Oct. 21, 1969 E. W. DRUM 3,473,735

ELECTROSTATIC COATING APPARATUS

Original Filed Sept. 22, 1964 3 Sheets-Sheet 1

Fig. 1

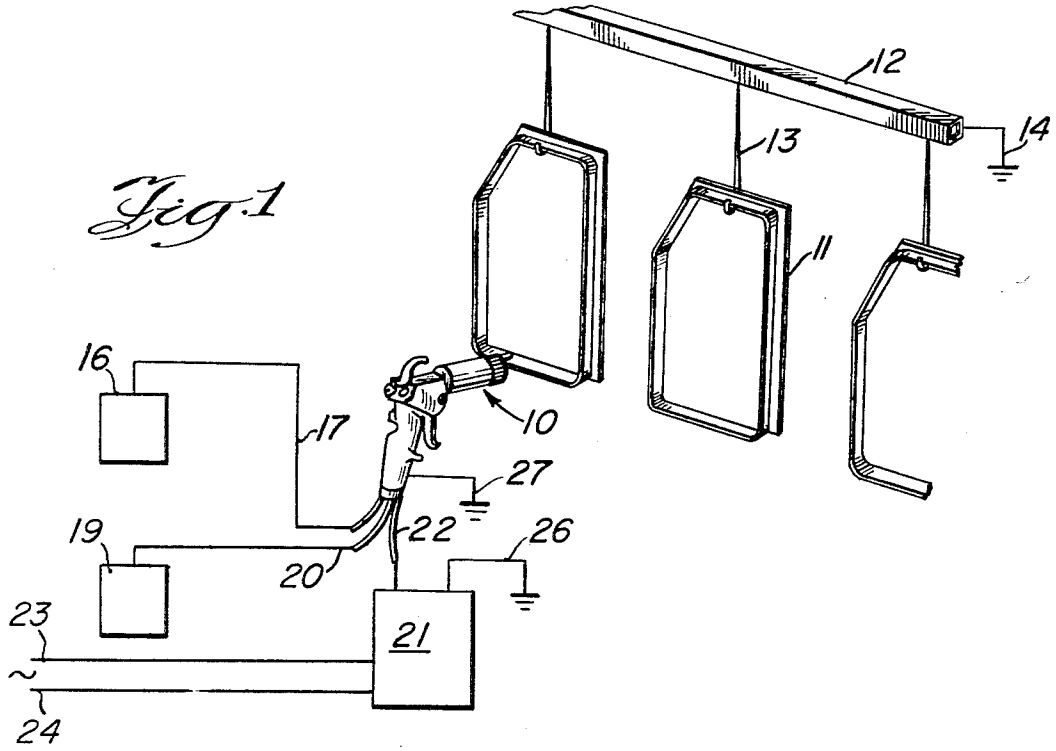
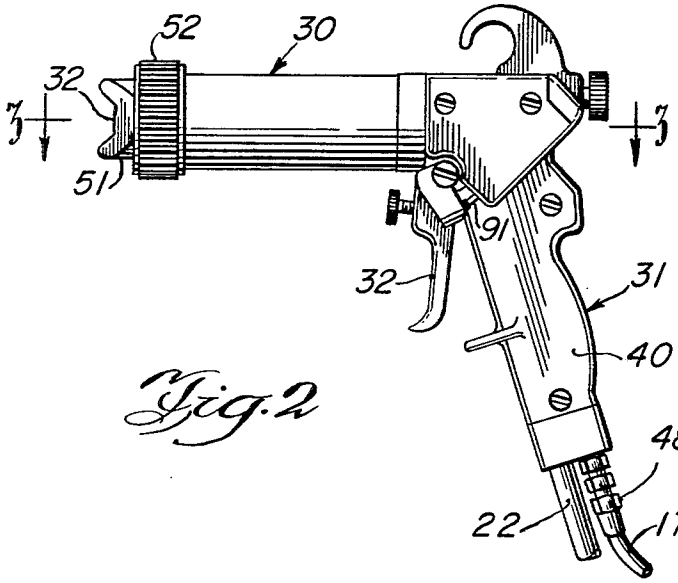


