



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
17.12.2008 Bulletin 2008/51

(51) Int Cl.:
B05B 13/02 (2006.01) B05B 13/06 (2006.01)

(21) Application number: **07252414.3**

(22) Date of filing: **14.06.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

(71) Applicant: **Rexam Beverage Can Europe Limited**
Luton,
Bedfordshire LU1 3LG (GB)

(72) Inventors:
• **Moser, Klaas**
SE 26331 Höganäs (SE)

• **Taylor, Steven**
Milton Keynes MK5 7GL (GB)
• **Sweeney, Pat**
Rugby CV23 9DF (GB)

(74) Representative: **Probert, Gareth David**
Potter Clarkson LLP
Park View House
58 The Ropewalk
Nottingham
NG1 5DD (GB)

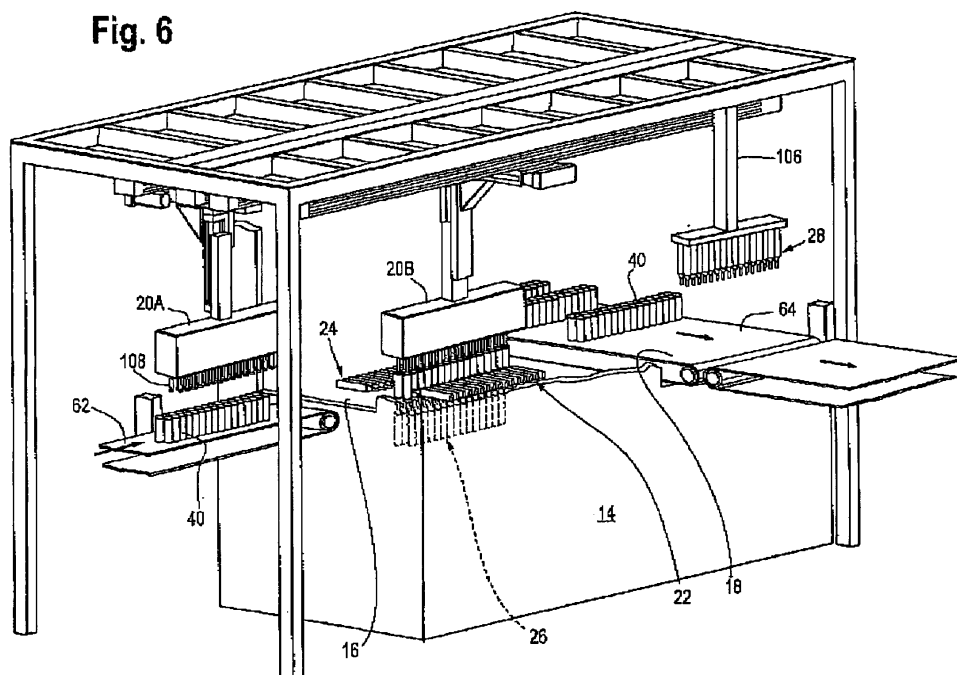
Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) **Powder coating method and system for can bodies**

(57) A system and method for powder coating of cans such as aluminium beverage cans. The system includes a powder booth (14), one or more robotic arms (20) carrying groups of cans (40), and powder guns (26,24) for applying powder to the interior and exterior of the cans. A conveyor (64) system receives the cans from the ro-

botic arm(s). The conveyor system carries the cans through a curing oven (60). A further set of powder guns (28) applies powder to the portion of the can which was attached to the robotic arm (20), e.g., the bottom of the can in an embodiment where the arm uses vacuum to hold the cans (40).

Fig. 6



Description

BACKGROUND

A. Field

[0001] The invention relates generally to methods of manufacturing cans, and more particularly relates to a method and system for coating a metal can with powder.

B. Related art

[0002] Cans, such as food cans and cans containing a beverage, are typically made from metals such as steel or aluminum alloy. During can manufacturing, can bodies are subject to a process in which a coating is applied to the interior of the can body. The interior coating is applied to the can body to protect the contents of the can from contamination or reaction with the can material, which can cause a change in the taste and/or color of the contents. An additional step of coating the exterior of the can body is also usually performed. The coating on the exterior of the container may be to protect the container from the environment (e.g., in the case of steel cans to inhibit formation of rust), and to supply a base for subsequent color printing.

[0003] Methods of coating metal objects using powders have been known for some time. Examples of prior art related to powder coating of cans and similar metal objects, and apparatus used in powder coating, include the following: Smith et al., US Patent 4,094,760; Wilson et al., US Patent 5,997,643; Mulder et al., US Patent RE 33,482; Knobbe et al., US Patent 5,173,325; Nussbaumer et al., US Patent 6,176,927; Mulder et al., US Patent 5,612,096; Peck, US Patent 4,180,844 and Payne, US Patent 4,291,640. The powders can be electrostatically charged in order to more reliably obtain adhesion of the powder to the can body. See for example Davidson et al., US Patent 4,210,507. Examples of powder compositions are disclosed in Pregmon, US Patent 3,882,064; Jung et al., US Patent 6,472,472, and Srinivasan, US Patent 5,994,462.

[0004] Despite the advent of powder coating technology, it is believed that the beverage can manufacturing industry has not adopted it widely. There are a variety of reasons for this, including difficulties in applying the technique at the speed required in high volume manufacturing plants, and the added costs for the powder coating equipment. Traditionally, at least in the beverage can art, the coatings applied to cans during manufacture are applied in the form of sprays which contain volatile organic chemicals. There is a need in the art for a more environmentally-friendly method and system for coating of can bodies using powder, which avoids the use of volatile organic chemicals or release of such chemicals into the environment, but which is also cost efficient when applied in a mass production scenario.

SUMMARY

[0005] This disclosure provides for methods and systems for environmentally friendly and cost efficient coating of cans during manufacturing with powder. The methods and systems are particularly suitable for application in high volume can manufacturing plants such as plants operated by manufactures of aluminum beverage cans. The methods are suitable for food and beverage cans in general, and in particular to aluminum beverage cans.

[0006] In a first aspect, a system is provided for powder coating of can bodies. The system includes a powder booth having an entrance and an exit. The powder booth includes at least one robotic arm and a plurality of powder application guns. The robotic arm is operable to move a plurality of can bodies as a group to a powder application zone where powder is applied to the interior and exterior of the can bodies by powder application guns. The system further includes a conveying system for receiving the can bodies as a group from the robotic arm. The system further includes an oven receiving the plurality of can bodies from the conveying system. The oven is operative to cure the powder that has been applied to the can bodies.

[0007] In one configuration, the can bodies include a closed end portion, such as for example in the case of beverage cans the dome portion forming the bottom of the can body. The robotic arm operates to contact to the group of can bodies by means of vacuum applied by the robotic arm to the closed end portion of each of the can bodies. Once connected to the arm in this manner, the arm moves the cans as a group to the powder application zone and then to the conveyor system. Release of vacuum releases the group of can bodies from the arm and allows them to be placed onto the conveyor system. The arm moves back to pick up another group of cans. Then, powder is applied to the cans at the location of where the cans were attached by vacuum to the robotic arm.

[0008] In one possible configuration, the system includes at least two robotic arms, each of which operates to successively move a plurality of can bodies as a group to the powder application zone and then to the conveyor system. For example, in a configuration with two robotic arms, one robotic arm holds one group of can bodies at the powder zone as powder is being applied to the can bodies, and then moves the can bodies to the conveyor system. Meanwhile, the other robotic arm becomes connected to a new group of can bodies and then operates to move the new group to the powder application zone. Having two robotic arms operating in this manner serves to increase the throughput of the powder coating system.

[0009] The robotic arm may further be constructed with a feature whereby the robotic arm operates to rotate each of the plurality of can bodies about each can's longitudinal axis while powder is being applied to the can bodies by the powder guns.

[0010] In another aspect, an improved powder booth of a powder coating system for cans is described. The

powder booth includes a robot arm operable to hold and transport a plurality of can bodies as a group within the powder booth, a first set of power guns operative to apply a powder to the exterior of the can bodies as the can bodies are held by the robotic arm, a second set of powder guns operative to apply a powder to the interior of the can bodies as the can bodies are held by the robotic arm, and a third set of powder guns operative to apply a powder to the location on the can bodies where the can bodies were held by the robotic arm. In one possible configuration of the powder booth, the booth includes a conveyor system receiving the plurality of can bodies from the robotic arm after application of powder from the first and second sets of powder guns. The third set of powder guns is operative to spray powder onto the can bodies after the can bodies have been deposited onto the conveyor system by the robotic arm. In one further variation, the robotic arm travels back and forth to deposit the cans onto the conveyor in a linear direction. The direction of movement of the conveying system is substantially perpendicular to the linear direction of travel of the robotic arm. This feature allows for narrow spacing for the groups of cans after they are placed onto the conveying system.

