June 11, 1963 TAMOTSU WATANABE 3,093,309

ELECTROSTATIC COATING APPARATUS OF SPRAY-GUN TYPE

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FIG. 1.

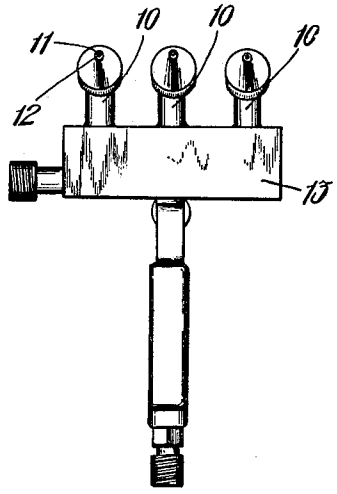

FIG. 2.

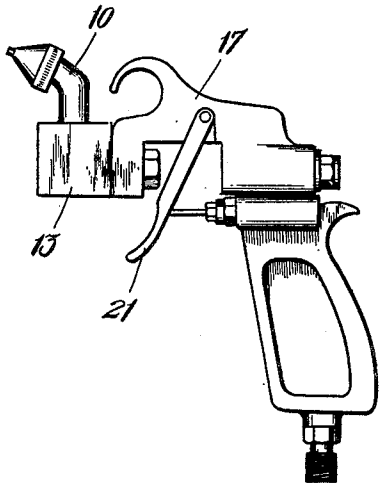

FIG. 3.

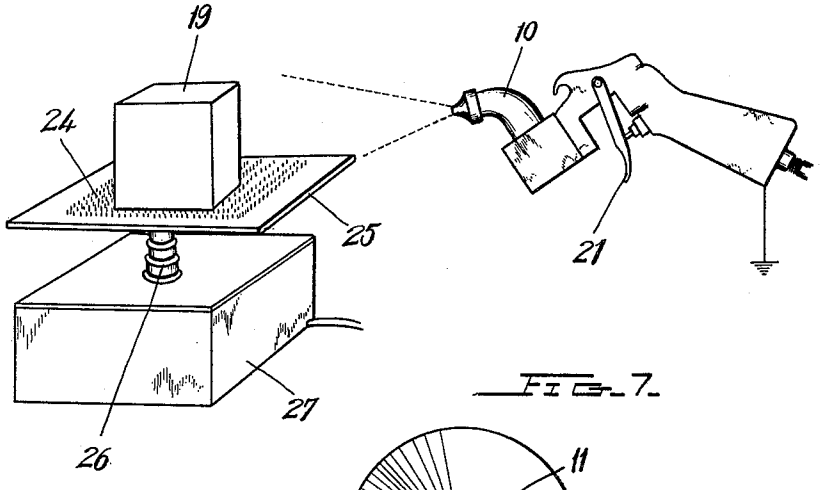

FIG. 7.

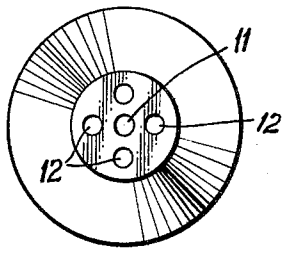

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FIG. 4.

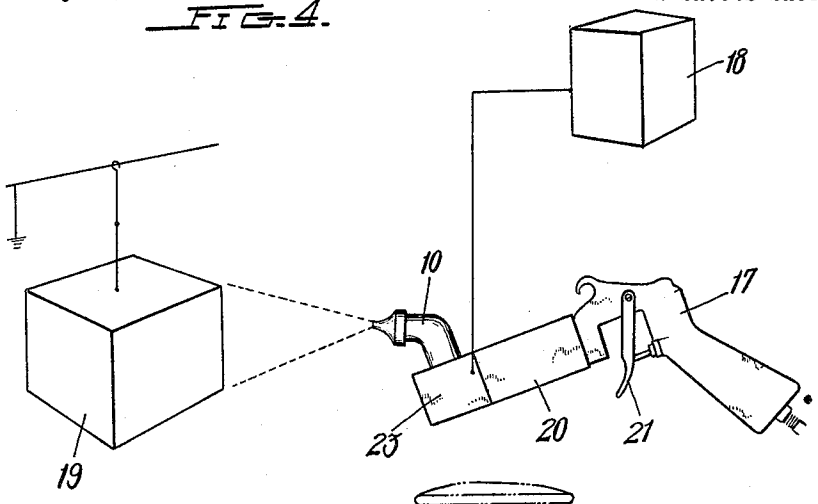


FIG. 5.