Fig. 2



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ATTORNEYS

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Fig. 3

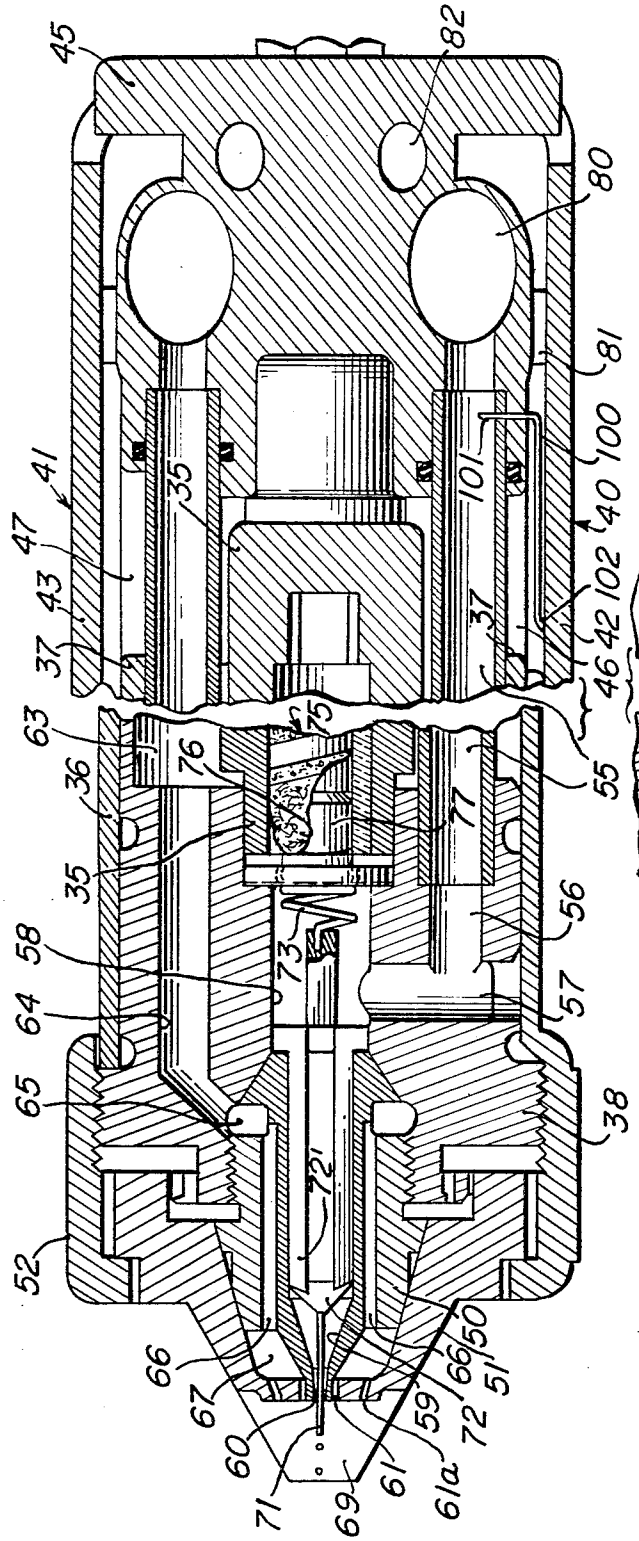
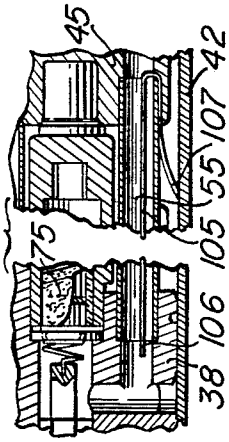