[0011] In another aspect, a method of powder coating of can bodies is disclosed. The method includes the steps of: a) moving a plurality of can bodies to a location exterior of a powder booth; b) moving the plurality of can bodies as a group into the powder booth and to a powder application zone within the powder booth; c) applying a powder to the can bodies; d) moving the group of can bodies to a conveyor system; and e) applying additional powder to the group of can bodies after placement of the can bodies on the conveyor system.

[0012] In one embodiment where the powder is such that oven curing of the powder is desirable, the method further includes the step of f) moving the group of can bodies from the powder booth to an oven for curing of the powder applied to the can bodies.

[0013] Step c) of the method may optionally include the additional step of rotating each of the cans of the group about an axis.

[0014] In one embodiment, in step a) the cans are placed in the location exterior to the powder booth in a predetermined configuration matching a configuration of the robotic arm. While various configurations are possible, in one embodiment the configuration is in the form of rows and columns of can bodies, and wherein there are two columns and N rows, and wherein N is greater than or equal to two. One specific example, N is greater than 10, such as for example 16. In this arrangement, the robotic arm operates to lift 32 cans simultaneously as a group and carry the cans to the powder coating zone and then to the conveyor system.

[0015] In another aspect, a method of continuous powder coating of can bodies is disclosed including the steps of a) providing a set of can bodies at a location exterior of a powder booth in a predetermined configuration; b) moving a robotic arm to the location, connecting the set

of can bodies to the robotic arm and moving the robotic arm and connected can bodies into the powder booth; c) while holding the set of can bodies with the robotic arm, applying a powder to the can bodies within the powder booth; d) releasing the group of can bodies from the robotic arm; e) applying additional powder to the group of can bodies at the location where the can bodies were connected to the robotic arm, and f) repeating steps a), b), c), d) and e).

[0016] These and still other exemplary aspects and features of the present disclosure will be more fully described in the following detailed description and the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Figure 1 is a plan view of a system for continuous powder coating of can bodies, including a powder booth, conveyor system, and curing oven.

Figure 1A is a diagram showing the functional layout of the system of Figure 1.

Figure 2 is a more detailed plan view of the powder booth of Figure 1.

Figure 3 is a more detailed plan view of the portion of the powder booth of Figure 2 where powder is applied to the exterior and interior portion of the can. Figure 4 is a more detailed plan view of the exit cleaning belt carrying coated cans from the powder booth and the belt carrying cans into the curing oven of Figure 1.

Figure 5 is a perspective view of the powder booth of Figures 1 and 2 showing the robotic arms which act as can transporters within the powder booth, and the external and internal spray guns of the powder booth.

Figure 6 is another perspective view of the powder booth of Figures 1, 2 and 5, with the arms in a different position during processing of groups of can bodies. The arms are arranged to hold a set or group of a plurality of can bodies, in a predetermined configuration of 2 columns of N rows, where $N = 16$ in this example. The robotic arms of Figures 5 and 6 has a configuration of vacuum apparatus so that the robotic arm can travel to the loading zone and connect to all 32 cans simultaneously and carry them as a group into the powder coating booth for application of powder and transfer to the conveying system.

Figure 7 is a perspective view of a can body to be coated with powder in the system of Figure 1-6.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Overview

[0018] Figure 1 is a plan view of a system 10 for continuous powder coating of can bodies 12. The system 10 includes a powder booth 14 having an entrance 16 and an exit 18. The powder booth is shown in more detail in plan view in Figure 2 and in a perspective view in Figures 5 and 6.

[0019] The can bodies 12 could be any food or beverage can. One example of a beverage can body is shown in perspective view in Figure 7. The can body includes an interior surface 30, a top rim or "cut edge" 31, an exterior surface 32, a closed end 34, which, in this example, has an inwardly domed shape as found on common beverage cans, and a longitudinal axis 36. In one possible beverage can embodiment, the interior, and exterior surfaces 30 and 32 are powder coated in the system of Figure 1 prior to necking and flanging the can body 12. The can forming, powder coating, necking and flanging occur within one continuous manufacturing process. Accordingly, the powder coating system of Figure 1 may be installed in a plant where the cans 12 are manufactured. In order to contain the powder and prevent it from spreading in the plant, the powder coating occurs in a powder booth 14 as shown in Figure 1.

[0020] The powder booth 14 includes at least one robotic arm 20 shown best in Figure 5 and a plurality of powder application guns 22. The guns 22 are arranged in several sets, including a first set 24 which applies powder to the exterior of the cans, a second set 26 which applies powder to the interior of the cans, and a third set 28 (Figure 5) which applies powder to the closed end of the can bodies 12, namely the portion of the can body that was held by the robotic arm 20 during the interior and exterior coating step.

[0021] The robotic arm 20 operates to move a plurality of can bodies 12 as a group 40 into the powder booth 14 and to a powder application zone 42 (Figure 1A) in the booth where powder is applied to the interior and exterior of the can bodies by the powder application guns 22. The system of Figure 1 can include more than one arm 20, and in the illustrated embodiment of Figures 5 and 6 includes two arms 20 each operable independent of the other to connect to a group of can bodies 12 exterior of the powder booth, carry them into and through the booth for coating and to a conveying system 50 and deposit the cans onto a conveyor of 64 the conveying system. The arms 20 are timed so that as one arm is holding one group or set of can bodies in the powder coating zone and carrying that group to the conveyor system 50 the other arm is moved to the loading zone external of the powder booth to connect to the next group 40 of can bodies and carry them into the powder booth.

[0022] In an embodiment in which the can bodies include a closed end portion, such as shown in Figure 6,

the robotic arm 20 connects to each of the can bodies by means of suction applied to the closed end portion of the can bodies. The robotic arm further includes features for rotating the cans about the longitudinal axis 36 while being held by suction, such that the interior and exterior powder coating is evenly applied to all the surfaces of the can body.

[0023] The conveying system 50 receives a plurality of can bodies 12 as a group from the robotic arm 20 after application of the powder to the can bodies by the powder application guns 24 and 26. A third set of powder guns 28 (Figure 5) is provided above the conveyor system 50 which operates to apply powder to the portion of the can bodies which were held by the robotic arm, namely the closed end or dome 34 of the can bodies in this example. The cans are placed "dome up" on the feed conveyor belt, held "dome up" by the arm 20, and placed "dome up" on the belt 64 of the conveying system 50. The arms are placed on the belt 64 in a zone 54 (Figure 1A) where the dome powder guns 28 are located. The conveying system 50 then conveys the cans to an oven 60. The oven is equipped with servo-driven fans and thermal heating zones and operates to cure the powder applied to the can bodies. After passing through the oven 60, the cans are carried to downstream processing locations, such as can necking station for necking the can body.

[0024] A functional diagram of the powder system 10 of Figure 1 is shown in Figure 1A. A feed conveyor 62 supplies groups of cans "dome up" in a predetermined configuration to a loading zone external of the powder booth 14 adjacent to the entrance 16. An arm 20 (not shown in Figure 1A) picks up the group of cans 40 and carries them to the exterior and interior powder coat zone 42 where the exterior and interior surfaces of the cans in the group 40 are coated with powder. The arm carries the group 40 of cans to the conveyor 64 and deposits the group of cans onto the conveyor 64, dome up, in the dome coat zone 54. A set of spray guns 28 (Figure 5) moves horizontally over the cans deposited on the belt 64 and sprays the domes of the cans. The cans are then carried through the exit 18 of the powder booth 14 where they are placed on a cleaning and powder recovery belt 66. The belt includes two powder recovery suction zones 70A and 70B, where excess powder is recovered from the belt. The conveyor 66 carries the cans to the oven 60, or as shown in Figure 1, to a separate oven conveyor 68. The cans are advanced through the oven 60 where the powder is cured. The cured, coated cans then exit out of the oven and are subject to downstream processing steps, such as necking, flanging, and color printing.

[0025] The system 10 is designed such that powder is applied to cans on both the inside and the outside (inclusive dome and chime) in one application station (powder booth) and only one curing station (oven). The speed for one application of powder to the cans can reach between 400 - 600 cans per minute in the illustrated embodiment. In preferred embodiments the coating weight for powder coatings is low (2g/ 50ml Can) and applied in a narrow

coating tolerance, with maximum thickness variation on coated cans between 10 and 15 microns, for example.