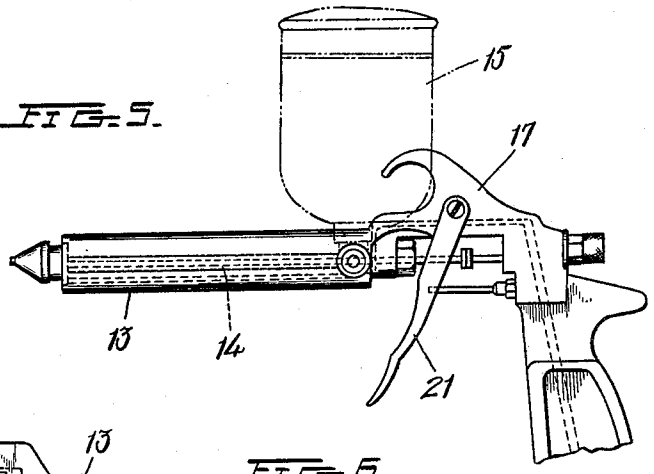
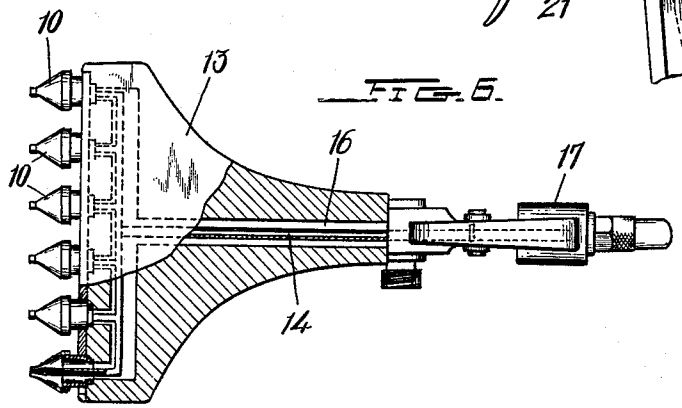


FIG. 6.



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ELECTROSTATIC COATING APPARATUS OF SPRAY-GUN TYPE

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4 Claims. (Cl. 239—15)

This invention relates to electrostatic coating apparatus of spray-gun type characterized in that coating material is atomized by employing compressed air and atomized coating material is deposited on article to be coated by means of electrostatic force.

Inasmuch as coating material particles have an initial velocity of some extent when the material is atomized, a certain proportion of the coating material particles, whose initial kinetic energy exceeds the electrostatic force, fly out of the electrostatic field, causing loss of coating material. In order to prevent this, the spray velocity must be reduced but with nozzles of conventional construction, coating material particles become coarse if the pressure of compressed air is reduced, and the spray volume of coating material will be reduced when nozzles of smaller diameter are used, necessitating a longer period for effecting a desired coating.

An object of this invention is to lower the spray velocity without reducing the spray volume of coating material per unit time, to effect atomization of sprayed coating material particles, to cause substantially all of the coating material to deposit on articles to be coated and to obtain uniformly coated, surfaces irrespective of different shapes of surfaces to be coated.

Another object of this invention is to prevent atomized coating material from flying out of the electric field, and to reduce the loss of coating material by providing a variable spray width and variable spraying positions.

Still another object of the present invention is to lower the velocity of air streams containing sprayed coating material, besides increasing the effect of the adsorbent force of the electric field applied to atomized coating material, and to decrease the volume of coating material flying out of the electric field and to uniformly coat the work surface.