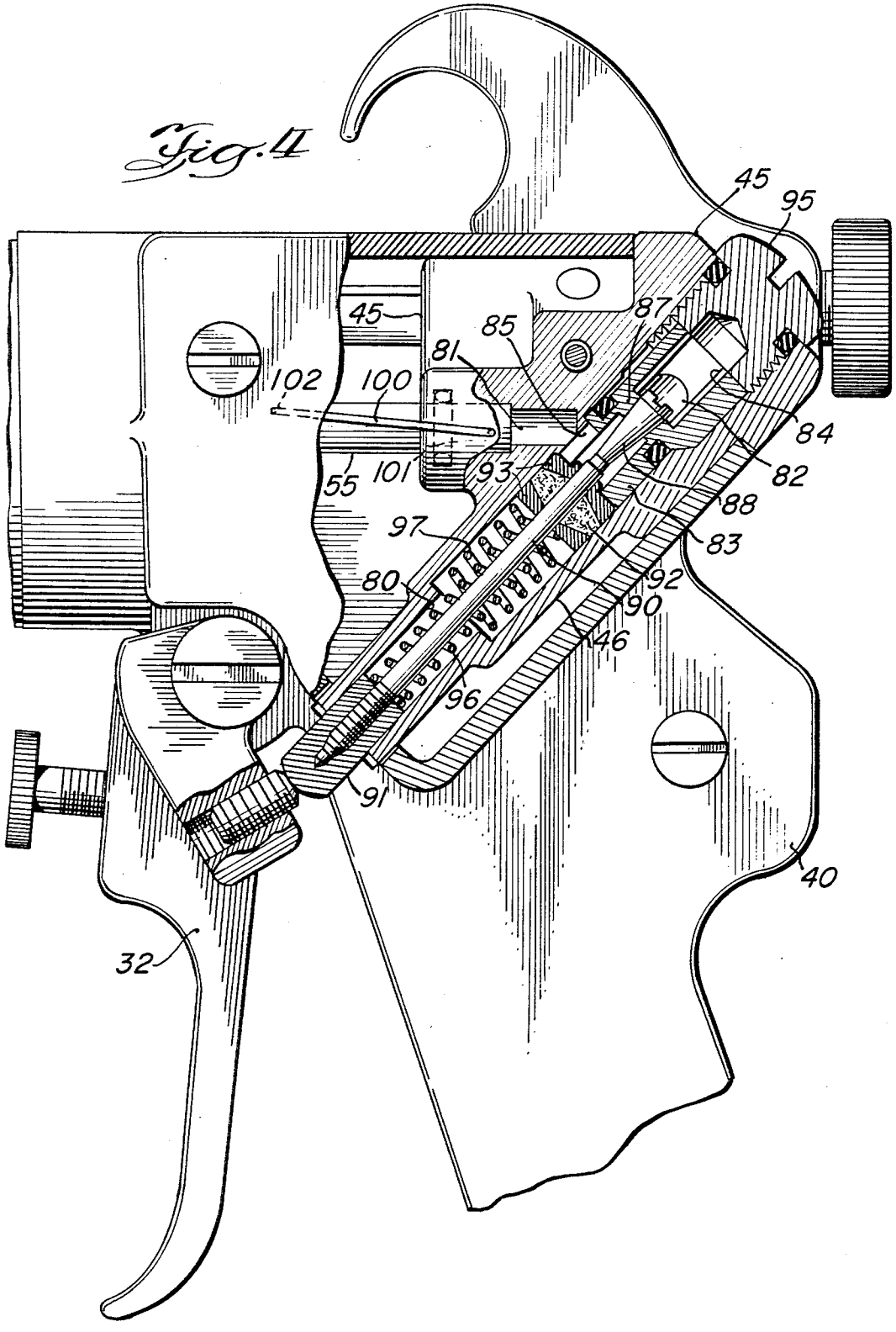
Fig. 5



ELECTROSTATIC COATING APPARATUS

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Fig. 4



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3,473,735

ELECTROSTATIC COATING APPARATUS

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Continuation of application Ser. No. 398,242, Sept. 22, 1964. This application Apr. 25, 1968, Ser. No. 724,297
Int. Cl. B05b 5/08
U.S. Cl. 239—15 6 Claims

ABSTRACT OF THE DISCLOSURE

A hand gun for electrostatic spray painting having an electrically charged electrode in the coating material flow path. A grounded electrode in the coating material flow path between the charged electrode and a valve in the handle prevents the valve from acquiring a charge through the coating material and improves transfer efficiency.

This application is a continuation of application Ser. No. 398,242, filed Sept. 2, 1964, now abandoned.

This invention is concerned with an electrostatic coating apparatus and method and more particularly to an improvement in a hand gun for electrostatic spray painting.

In certain type of electrostatic coating apparatus, as, for example, the hand gun illustrated and claimed in Juvinall et al. application Ser. No. 306,808, filed Sept. 5, 1963, now Patent 3,367,578, which issued Feb. 6, 1968, and assigned to the assignee of this invention, a charged electrode is located in the coating material flow path. Coating material particles acquire a charge in the field which extends from the charged electrode and are deposited on the article to be coated.