[0026] The illustrated embodiment and method of operation produces a coated aluminum beverage can, which compared to prior art approaches, eliminates 4 processes stations, and replace such stations with one station - powder booth 14. For steel cans, the inventive system and method of operation eliminates five process stations and replaces them with one station. Consequently, the methods and system of this invention presents an attractive option in terms of capital and operation costs as compared to prior an coating methods.

Powder booth 14

[0027] The powder booth 14 will be described further in conjunction with Figures 1-6.

A. Powder supply

[0028] The powder booth 14 includes guns 22 and 28 which supplied are supplied with a powder, preferably subject to electrostatic charge, from a powder source 90 via a supply conduit 92, shown in Figure 2. The powder may be any suitable powder for powder coating purposes, such as disclosed in Pregmon, US Patent 3,882,064; Jung et al., US Patent 6,472,472, and Srinivasan, US Patent 5,994,462. The nature, color, composition or characteristics of the powder are not considered particularly critical and these and other powder compositions either now known or later developed may be used. Examples of suitable powders are pure polyester powders, pure epoxy powders, and hybrids of polyester and epoxy.

[0029] In theory any color of direct food contact approved powders can be used, including white or dear powders. Generally, the same powder is used for internal and external application.

B. Powder application guns

[0030] The powder application guns 22, 28 are conventional in design and may take the form of powder guns described in the patent and technical literature. The guns preferably are designed so as to not disturb the electrostatic charge applied to the powder while the exterior and interior surfaces of the cans are sprayed with powder simultaneously at the exterior and interior coat zone 42 of the powder booth.

C. Robotic Arms

[0031] The robotic arms 20 of the powder booth are shown best in Figures 5 and 6. Each arm 20 is suspended from a track 102 extending the length of the powder booth. The tracks include a portion 104 which allow the arms to move laterally and out of the way to allow the other arm to pick up new group of cans 40 or deposit the group of cans 40 onto the belt 64. Basically, in operation,

each arm 40 is operable to hold and transport a plurality of can bodies as a group 40 within the powder booth 14. The operate in a fashion such that they alternate to transport groups of can bodies to the location of the first and second set of powder guns 24 and 26 for exterior and interior coating and depositing the groups of cans onto the belt 64. Furthermore, the tracks 102 are arranged such that the robot arm moves exterior of the entrance to the powder booth to pick up a plurality of cans as a group 40 (see Figure 6) and move them through the entrance 16 of the powder booth to the powder application zone (location of sets of guns 24 and 26) and from the powder application zone to the conveyor 64 of the conveyor system 50. As shown in Figure 6, while one arm 20A is picking up a new group 40 of cans, the other arm 20 is carrying a group of cans to the guns 24 and 26 for exterior and interior coating and then for placement on the conveyor 64- With further reference to Figure 6, after the group of cans 40 are placed on the belt 64, a third arm 106 carrying the dome spray guns 28 moves laterally over the cans 40 and spray coats the domes of the cans.

[0032] The arms 20 are constructed with a plurality of vacuum chucks (suction elements) 108 (see Figures 5 and 6). Referring to Figure 6, when the arms 20 are lowered onto the group of cans 40 on the feed conveyor 62, the vacuum chucks 108 make contact with the domes of the cans, and vacuum is applied to the elements 108 which allow the cans to be retained to the arm when the arm lifts the cans off the conveyor 62 and carry them into the powder booth. Additionally, the arms include an internal mechanical arrangement (not shown) which operates to rotate each of the can bodies about the longitudinal axis 36 (Figure 7) while powder is being applied to the can bodies by the powder guns 24 and 26, insuring an even coating of powder to the cans 12. A suitable rotation rate is 20 RPM but of course this can vary as desired.

[0033] The cans placed on the feed conveyor 62 are arranged in a predetermined configuration matching the configuration of the robotic arm. For example, the configuration can be rows and columns of cans. In the example of Figure 1A and 6, the configuration is two columns of cans and N rows, and wherein N is greater than or equal to two. N may be greater than 10, such as 16. Other configurations are possible such as a clusters of cans, each cluster in a circular arrangement or otherwise.

D. Conveying System

[0034] Referring to Figures 1-6 and in particular to Figure 2, the system 10 includes a conveying system 50 which serves to advance the cans through and out of the powder booth 14 and into and through the oven 60. The conveying system 50 in the illustrated embodiment includes several different belts to accomplish, these functions.

[0035] Belt or matt 64 receives the groups of cans from the arms 40. The belt 64 is a perforated metal matt in the

illustrated embodiment. Powder recovery may occur below the belt 64.

[0036] Note that the arms 20 travel in a generally a linear direction (as dictated by the tracks 102 of Figure 2 and 3), and the direction of movement of the conveying system 50 including the belt 64 is substantially perpendicular to the linear direction of travel of the robotic arm. This feature allows the cans to be closely stacked by the arm, see for example the arrangement of the cans on the belt 64 in Figure 2.

[0037] As shown in Figure 2, after the cans have been conveyed out of the powder booth they are transferred onto a second, perforated cleaning belt 66. At least one suction zone is provided proximate to the conveying system belt 55 wherein excess powder is recovered from the can bodies after the can bodies have been applied with powder at the powder application zones 42 and 54. In the illustrated embodiment, are two such suction zones shown at 70A and 70B in Figure 1A. Belt 66 may be made from Teflon or include a Teflon coating.

[0038] The conveyor system also preferably includes a third component, shown as belt 68 in Figure 2, which receives the cans from belt 66 and carries the cans through the oven 60. The belt is also a perforated belt

Curing Oven 60

[0039] The electrical melting/curing oven 60 contains 3 heating zones (approx. 40kw each) and 1 cooling zone. The fan motors (not shown) are servo driven and the exhaust speed can be adjusted independently (to avoid spoilage from falling cans. The length of the oven will depend on such factors as the melting temperatures and curing times of powders to be used, and speed of the belt 68. An ideal powder only needs a 12m oven with two 36kw heating zones. The temperature of the oven will vary depending on the powder used and may be between 180° C. and 220° C., ideally the temperature is as low as possible to reduce energy consumption for the system. The curing time for curing the powder will depend on the powder composition. Representative times are between 2 and 10 minutes.

[0040] A matt cleaner is installed at the end of the oven for cleaning the belt 68.

Method of Operation

[0041] With reference to Figures 1-7 and in particular to Figure 6, a group 40 of two rows of sixteen cans each is delivered "dome-up" outside the powder booth 14 on the feed conveyor 62, the cans resting on their cut edge 31. Then the cans are picked up by the powder application robot arm 20. In particular, the robot arm 20 lowers down and picks up the thirty two cans (with ' vacuum applied at the vacuum chucks 108) simultaneously at the dome 34 of the cans.

[0042] From the moment the cans are lifted from the feed conveyor all thirty-two cans start rotating at 20 RPM.

The cans are moved by the arm 20 into the powder booth 14.

[0043] The cans are moved at high speed upward and horizontal to the application position or exterior and interior coat zone 42. At the application position 42 the robot arm triggers the external application guns 24 and moves the cans vertically downwards towards the interior application guns 26, during this operation the external powder is applied by the guns 24. At the lowest point the robot arm stops for 30ms..

[0044] At this point the external guns 24 stop spraying and the thirty two internal application guns 26 are triggered, now the cans are moved vertically upwards and the internal coating is applied to the cans. The entire powder application process (external and internal) should take no longer than 2.3 seconds.

[0045] Then the cans are moved by the robot arm with high speed to the dome application matt or belt 64. During this movement the cans stop rotating. All thirty-two cans are placed simultaneously on the perforated metal matt 64, "dome up". The metal matt 64 is grounded to maintain an electrostatic potential between the cans placed on the matt and the charged powder applied by the dome spray guns 28 of Figure 6.

[0046] The perforated matt 64 moves the cans 90° sideways from the robot movement; this allows narrow spacing between the cans.

[0047] The dome application spraying is done with guns 28 (Figure 6) spraying a continuous haze of powder onto the can domes. The guns are mounted to an arm 106 which moves laterally over the cans to apply the powder to the domes.

[0048] Then the cans are transported from the metal belt 64 to the cleaning belt 66 (Figure 1A, 2). At this point the cans are still dome up (standing on cut edge 31, Figure 7).

[0049] To avoid powder residue at the cut edge of the can, a suction slit for powder recovery is placed at the end the metal belt 64; the end of the metal belt 64 is just outside the powder booth as shown in Figures 5 and 6.