An additional object of this invention is to provide a portable apparatus for electrostatic coating which have a wide use and is suitable to be used at any location such as within or outside of a building or at higher or lower elevations.

Still another object of the invention is to provide an apparatus particularly adapted for electrostatic coating using coating material soluble in water, in order to effect its atomization by compressed air rather than by electric forces.

While electrostatic coating systems wherein pneumatic atomization is employed have a superiority in atomization, the atomized coating material is energized with a certain velocity, they require spray pressures of about 50 lbs., in the case of using an ordinary spray-gun, and needs pressures of approximately 30 lbs. when using a so-called low-pressure gun. In addition, the velocity imparted to the atomized coating material particles by spray pressure is 15 m./sec. at a point 30 cm. from nozzle tip. Accordingly, the percentage of the sprayed coating material deposited on an article to be coated, when the article with an applied voltage of 90 kv. is placed at such a point, is of about the order of 40%, and the remaining 60% is dispersed or deposited on surfaces other than the desired work surface. Also, coating material particles having velocity of about 15 m./sec. cannot be satisfactorily attracted by an electrostatic field even by a strong corona discharge at about 90 kv.

Therefore, in order to assure keeping the atomized coating material under the effect of the electric field, the kinetic energy of coating material particles, due to their initial velocity particles must be kept within values smaller than electrostatic attraction force.

In accordance with the invention, the total volume of coating material to be applied per unit time is divided between a plurality of nozzles the sum of whose discharge rates is equal to the total volume of coating material to be deposited in such unit time. In addition, the total air pressure normally required for properly atomizing such total volume of coating material is divided by the number of such nozzles so that each nozzle has an air pressure effective on the coating material discharged therefrom, of a value equal to the normal total air pressure required for such total volume of coating material divided by the number of nozzles.

The kinetic energe level due to the spray velocity is thus kept lower than electrostatic attraction force; in other words, the requirements of keeping the energy due to spray pressure lower than the electrostatic force can be met, and the spray volume can become the sum total of the spray volumes of the nozzles.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings. In the drawings:

FIG. 1 is a front elevational view of one form of apparatus embodying the invention, shown in the working position;

FIG. 2 is a side elevational view of the apparatus shown in FIG. 1;

FIG. 3 is a part perspective and part schematic view illustrating the operation of the apparatun shown in FIGS. 1 and 2;

FIG. 4 is a view similiar to FIG. 3 illustrating another embodiment of the invention;

FIG. 5 is a side elevational view of another embodiment of apparatus embodying the invention;

FIG. 6 is a part plan and part sectional view of the apparatus shown in FIG. 5; and

FIG. 7 is an enlarged end elevational view of the tip of a nozzle.

Referring now to FIG. 1 and FIG. 4, the apparatus comprises a gun head **13** carrying several nozzles **10** arranged with extremely small central coating material outlets or orifices **11** and peripheral compressed air outlets or orifices **12**. The coating material orifices communicate with a passage **14**, best shown in FIG. 6, extending through the head of the gun and having its outer end connected either to a coating material tank (not shown) disposed independently of the gun and connected to the passage **14** or to a bowl or reservoir **15** which may be mounted on the gun and have its outlet connected to the passage **14**. The air orifices **12** are connected or communicate with a passage **16** extending through the gun head and annularly embracing the passage **14**. The outer end of passage **16** may be connected to a suitable source of air under a relatively low pressure. The gun head **13** is preferably made of dielectric material, while the nozzles **10** are of electrically conductive metallic material.

The fluid coating material, such as paint, lacquer, wax, or the like supplied to the orifices **11** through the passage **14** and discharged from these orifices is atomized by the compressed air jets delivered from the orifices **12** and directed inwardly toward the stream of coating material issuing from each orifice **11**. A high electrostatic potential gradient is provided between the coating apparatus and the work to be coated, such as the article **19**.