It has been found that the introduction of a grounded element or electrode into the coating material flow path closely adjacent the high voltage electrode causes a decrease in the overspray of the coating system when using relatively nonconductive paints. The overspray, as used herein, means the ratio of the weight of coating material particles which are not deposited on a given article, as a broom handle, to the total weight of coating material discharged. In measuring and comparing overspray, other conditions of operation of the system are maintained constant. Certain guns, as the gun shown in the Juvinall et al. application, include a coating material flow control valve which has a metal portion. With some coating materials, an ungrounded conductive element, such as a valve, may become charged and cause sparking to grounded adjacent elements as the trigger or even shock the operator. A grounded element in the coating material flow path between the charged electrode and the conductive element or valve prevents this.

A principal object of this invention is the provision of a spray coating apparatus having a grounded electrode in the coating material conduit preferably closely adjacent the charged electrode. The auxiliary grounded electrode reduces the overspray of the hand gun. In addition, the electrode in the coating material conduit prevents the accumulation of an electrical charge on ungrounded conductive members in contact with the coating material.

One feature of the invention is the provision of an electrostatic coating apparatus and method in which the coating material is subjected to a field, as an electric field, prior to discharge as small particles in a charging field. More particularly, the coating apparatus has a coating material conduit for connection with a source of coating material and means connected with the conduit for discharging finely divided particles of coating material. A source of high voltage with respect to a reference potential is connected with a charging electrode to impart a

charge to the particles. In accordance with the invention, a connection is provided from the coating material conduit, at a point between the electrode and its coating material source, to the reference potential means, subjecting the coating material to an electric field.

More particularly, the coating material conduit is of a nonconductive material while a conductive element, as a valve, is provided therein, located between the charging electrode and the coating material source. The reference potential or ground connection is connected with the coating material conduit at a point between the charging electrode and the conductive element.

A further feature of this invention is that the grounded metallic electrode in the coating material conduit permits the use of conductive elements in contact with the coating material and in the flow path. Thus, it is possible to use a valve having conductive metallic portions without the necessity of providing an electrical ground to the conductive portions while preventing these portions from acquiring an electrostatic charge and shocking the operator.

Further features and advantages of the invention will readily be apparent from the following specifications and the drawings in which:

FIGURE 1 is a diagrammatic perspective view of a system embodying the invention;

FIGURE 2 is an elevation of a gun embodying the invention;

FIGURE 3 is an enlarged broken horizontal section through the gun of FIGURE 2;

FIGURE 4 is a fragmentary side view, partially in section, illustrating the valve assembly and the location of the grounded connector; and

FIGURE 5 is a fragmentary view illustrating a modification of the invention.

Turning now to the drawings, and more particularly to FIGURE 1, an electrosatic spray painting system utilizing an air atomizing hand gun **10** is illustrated. Articles **11** to be coated are carried on conveyor **12** by hangers **13**. The hangers and conveyor are conductive and the conveyor is connected with a reference potential or ground **14** so that the conductive articles **11** are electrically grounded. The gun **10** is adapted to be held in the hand of an operator and to be manipulated as necessary to coat the articles passing through a coating zone. Coating material, as paint, is supplied to the gun **10** from a source **16** through a flexible hose **17**. The paint source **16** may be a paint tank maintained under pressure in a suitable manner. The gun **10** illustrated herein utilizes compressed air to atomize the coating material. Air for this purpose, and for shaping the coating material spray, if this is desired, is supplied from a compressed air source **19** through a hose **20**. High voltage for charging the atomized coating material particles is provided by a rectifier power supply **21** through a high voltage cable **22**. The power supply may be energized from a suitable source as 110 volts AC, through leads **23** and **24**. One output terminal **26** of the power supply is returned to ground. Hand gun **10** has a conductive body portion which is also connected with ground as indicated at **27**. The operating output voltage of power supply **21** may be varied over a considerable range depending upon the particular coating apparatus, coating material being used and articles being coated. With the hand gun described herein, using nonconductive paints, the output voltage is preferably of the order of 65 kilovolts.

