordance with Claim 23 wherein said pipe is maintained in a generally horizontal orientation while being coated.

20 34. Method in accordance with Claim 20 wherein increased electrostatic charge is readily imparted to the powdered coating agent by using a conical or telescopic element in the closed circuit conduit, said conical or telescopic element increasing in diameter in the direction of flow of the powdered agent.

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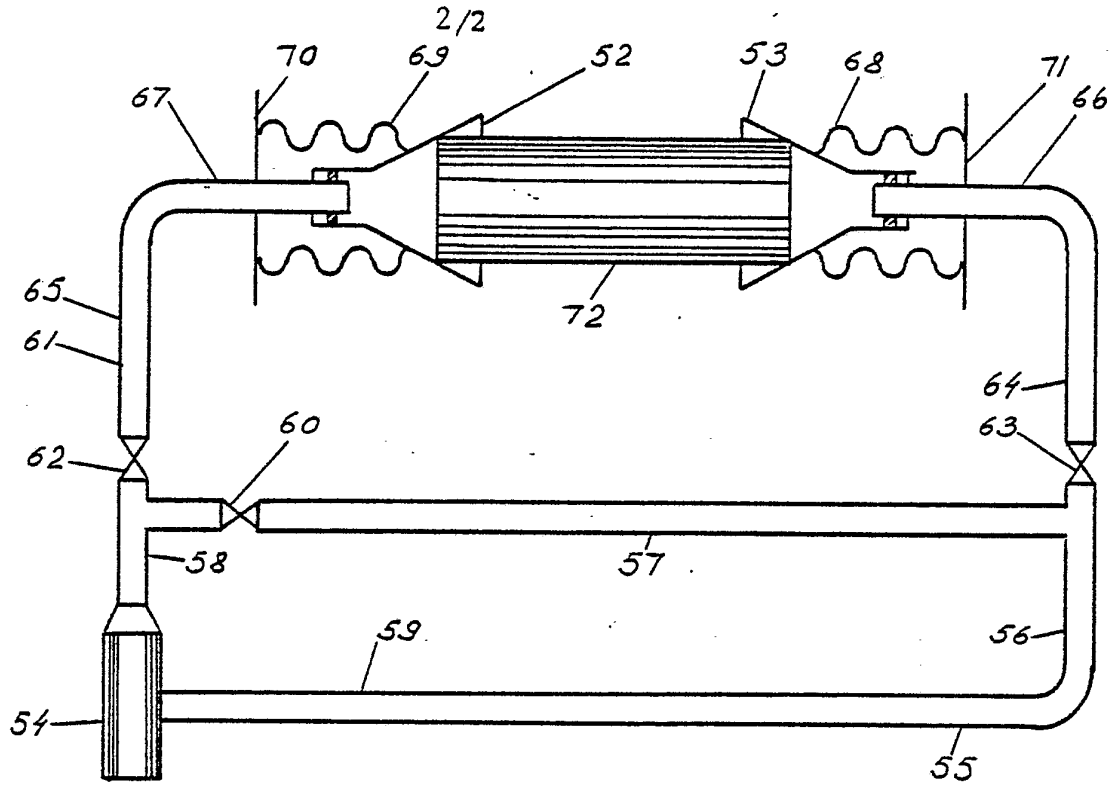


FIG. 4

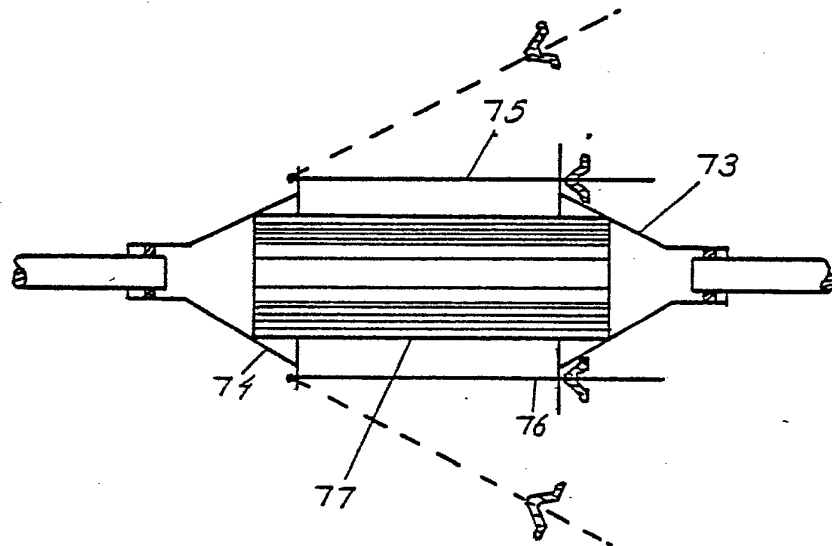
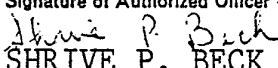


FIG. 5

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 79/00247

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³				
According to International Patent Classification (IPC) or to both National Classification and IPC				
INT. CL. B05B 5/02 B05D 1/06				
U.S. CL. 118/312, 629 427/28, 181, 236, 239				
II. FIELDS SEARCHED				
Minimum Documentation Searched ⁴				
Classification System	Classification Symbols			
U.S.	118/629-635, 310, 312, 317, 318, 602, 603, Dig. 5, 653, 654 427/21, 27, 28, 29, 181, 182, 185, 195, 236, 239			
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched ⁵				
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴				
Category *	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸		
X	US, A, 2,763,575 Published 18 SEPTEMBER 1956 BEDE	1-34		
X	US, A, 3,918,401 Published 11 NOVEMBER 1975 BLAKESLEE	1-34		
X	US, A, 3,976,031 Published 24 AUGUST 1976 ITOH	1-34		
A	US, A, 3,982,050 Published 21 SEPTEMBER 1976 KATO ET AL.	1-34		
A	US, A, 3,946,125 Published 23 MARCH 1976 SCHEIBER	1-34		
A	US, A, 2,602,418 Published 08 JULY 1952 PAASCHE	1-34		
A	US, A, 2,602,417 Published 08 JULY 1952 MEDCALF	1-34		
A	US, A, 1,534,627 Published 21 APRIL 1925 YEOMANS	1-34		
A	DE, A, 1,910,487 Published 17 SEPTEMBER 1970 EISENMANN K G MASCH BAUGES	1-34		
<p>* Special categories of cited documents: ¹⁵</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none; vertical-align: top;"> <p>"A" document defining the general state of the art</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document cited for special reason other than those referred to in the other categories</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> </td> <td style="width: 50%; border: none; vertical-align: top;"> <p>"P" document published prior to the international filing date but on or after the priority date claimed</p> <p>"T" later document published on or 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</p> <p>"X" document of particular relevance</p> </td> </tr> </table>			<p>"A" document defining the general state of the art</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document cited for special reason other than those referred to in the other categories</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p>	<p>"P" document published prior to the international filing date but on or after the priority date claimed</p> <p>"T" later document published on or 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</p> <p>"X" document of particular relevance</p>
<p>"A" document defining the general state of the art</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document cited for special reason other than those referred to in the other categories</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p>	<p>"P" document published prior to the international filing date but on or after the priority date claimed</p> <p>"T" later document published on or 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</p> <p>"X" document of particular relevance</p>			
IV. CERTIFICATION				
Date of the Actual Completion of the International Search ²	Date of Mailing of this International Search Report ²			
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International Searching Authority ¹	Signature of Authorized Officer ²⁰			
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