[0050] Now, the cans are transferred from the belt 64 to the perforated Teflon cleaning belt 66. This belt 66 contains two strong powder recovery suction zones 70A and 70B (Figure 1A), one (70B) at the beginning of the belt, and one (70A) at the end of the belt where the final powder residue is collected and recovered.

[0051] Now, the cans are transferred onto the perforated Teflon oven belt 68 (Figure 2), still dome up. A perforated belt is used for the oven belt 68 to avoid condensate remains inside the cans.

[0052] The belt 68 advances the cans as a group through the oven 60 where the powder is cured. The cans are then transferred to downstream processing locations. The downstream processing details are not important and will vary depending on the type of can.

[0053] From the above discussion, it will also be appreciated that we have disclosed a method of continuous powder coating of can bodies, comprising the steps of:

- a) providing a set 40 of can bodies 12 at a location exterior of a powder booth in a predetermined configuration (see Figure 6);
- b) moving a robotic arm 20 to the location, connecting the robotic arm to the set of can bodies and moving the robotic arm and connected can bodies into the powder booth 14;
- c) while holding the set of can bodies with the robotic arm, applying a powder to the can bodies within the powder booth (using spray guns 24 and 26);
- d) releasing the group of can bodies from the robotic arm (onto the metal mat 64); and
- e) applying additional powder to the group of can bodies at the location where the can bodies were connected to the robotic arm, by virtue of guns 28 moving over the domes of the cans on the mat 64 and applying powder to the "dome up" cans, and
- f) repeating steps a), b), c), d) and e), by virtue of the operations of arms 20A and 20B repeatedly picking up sets of cans delivered on the feed conveyor 62 and moving the cans through the powder booth, see the above description and Figures 5 and 6.

[0054] It will also be appreciated that we have described a method of powder coating of can bodies 12 comprising the steps of:

- a) moving a plurality of can bodies to a location exterior of a powder booth (using feed conveyor 62, see Figure 6);
- b) moving the plurality of can bodies as a group into the powder booth 14 and to a powder application zone 42 within the powder booth (see Figures 1A and 6);
- c) applying a powder to the can bodies (see above discussion of powder booth and guns 24 and 26);
- d) moving the group of can bodies to a conveyor system (See Figures 5 and 6, cans being deposited on the metal mat 64 of the conveyor system 50 of Figure 2); and
- e) applying additional powder to the group of can bodies after placement of the can bodies on the conveyor system (operation of the dome spray guns 28 after release of the cans onto the metal mat 64, see the above discussion).

[0055] While a number of exemplary aspects and embodiments have been discussed above, those of skill in the art will recognize that modifications, permutations, additions and sub-combinations thereof and variation from the specifics from the illustrated embodiments are of course possible. It is therefore intended that the following appended claims and claims hereafter introduced are interpreted to include all such modifications, permutations, additions and sub-combinations as are within their true spirit and scope.

Claims

1. A system for powder coating of can bodies, comprising:
 - a powder booth having an entrance and an exit, the powder booth comprising of least one robotic arm and a plurality of powder application guns, the at least one robotic arm operable to move a plurality of can bodies as a group to a powder application zone where powder is applied to the interior and exterior of the plurality of can bodies by the plurality of powder application guns;
 - a conveying system for receiving the plurality of can bodies as a group from the at least one robotic arm; and
 - an oven receiving the plurality of can bodies from the conveying system and operative to cure the powder applied to the plurality of can bodies.
2. The system of claim 1, wherein the can bodies include a closed end portion and wherein the at least one robotic arm connects to the plurality of can bodies by means of suction applied to the closed end portion of each of the can bodies.
3. The system of claim 2, wherein the powder booth further includes a zone where powder is applied to the closed end portion of the can bodies after the can bodies have been released from the robotic arm onto the conveying system.
4. The system of claim 1, wherein the system further comprises at least one suction zone proximate to the conveying system wherein excess powder is recovered from the can bodies after the can bodies have been applied with powder at the powder application zone.
5. The system of claim 1, wherein the system comprises at least two robotic arms, each of which operates to move a plurality of can bodies as a group to the powder application zone and then to the conveying system.
6. The system of claim 1, wherein the conveying system includes a first component comprising a perforated belt receiving the group of cans from the at least one robotic arm, wherein the robotic arm moves in a linear direction, and wherein the direction of movement of the first component of the conveying system is substantially perpendicular to the linear direction of movement of the robotic arm.
7. The system of claim 6, wherein the conveying system includes a second component comprising a perforated cleaning belt having powder recovery suction areas, the second component receiving the group of

can bodies from the first component, and a third component comprising a conveyor for conveying can bodies through the oven.

8. The system of claim 7, wherein the conveyor conveying can bodies through the oven comprises a perforated belt.
9. The system of claim 1, wherein the at least one robot arm moves exterior of the entrance to the powder booth to pick up a plurality of cans as a group and move them through the entrance of the powder booth to the powder application zone and from the powder application zone to the conveyor system.
10. The system of claim 1, wherein the at least one robotic arm operates to rotate each of the plurality of can bodies while powder is being applied to the can bodies by the powder guns.
11. A powder booth for a powder coating system for cans, comprising:
 - a robotic arm operable to hold and transport a plurality of can bodies as a group within the powder booth;
 - a first set of power guns operative to apply a powder to the exterior of the plurality of can bodies as the plurality of can bodies are held by the robotic arm;
 - a second set of powder guns operative to apply a powder to the interior of the plurality of can bodies; and
 - a third set of powder guns operative to apply a powder to the location of the plurality of can bodies where the plurality of can bodies were held by the robotic arm.
12. The powder booth of claim 11, further comprising:
 - a conveying system receiving the plurality of can bodies from the robotic arm after application of powder to the can bodies by the first and second sets of powder guns.
13. The powder booth of claim 12, wherein the robot arm travels in a linear direction, and wherein the direction of movement of the conveying system is substantially perpendicular to the linear direction of travel of the robotic arm.
14. The powder booth of claim 12, wherein the conveying system comprises a perforated belt.
15. The powder booth of claim 12, wherein the powder booth further comprises a second robotic arm, the second robotic arm operable to hold and transport a plurality of can bodies as a group within the powder

booth, and wherein the first and second arms alternating to transport groups of can bodies to the location of the first and second set of powder guns.

16. A method of powder coating of can bodies comprising the steps of:
 - a) moving a plurality of can bodies to a location exterior of a powder booth;
 - b) moving the plurality of can bodies as a group into the powder booth and to a powder application zone within the powder booth;
 - c) applying a powder to the can bodies;
 - d) moving the group of can bodies to a conveyor system; and
 - e) applying additional powder to the group of can bodies after placement of the can bodies on the conveyor system.
17. The method of claim 16, further comprising the step:
 - f) moving the group of can bodies from the powder booth to an oven for curing of the powder applied to the can bodies.
18. The method of claim 16, wherein during step c), performing the additional step of rotating each of the cans of the group about an axis.
19. The method of claim 16, wherein the cans comprise beverage cans having a dome portion closing one end of the can, and during steps b), c) and d) the group of cans are held by a robotic arm by means of suction applied by the robotic arm to the dome portion of the can.
20. The method of claim 19, wherein in step a) the cans are placed in the location exterior to the powder booth in a predetermined configuration watching a configuration of the robotic arm.
21. The method of claim 20, wherein the predetermined configuration comprises a configuration of rows and columns of cans, wherein there are two columns and N rows, and wherein N is greater than or equal to two.
22. The method of claim 21, wherein N is greater than 10.
23. A method of continuous powder coating of can bodies, comprising the steps of:
 - a) providing a set of can bodies at a location exterior of a powder booth in a predetermined configuration;
 - b) moving a robotic arm to the location, connecting the robotic arm to the set of can bodies and moving the robotic arm and connected can bodies into the powder booth;

- c) while holding the set of can bodies with the robotic arm, applying a powder to the can bodies within the powder booth;
 d) releasing the group of can bodies from the robotic arm; and
 e) applying additional powder to the group of can bodies at the location where the can bodies were connected to the robotic arm, and
 f) repeating steps a), b), c), d) and e).
24. The method of claim 23, wherein the predetermined configuration comprises a configuration of rows and columns of cans, wherein there are two columns and N rows, and wherein N is greater than or equal to two.
25. The method of claim 24, wherein N is greater than 10.
26. The method of claim 23, wherein the can bodies have interior and exterior surfaces and wherein in step c) the powder is applied to the interior and exterior surfaces.
27. The method of claim 16, wherein the can bodies comprise beverage can bodies.
28. The method of claim 23, wherein the can bodies comprise beverage can bodies.