The gun **10** is shown in somewhat more detail in FIGURE 2. The barrel portion **30** has a conductive grip portion **31** extending from the rear portion thereof with a trigger **32** pivotally mounted in front of the grip and adjacent thereto to be squeezed by the operator. The coating material and air hoses **17** and **20**, respectively, and the

high voltage cable 22 enter the gun through the base of grip 31. The high voltage cable includes a grounded conductive sheath connected with grip 31. The spray of coating material is discharged from the front of the barrel where the particles are electrically charged as a result of a field established between electrode 32, which is connected with the high voltage circuit, and ground. The electric field between electrode 32 and the articles 11 affects the travel of the charged particles so that substantially all of them are attracted to and deposited on the articles.

The portions of the interior construction of the gun pertinent to this invention are illustrated in FIGURES 3 and 4. With particular reference to FIGURE 3, the barrel is built up around the leg 35 of an interior casing member which has a second leg (not shown) extending into the grip 31. A sleeve 36 of insulating material forms the outer wall of barrel 30 and is supported by a series of flanges 37 which are integral with casing leg 36 and by a plug 38 of insulating material secured to the forward end of the casing leg. The grip, which is preferably formed of a pair of complementary metal stampings 40, 41, is secured to the lower leg of the interior casing as by suitable screws. The two complementary grip sections have upper portions 42, 43, which form a collar about the rear end of casing leg 35. Mounted within and secured to the grip members is a valve block or housing 45 preferably of a molded nonconductive plastic material. The valve block has two leg portions 46 and 47 which house the coating material and air valves, respectively. The coating material conduit 17 is grounded at the grip 31 by metallic hose fitting 48 threadedly connected to the grip.

At the forward end of the gun barrel, a paint cap 50 is secured to plug 38 and is in turn surrounded by an air cap 51 held in place by a collar 52 threaded to the plug. Paint is delivered from a tube 55 through a passage 56 to a transverse paint port 57 in plug 38 where it flows into a central opening 58. The paint flows forwardly through the opening 58, the bore 59 of paint cap 50 and is discharged through a small nozzle 60 which projects into an opening 61 centrally located in the face of air cap 51.

Atomizing air flows through the space 63 within barrel 36, surrounding casing leg 35, and enters air passage 64 in the plug from which it flows to an annular groove 65, through passages 66 in the paint cap to an annular space 67 within the air cap. Atomizing air is discharged through small openings 61, 61*a* surrounding the nozzle 60 of the paint cap to interact with the discharged coating material and break it up into small particles. Shaping air is delivered through passages (not shown in detail) to horns 69 from which it is discharged to affect the shape of the spray pattern.

The spray charging electrode 71 is carried by and extends through an elongated support member 72, of insulating material located within the bore 59 of paint cap 50 and extending into the passage 58 in plug 38. The rear end of electrode 71 is coiled into a resilient helix 73 through which connection is made with the high voltage circuit. Electrode support 72 is provided with longitudinal grooves 72' through which the coating material passes.

The high voltage cable 22, which enters the gun through the base of the grip portion, extends through the grip and is connected with the rear end of a multimegohm resistor 75 carried within casing leg 35. The resistor is a tubular member of ceramic having a high resistance material deposited thereon and the forward end is provided with a conductive coating 76. The end of the resistor is closed by a plug 77 which carries a conductive element that contacts the conductive surface 76 of the resistor and is contacted by the helical end portion 73 of electrode 71. Plug 77 is preferably cemented to the end of resistor 75 and to casing leg 35 preventing paint from reaching the resistor. From an examination of the drawing, it is apparent that the paint flowing to the nozzle opening 60 is in contact with the surface of charged electrode 71 for an appreciable distance. Thus, paints which have a constituent that is slightly conductive become a part of the high voltage circuit.

Referring to FIGURE 4, the leg 46 of valve housing block 45 has a bore or recess 80 therethrough, which receives the valve assembly. Paint tube 55 is connected with the valve housing and communicates with a paint outlet passage 81. Flexible paint hose 23 is connected through suitable tubing (not shown) with a passage 82 which enters the upper portion of bore 80.

The valve assembly includes a sleeve 83 which is received within the recess 80 and has notches 84 and 85 therein registering with inlet passage 82 and outlet passage 81, respectively. A web 87 across the sleeve provides a seat for valve head 88. The valve head is connected with a valve stem 90 which extends through the valve housing leg 46 and has a bearing cap 91 secured to the lower end, for engagement by trigger 32. The valve stem is sealed by packing material 92 carried between a pair of brass washers 93. The valve assembly is held in the bore 80 by a threaded plug 95. Valve head 88 is seated by a spring 96 which acts between bearing member 91 and washer 93. A second spring 97 is seated on a shoulder in bore 80 and also acts against packing washer 93. The spring 97 aids in the establishment of the valve stem seal and acts to force the valve assembly out of bore 80 upon removal of plug 95. A similar valve, controlling the flow of atomizing air, is located in leg 47.