When, for example, five nozzles **10** each having a coating material discharge orifice of 0.5 mm. diameter is provided, and these nozzles are supplied with a pressure

of seven pounds per square inch, the coating material is perfectly atomized by air pressure and has a velocity, due to its kinetic energy, at a distance of 30 cm. from the tips of nozzles **10** of 0.5 m./sec. In this case, the volume of coating material sprayed is equal to that sprayed from a single nozzle operating at an air pressure of forty pounds per square inch. Thus, the air stream supporting the atomized coating material has a relatively slow velocity and contains the atomized material in what amounts to being practically a floating state. Thus, when the atomized coating material particles are within the electrostatic field, they are entirely under the influence of this field and are all directed to the work piece **19**.

FIGS. 5 and 6 illustrate a further embodiment of the invention in which a different form of gun head **13'** is provided with several nozzles **10'**, shown as 6 by way of example. As in the embodiment previously described, each nozzle is adapted to discharge a proportionate volume of the coating material and is adapted to have applied thereto a proportion only of the total air pressure. In this embodiment of the invention, a bowl or reservoir **15** is illustrated as being mounted directly upon the gun head **13'** and connected to the passage **14**. In this embodiment, as in the one shown in FIGS. 1, 2 and 3, control of the discharge is effected by a trigger **21** pivoted to the body and operating a suitable valve means.

The electrostatic potential gradient may be applied in different ways. As shown in FIG. 3, the work piece **19** is supported upon a plurality of electrically conductive lug extending from the surface of a dielectric turn table **25** mounted, through the medium of a high voltage insulator **26**, upon a high voltage generator **27**. The generator **27** is connected to the lugs **24** and thus the output potential thereof is supplied to the article **19**. In this case, the gun of FIGS. 1, 2 and 3 is grounded, as schematically illustrated. As shown in FIG. 4, the gun head **23** is insulated from the grip of the apparatus by a piece of dielectric **20**, and is connected to the output of a high voltage generator **18**. Correspondingly, the work piece **19** is grounded as schematically illustrated. If the head **13** is made of dielectric material, as stated, the nozzles **10** may be grounded directly in the arrangement shown in FIG. 3, or may be directly connected to the high voltage generator **18** in the arrangement shown in FIG. 4.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. Electrostatic spray coating apparatus comprising, in combination, a nozzle support body having separate fluid coating material and air passages for respective connection to a source of coating material and a source of air under a preselected relatively low pressure of the order of seven p.s.i.; a plurality of atomizing nozzles on said body having their discharge axes lying in substantially the same plane and substantially parallel to each other for discharge of atomized coating material toward a common work surface; each of said nozzles having a relatively small diameter central orifice of the order of 0.5 mm. connected to said coating material passage and each having air discharge orifice means arranged around said central orifice and connected to said air passage, said air discharge orifice means directing compressed air inwardly toward the fluid coating material discharged from said central orifice to atomize the material solely by compressed air; the value of such low pressure, at nozzles, being of the order of seven p.s.i. and being coordinated with the relatively small discharge area of each of said relatively small diameter central orifices to effect thorough atomization of the coating material discharged therethrough; and means for establishing an electrostatic potential gradient between said nozzles and the work surface to move the thus compressed-air atomized coating material particles to the work surface to coat the latter; the atomized particle velocity, at a selected distance of the order of 30 cm. from the tips of said nozzles, being of the order of 0.5 mm./sec.; the sum of the discharge rates of five of said nozzles being of the order of the discharge rates of a single spray nozzle operating at a nozzle pressure of the order of 40 p.s.i. and with an atomized particle velocity, at a distance of the order of 30 cm. from its tip, of 15 mm./sec.

2. Electrostatic spray coating apparatus, as claimed in claim 1, in which said passages extend coaxially through the support body, one being a central passage and the other being an annular passage surrounding the central passage.

3. Electrostatic spray coating apparatus, as claimed in claim 1, in which said electrostatic potential gradient establishing means comprises a high voltage generator electrically connected to said nozzles, the work surface being grounded; said nozzles being electrically isolated from the remainder of said apparatus.

4. Electrostatic spray coating apparatus, as claimed in claim 1, in which said electrostatic potential gradient establishing means comprises a high voltage generator having its output in electrical connection with the work surface, said nozzles being grounded.

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