Amended claims in accordance with Rule 137(2) EPC.

1. A system (10) for powder coating of can bodies (12), comprising:
- a powder booth (14) having an entrance (16) and an exit (18), the powder booth comprising at least one robotic arm (20) and a plurality of powder application guns (22), the at least one robotic arm operable to move a plurality of can bodies as a group (40) to a powder application zone (42) where powder is applied to the interior and exterior of the plurality of can bodies by the plurality of powder application guns;
 a conveying system (50) for receiving the plurality of can bodies as a group from the at least one robotic arm; and
 an oven (60) receiving the plurality of can bodies from the conveying system and operative to cure the powder applied to the plurality of can bodies.
2. The system (10) of claim 1, wherein the can bodies (12) include a closed end portion (34) and wherein the at least one robotic arm (20) connects to the plurality of can bodies by means of suction applied to the closed end portion of each of the can bodies.
3. The system (10) of claim 2, wherein the powder

booth (14) further includes a zone (54) where powder is applied to the closed end portion (34) of the can bodies (12) after the can bodies have been released from the robotic arm (20) onto the conveying system (50).

4. The system (10) of claim 1, wherein the system further comprises at least one suction zone (70A, 70B) proximate to the conveying system (50) wherein excess powder is recovered from the can bodies (12) after the can bodies have been applied with powder at the powder application zone (42).

5. The system (10) of claim 1, wherein the system comprises at least two robotic arms (20), each of which operates to move a plurality of can bodies (12) as a group (40) to the powder application zone (42) and then to the conveying system (50).

6. The system (10) of claim 1, wherein the conveying system (50) includes a first component comprising a perforated belt (64) receiving the group (40) of cans (12) from the at least one robotic arm (20), wherein the robotic arm moves in a linear direction, and wherein the direction of movement of the first component of the conveying system is substantially perpendicular to the linear direction of movement of the robotic arm.

7. The system (10) of claim 6, wherein the conveying system (50) includes a second component comprising a perforated cleaning belt (66) having powder recovery suction areas (70A, 70B), the second component receiving the group (40) of can bodies (12) from the first component, and a third component comprising a conveyor (68) for conveying can bodies through the oven (60).

8. The system (10) of claim 7, wherein the conveyor (68) conveying can bodies (12) through the oven (60) comprises a perforated belt.

9. The system (10) of claim 1, wherein the at least one robot arm (20) moves exterior of the entrance (16) to the powder booth (14) to pick up a plurality of cans (12) as a group (40) and move them through the entrance of the powder booth to the powder application zone (42) and from the powder application zone to the conveyor system (50).

10. The system (10) of claim 1, wherein the at least one robotic arm (20) operates to rotate each of the plurality of can bodies (12) while powder is being applied to the can bodies by the powder guns (22).

11. The system (10) of claim 1, wherein the plurality of powder application guns (22) comprises :

a first set (24) of power guns operative to apply a powder to the exterior of the plurality of can bodies (12) as the plurality of can bodies are held by the at least one robotic arm (20);
 a second set (26) of powder guns operative to apply a powder to the interior of the plurality of can bodies; and
 a third set (28) of powder guns operative to apply a powder to the location of the plurality of can bodies where the plurality of can bodies were held by the at least one robotic arm.

12. The system (10) of claim 11, wherein the

a conveying system (50) is for receiving the plurality of can bodies (12) from the robotic arm (20) after application of powder to the can bodies by the first (24) and second (26) sets of powder guns.

13. The system (10) of claim 12, wherein the powder booth (14) further comprises a second robotic arm (20), the second robotic arm operable to hold and transport a plurality of can bodies (12) as a group (40) within the powder booth, and wherein the first and second arms alternating to transport groups of can bodies to the location of the first (24) and second (26) set of powder guns.

14. A powder booth (14) for a powder coating system (10) for cans, comprising:

a robotic arm (20) operable to hold and transport a plurality of can bodies (12) as a group (40) within the powder booth;
 a first set (24) of power guns operative to apply a powder to the exterior of the plurality of can bodies as the plurality of can bodies are held by the robotic arm;
 a second set (26) of powder guns operative to apply a powder to the interior of the plurality of can bodies; and
 a third set (28) of powder guns operative to apply a powder to the location of the plurality of can bodies where the plurality of can bodies were held by the robotic arm.

15. The powder booth (14) of claim 14, further comprising:

a conveying system (50) receiving the plurality of can bodies (12) from the robotic arm (20) after application of powder to the can bodies by the first and second sets (24, 26) of powder guns.

16. The powder booth (14) of claim 15, wherein the robot arm (20) travels in a linear direction, and wherein the direction of movement of the conveying system

(50) is substantially perpendicular to the linear direction of travel of the robotic arm.

17. The powder booth (14) of claim 15, wherein the conveying system comprises a perforated belt (64).

18. The powder booth (14) of claim 15, wherein the powder booth further comprises a second robotic arm (20), the second robotic arm operable to hold and transport a plurality of can bodies (12) as a group (40) within the powder booth, and wherein the first and second arms alternating to transport groups of can bodies to the location of the first and second set (24, 26) of powder guns.

19. A method of powder coating of can bodies (12) comprising the steps of:

- a) moving a plurality of can bodies to a location exterior of a powder booth (14);
- b) moving the plurality of can bodies as a group (40) into the powder booth and to a powder application zone (42) within the powder booth;
- c) applying a powder to the can bodies;
- d) moving the group of can bodies to a conveyor system (50); and
- e) applying additional powder to the group of can bodies after placement of the can bodies on the conveyor system.

20. The method of claim 19, further comprising the step:

- f) moving the group (40) of can bodies (12) from the powder booth (14) to an oven (60) for curing of the powder applied to the can bodies.

21. The method of claim 19, wherein during step c), performing the additional step of rotating each of the cans (12) of the group (40) about an axis.

22. The method of claim 19, wherein the cans (12) comprise beverage cans having a dome portion closing one end of the can, and during steps b), c) and d) the group (40) of cans are held by a robotic arm (20) by means of suction applied by the robotic arm to the dome portion of the can.

23. The method of claim 22, wherein in step a) the cans (12) are placed in the location exterior to the powder booth (14) in a predetermined configuration matching a configuration of the robotic arm (20).

24. The method of claim 23, wherein the predetermined configuration comprises a configuration of rows and columns of cans (12), wherein there are two columns and N rows, and wherein N is greater than or equal to two.

25. The method of claim 24, wherein N is greater than 10.

26. The method of claim 19, wherein step a) comprises providing a set of can bodies (12) at a location exterior of a powder booth (14) in a predetermined configuration; 5

step b) comprises moving a robotic arm (20) to the location, connecting the robotic arm to the set of can bodies (12) and moving the robotic arm and connected can bodies into the powder booth; 10

step c) comprises while holding the set of can bodies with the robotic arm, applying a powder to the can bodies within the powder booth; 15

step d) further comprises releasing the group of can bodies from the robotic arm;

step e) comprises applying additional powder to the group of can bodies at the location where the can bodies were connected to the robotic arm, and wherein the method further comprises the step ; f) repeating steps a), b), c), d) and e) as above. 20

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27. The method of claim 26, wherein the predetermined configuration comprises a configuration of rows and columns of cans (12), wherein there are two columns and N rows, and wherein N is greater than or equal to two. 30

28. The method of claim 27, wherein N is greater than 10.

29. The method of claim 26, wherein the can bodies (12) have interior and exterior surfaces and wherein in step c) the powder is applied to the interior and exterior surfaces. 35