A substantial portion of the coating material valve assembly is preferably made of conductive material and could acquire a charge if not grounded. The conductive portions include the valve head 88, valve stem 90, bearing member 91, packing washers 93 and springs 96 and 97. Where the paint is sufficiently conductive, the paint stream between the electrode and the valve, and the valve itself, became a part of the high voltage circuit. The coating material valve is not directly grounded but is connected with ground through the trigger assembly only when the trigger is squeezed. If there is a charge on the valve when the trigger contacts bearing member 91, sparking may occur.

In accordance with the invention, a grounded electrode is provided between the charging electrode and the remote grounded portion of the coating material flow path, which in the hand gun illustrated is the conductive valve portion. In the specific embodiment of the invention illustrated herein, the grounded electrode is best seen in FIGURES 3 and 4. A length of resilient wire 100, as a piano wire, has one end 101 inserted in a hole through the valve housing 45 and extends into the bore of paint tube 55. The other end 102 of resilient wire 100 extends forwardly from the point of entry into the valve housing block and is formed outwardly for engagement with conductive collar portion 42 of the grip 31. The end 101 of conductor 100 preferably extends into the paint passage a distance no more than one-half the inner diameter of the passage, to avoid obstruction of the flow of paint.

The grounded electrode 100 completes an electric circuit to the reference potential or ground establishing an electric field in the paint column between the high voltage circuit and the grounded electrode. As the ground is at a point in the paint system ahead of the paint valve, the valve structure cannot acquire an electric charge. Any current conducted through the paint from the charging electrode or other portions of the high voltage circuit is returned to ground through grounded electrode 100 in the paint path. This construction places the paint column between charging electrode 71 and grounded electrode 100 directly across the high voltage circuit. Where a highly conductive paint is used, the voltage at the charging electrode is reduced as a result of the increased current flow through resistor 75. If the voltage drops below a value which will establish an electrostatic field of sufficient value to impart an adequate charge to the coating

material particles, deposition efficiency is reduced. Accordingly, the grounded electrode should not be used with highly conductive paints, as, for example, paint with metallic particles therein.

The ground connection **100** is conveniently provided in the position illustrated in FIGURES 3 and 4 as the valve housing **45** provides adequate support for the wire connector and the conductive collar portion **42** of the grip affords a ground connection. It has been found, however, that the reduction of overspray is directly related to the distance between the charging electrode **71** and the grounded electrode **100**. In the embodiment of the invention illustrated in FIGURE 5, the grounded wire electrode **105** is looped around the end of coating material tube **55** which is received in the valve block **45**, the electrode extending through the tube receiving hole in the block. The electrode has a portion **106** which extends longitudinally through the tube to a point at the forward end thereof, adjacent the connection between the charging electrode **71** and the end of high voltage resistor **75**. The end **107** of electrode **105** extends outwardly from valve block **45** and engages grip collar portion **42**, which is grounded.

The distance between the end **106** of electrode **105** and the high voltage circuit determines the gradient of the field in the paint column. As this gradient is increased, overspray is reduced. For example, with a 6 inch separation between the charged and grounded electrodes, the apparatus exhibits a reduction of overspray from 20 to 18 percent. This is substantially the construction illustrated in FIGURES 3 and 4. With a 4 inch separation between the charged circuit and the grounded electrode, the overspray is reduced to 17 percent. With a one inch separation, as illustrated in FIGURE 5, the gradient through the coating material is substantially greater than that of the charging field, the overspray is reduced to 16 percent. This is a 20 percent reduction in overspray as compared with an apparatus having no grounded electrode.

Reduction of the distance between the grounded electrode and the high voltage circuit is limited by other factors. One is the sparking distance of the high voltage through the coating material. Furthermore, as the current through the paint column between the high voltage circuit and the grounded electrode becomes an appreciable portion of the total current through resistor **75**, the charging voltage is reduced. This may in turn result in a reduction of the charge imparted to the particles and the transfer efficiency of the apparatus. In the example given above, the coating material has a resistivity of approximately 0.50 megohm as measured between a 1½ inch long inner cylinder with a 1¼ inch outside diameter and a concentric outer cylinder 3½ inches long and having an inside diameter of 1½ inches, filled with the coating material. The measurement of resistivity is made with approximately 40 volts between the electrodes.