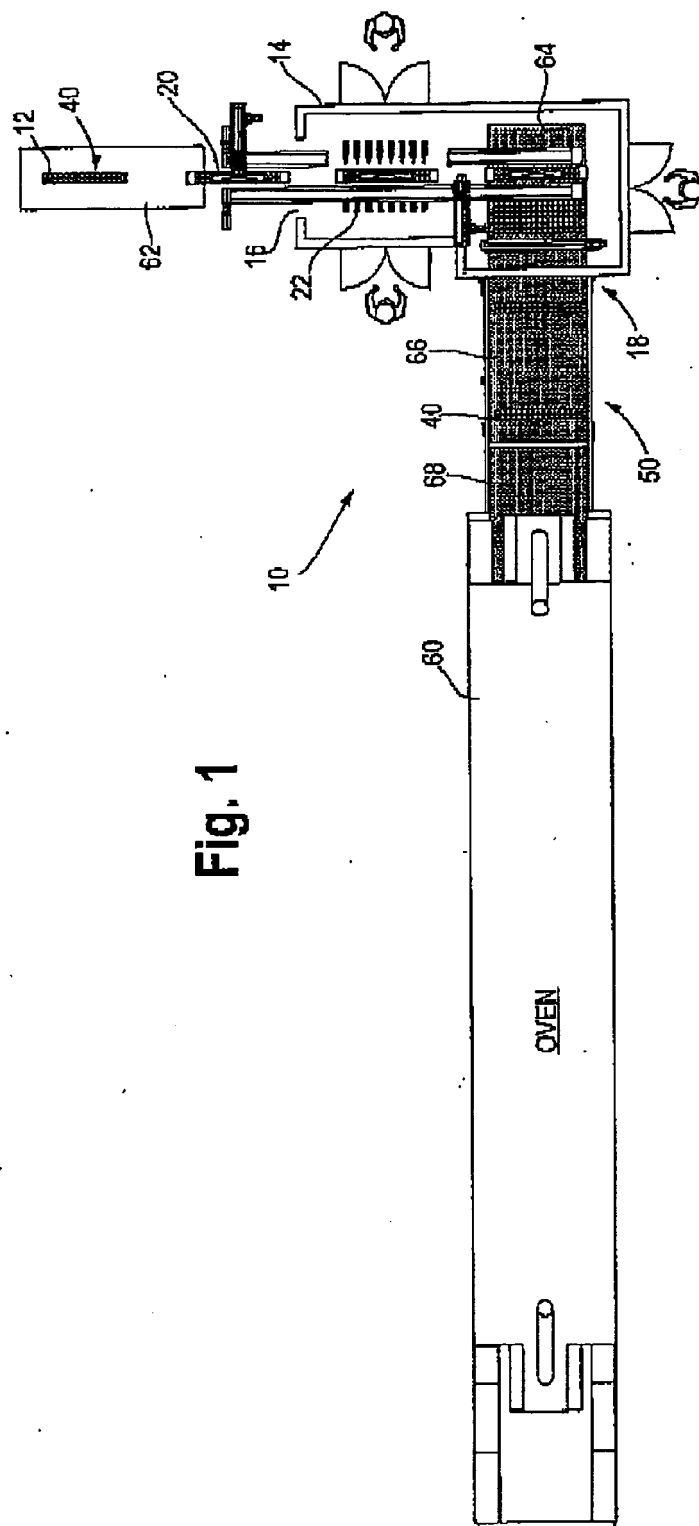
30. The method of claim 19, wherein the can bodies (12) comprise beverage can bodies. 40

31. The method of claim (26), wherein the can bodies (12) comprise beverage can bodies. 45

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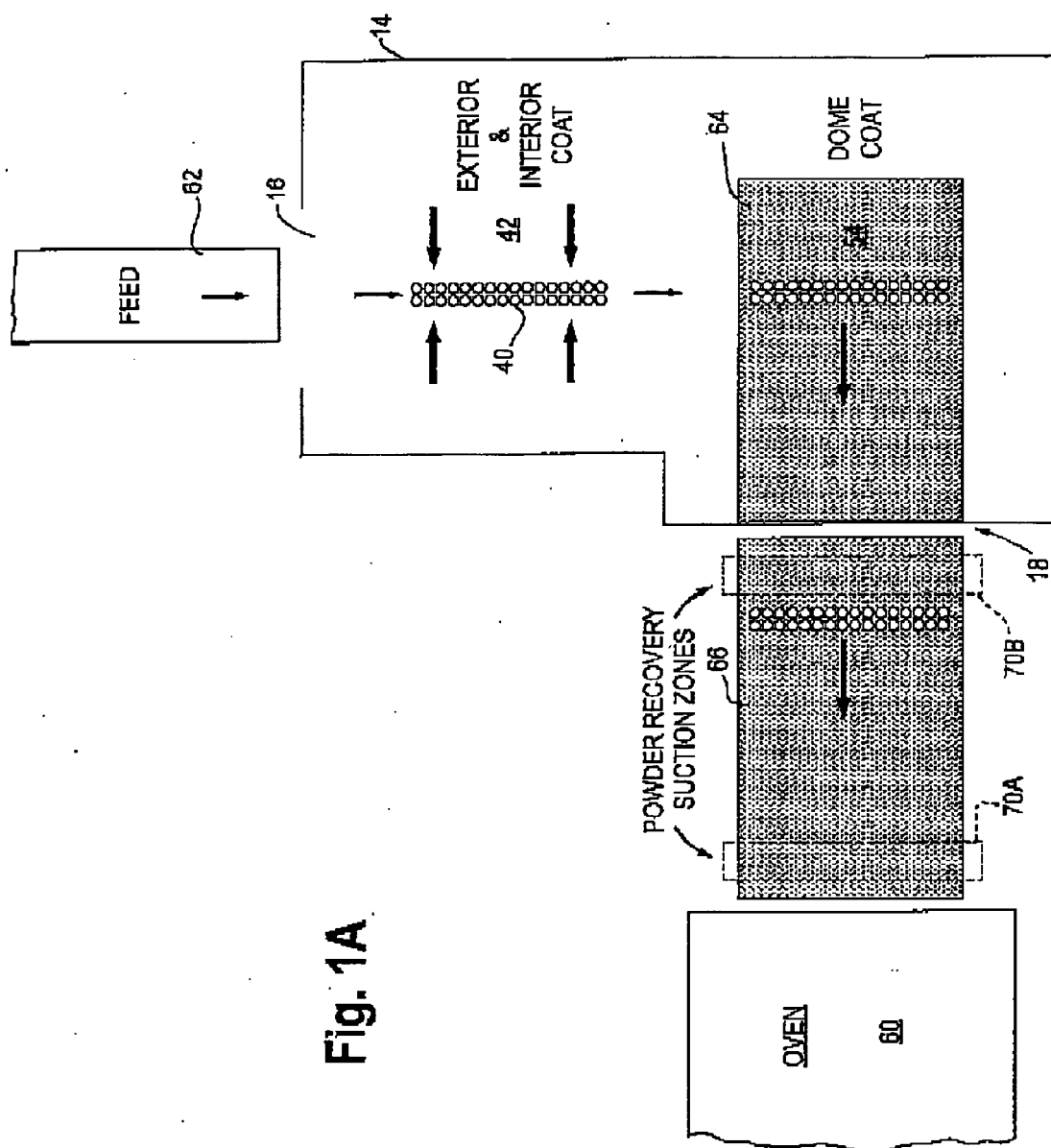


Fig. 1A

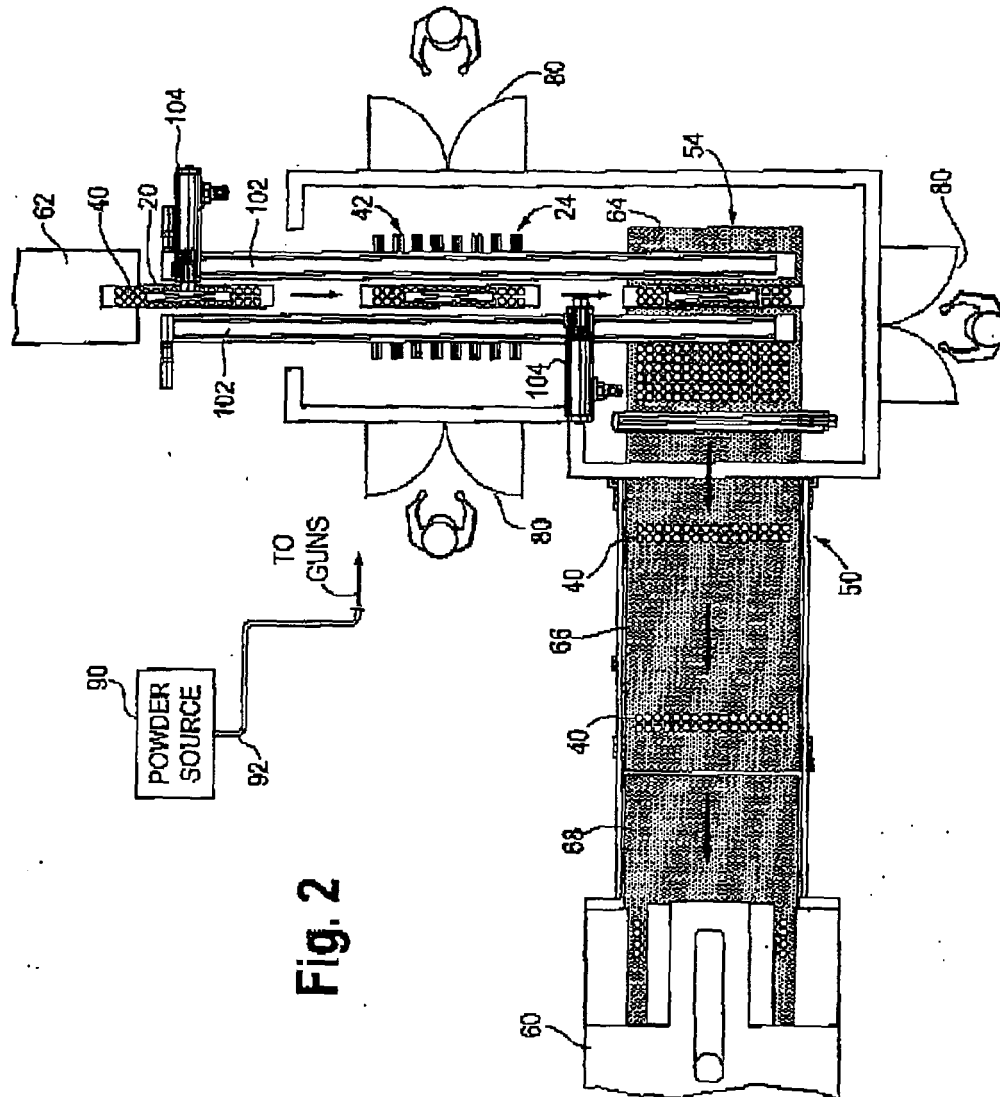


Fig. 2

Fig. 3

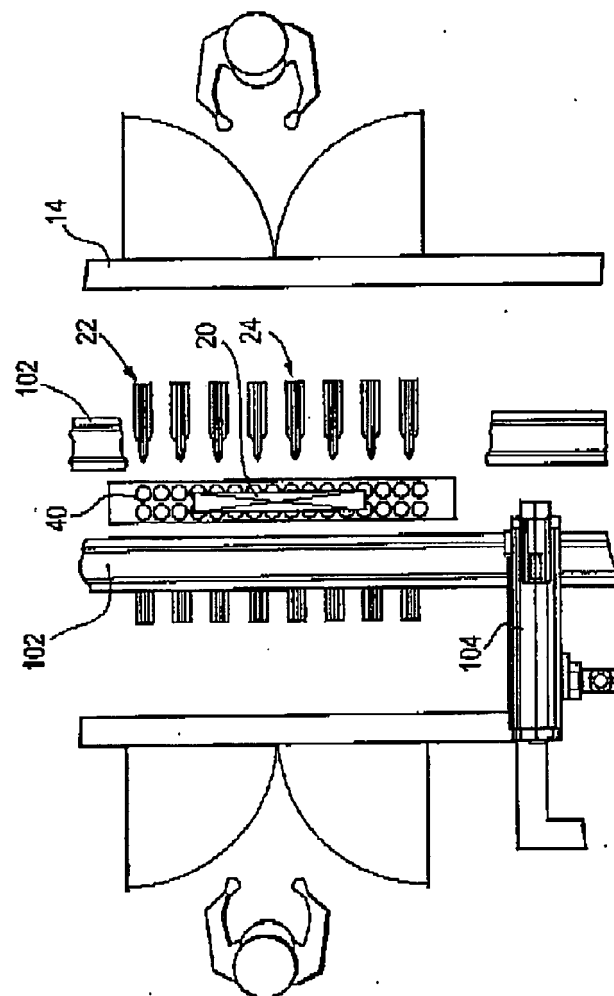
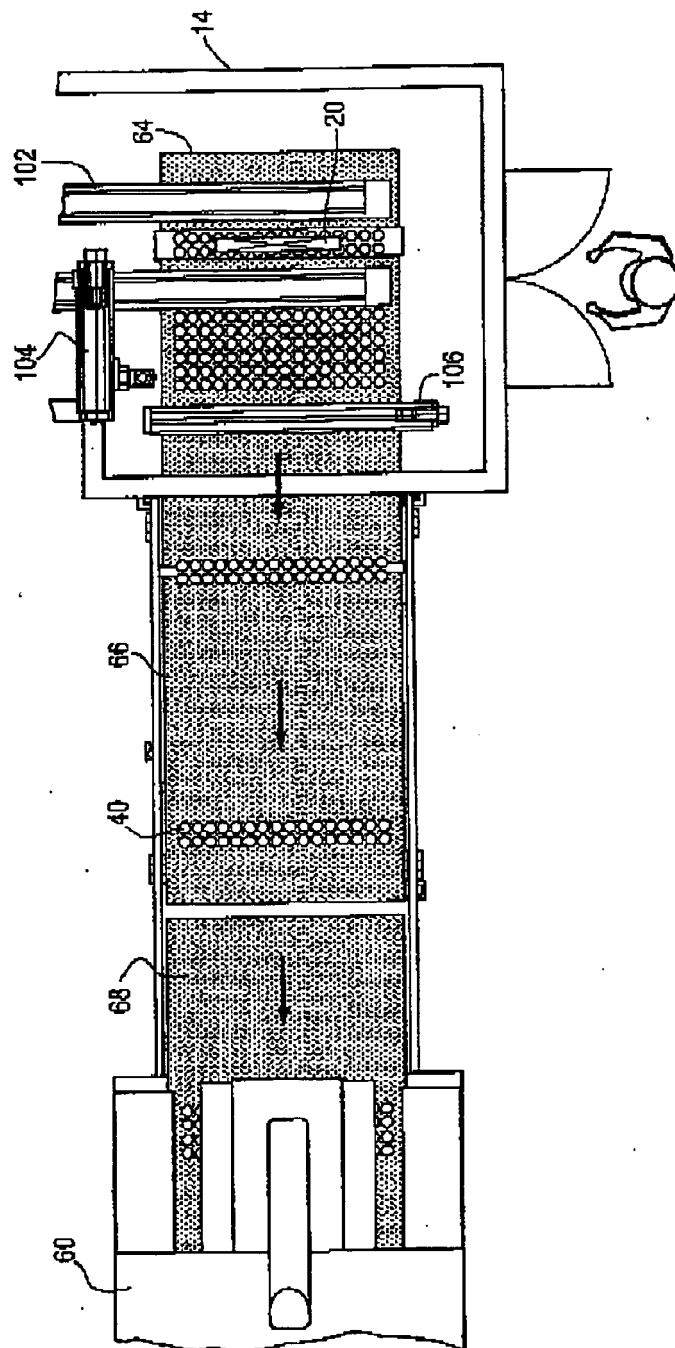