A decrease in paint resistivity to approximately 0.10 megohm causes a decrease of about one-third in the overspray reduction. The increase is reduced by two-thirds with a paint having a resistance of 0.05 megohm.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

I claim:

1. Electrostatic coating apparatus, comprising:
- a coating material conduit of insulating material, for connection with a source of coating material and having a hole through the wall thereof;
- means, including a charging electrode, connected with said conduit for discharging finely divided particles of said coating material;
- means establishing a reference potential, connected with said electrode;
- a valve in said coating material conduit between said electrode and said source;
- a conductive collar around said coating material conduit, spaced from the surface thereof, and connected with said reference potential;
- and a resilient wire member having a first end portion received in said hole and extending into the flow path of coating material through said conduit and having a second end portion bearing against said collar, said hole and first end portion being located between the charging electrode and the valve.

2. Electrostatic spray coating apparatus of the character described, comprising:
- a hand gun having a barrel and a conductive grip with a collar portion extending around said barrel, and a trigger adjacent said grip;
- a coating material conduit of nonconductive material for connection with a source of coating material;
- means including a charging electrode connected with said conduit for discharging finely divided particles of said coating material;
- means establishing a reference potential and connected with said conductive grip;
- a source of high voltage with respect to said reference potential, connected with said electrode;
- a block of insulating material having a portion within the collar portion of said grip, said block having a portion of the coating material conduit extending therethrough with a hole through the block into the conduit;
- a valve in said block, actuable by said trigger, having a portion of conductive material in said coating material conduit, between said electrode and said coating material source;
- and a resilient wire member having a first end portion received in the hole in said block and extending into the flow path of the coating material and having a second end portion bearing against said collar.

3. The coating apparatus of claim **2** in which the coating material conduit has an end received in the hole in the block and said resilient wire member is wrapped around said conduit end and the first end portion extends longitudinally of the conduit.

4. In an electrostatic spray coating apparatus having
- a hand gun with a barrel, a conductive grip portion and a trigger adjacent thereto,
- a coating material conduit of non-conductive material for connection with a source of liquid coating material and containing a column of liquid coating material in operation, said coating material conduit having one end abutting the grip portion,
- means, including a charging electrode, connected with said conduit for discharging finely divided particles of said coating material,
- means establishing a reference potential, connected with said grip and trigger,
- a source of high voltage with respect to said reference potential, connected with said charging electrode and having a portion in said liquid column,
- a valve actuable by said trigger, having a portion of conductive material in said coating material conduit, between said discharge means and said coating material source and connected with said source of high voltage through said column of liquid coating material, the improvement comprising:
  - first conductive means carried by the grip disposed adjacent the coating material conduit and connected to the means establishing the reference potential, and
  - second conductive means including a first portion extending into the conduit and a second portion passing about the end of the coating material conduit and contacting the first conductive

means, the first portion of the second conductive means being disposed between and spaced from the charging electrode and from the valve, the first portion of the second conductive means spaced from and near the charging electrode, the second conductive means isolating the valve electrically from the charged electrode.

5. The electrostatic coating apparatus of claim 4 wherein the first conductive means includes a collar portion extending around the rear end of the barrel, the coating material conduit extends through the barrel and the second conductive means is connected between the coating material conduit and the collar portion of the grip.

6. The electrostatic spray coating apparatus of claim 4 wherein a resistor is connected between the high voltage source and the charging electrode, the gradient of the electrical field through the column of liquid coating material between the charging electrode and the conductive means is substantially greater than the gradient of the

charging field from the charging electrode and the current flow through the resistor and the column of liquid coating material to the auxiliary electrode is less than that which would drop the voltage at the charging electrode below the level required for effective charging of said particles.

References Cited

UNITED STATES PATENTS

2,352,252	6/1944	Canetta	239—15
3,169,882	2/1965	Juvinall et al.	239—15

FOREIGN PATENTS

38-7120	5/1963	Japan.

EVERETT W. KIRBY, Primary Examiner

U.S. Cl. X.R.

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