Fig. 4



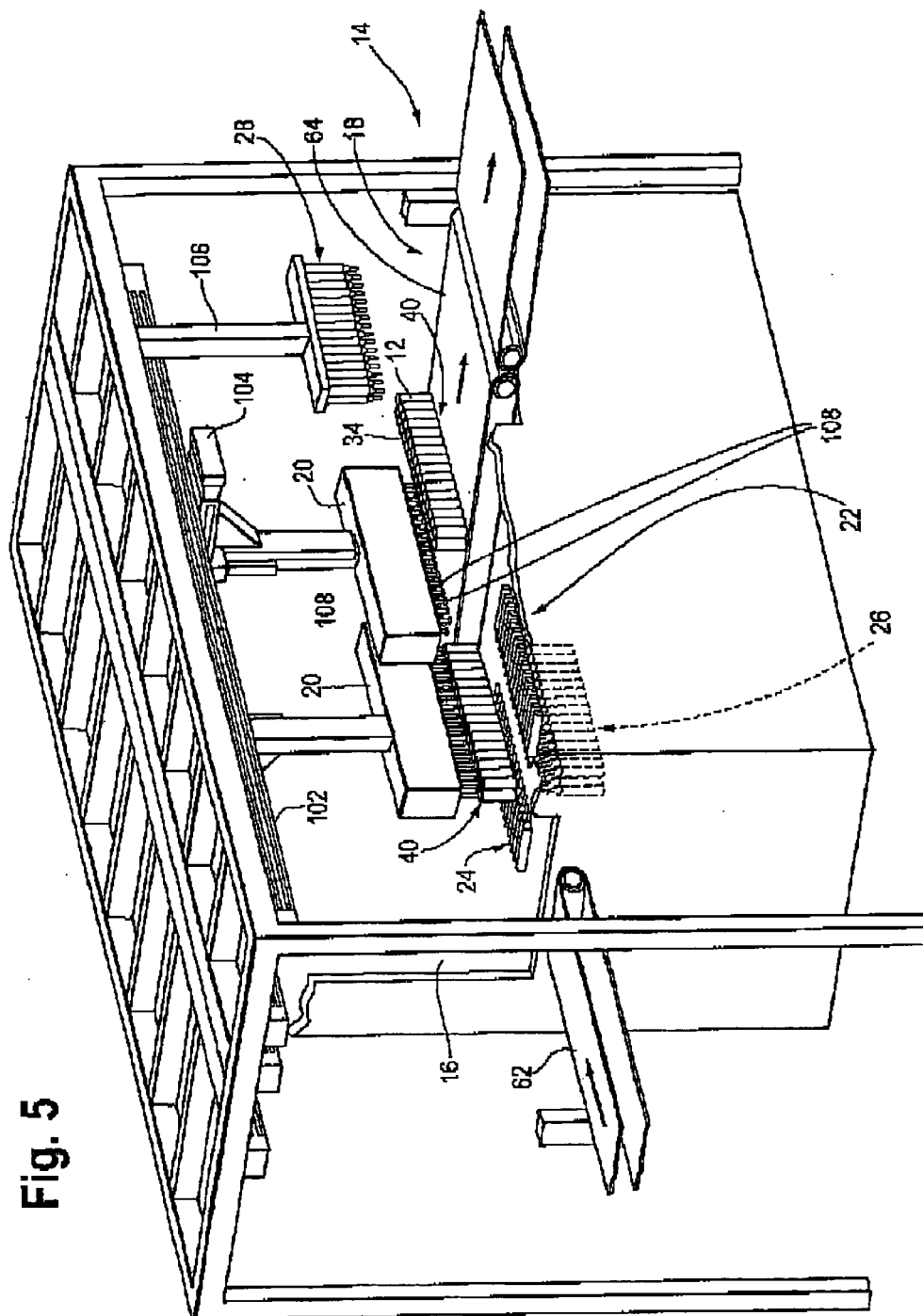


Fig. 5

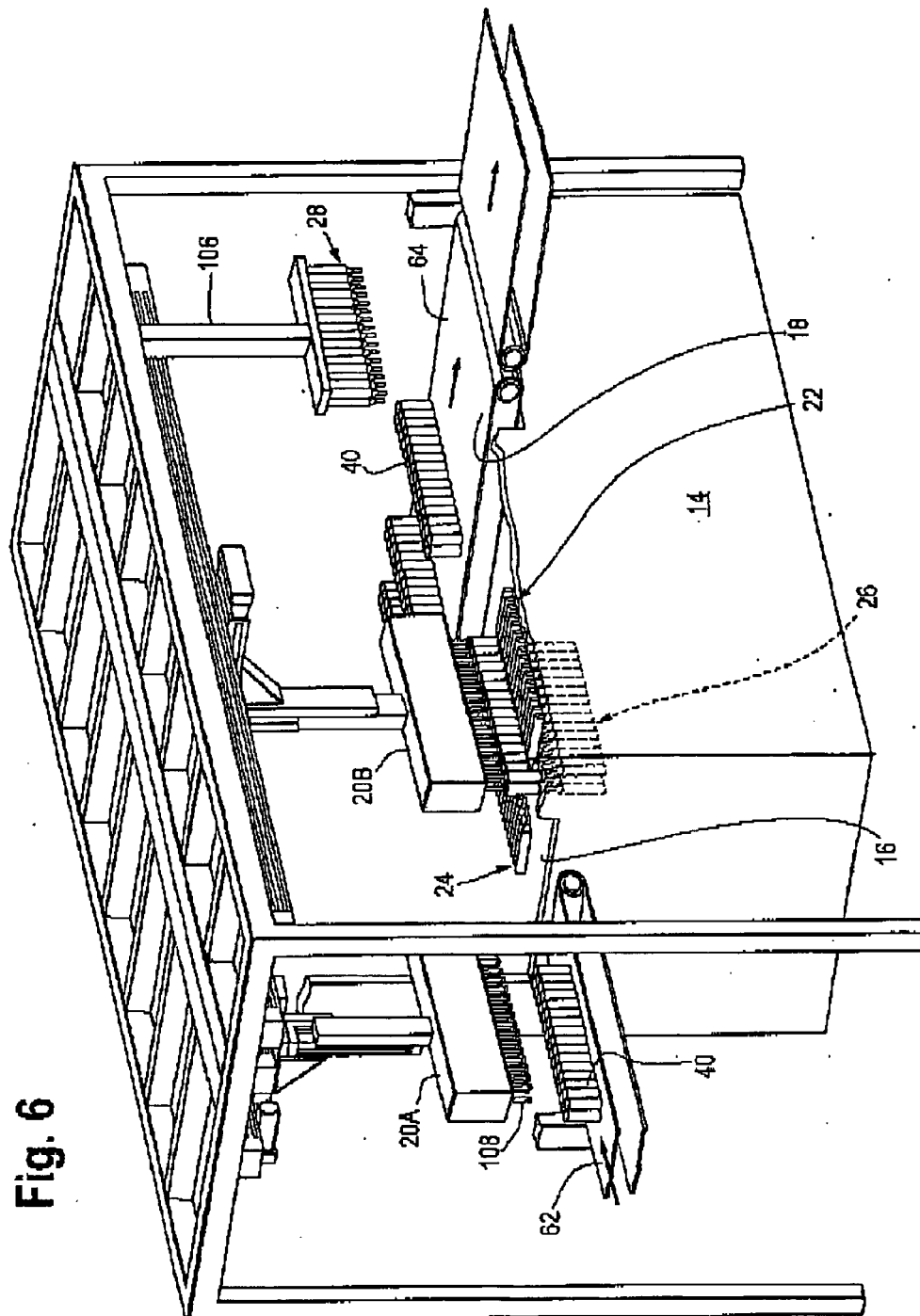
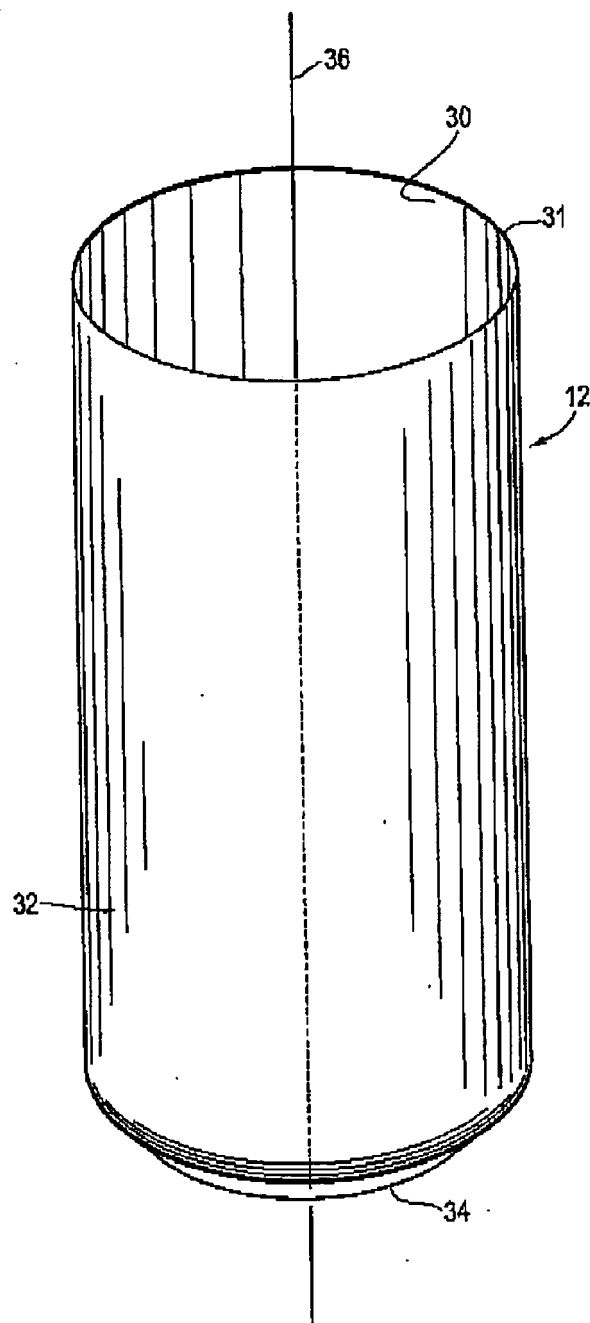


Fig. 6

Fig. 7





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 07 25 2414

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Place of search Munich		Date of completion of the search 12 October 2007	Examiner Lostetter, Yorick
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