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Wagner

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[54] **APPARATUS FOR ELECTRIFIED SPRAYING**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 231,210, March 2, 1972, abandoned.

[52] **U.S. Cl.** ..... **239/15,** 117/93.4 R, 118/621

[51] **Int. Cl.** **B05b 7/08,** B05b 5/02

[58] **Field of Search** ... 239/3, 4, 15; 117/17, 93.4 R; 118/621

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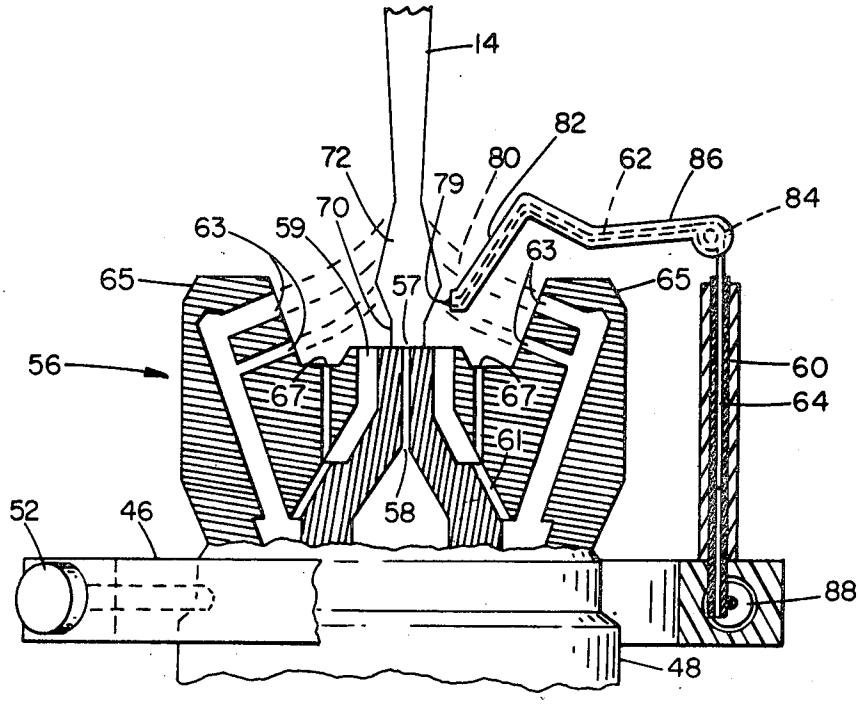
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Primary Examiner—Robert S. Ward, Jr.

[57] **ABSTRACT**

Apparatus for electrified spraying operation and including a power supply with a flow operated switch and an integral assembly with an elongated electrode mounted with an end adjacent to and outside of spray from a spray gun. The electrode is adjustable in position from 0.25 to 1.50 inches from the spray orifice and has a pointed distal end portion extending perpendicularly to the direction of flow of the spray, a sloped portion extending from said end portion laterally and forwardly, and a looped portion for resiliently maintaining the position of the pointed end, with the electrode having an insulating coating over its greater part but with its pointed end bare.

22 Claims, 4 Drawing Figures



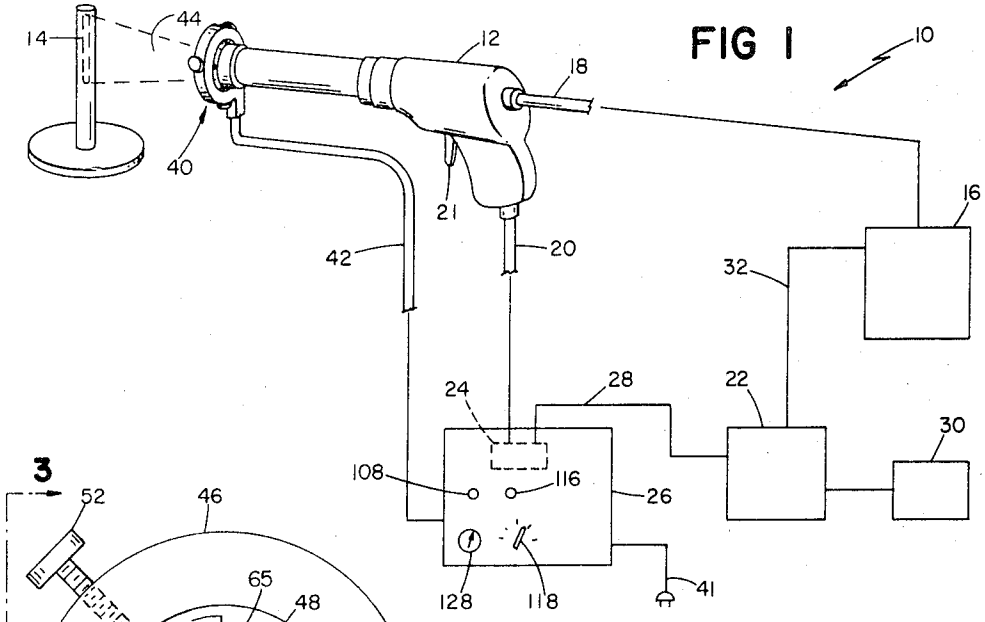


FIG 1

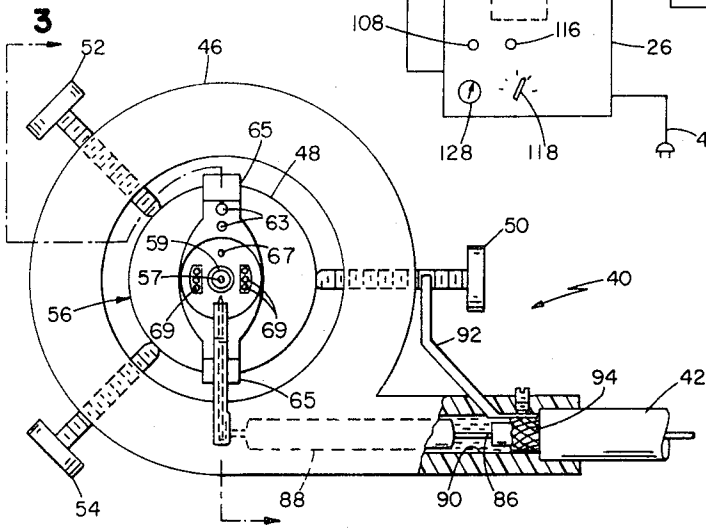


FIG 2

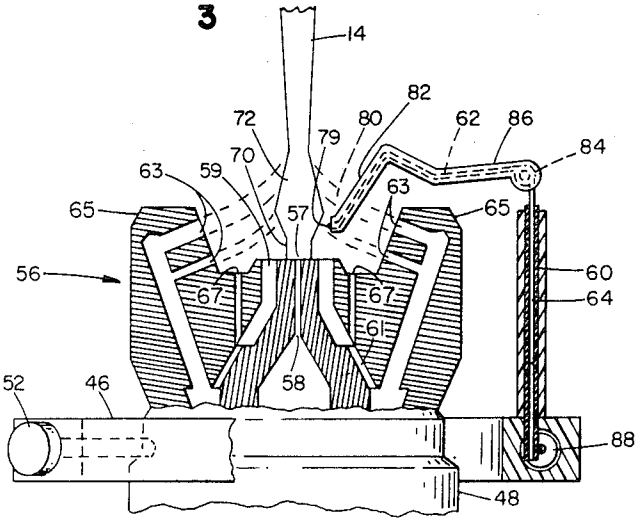
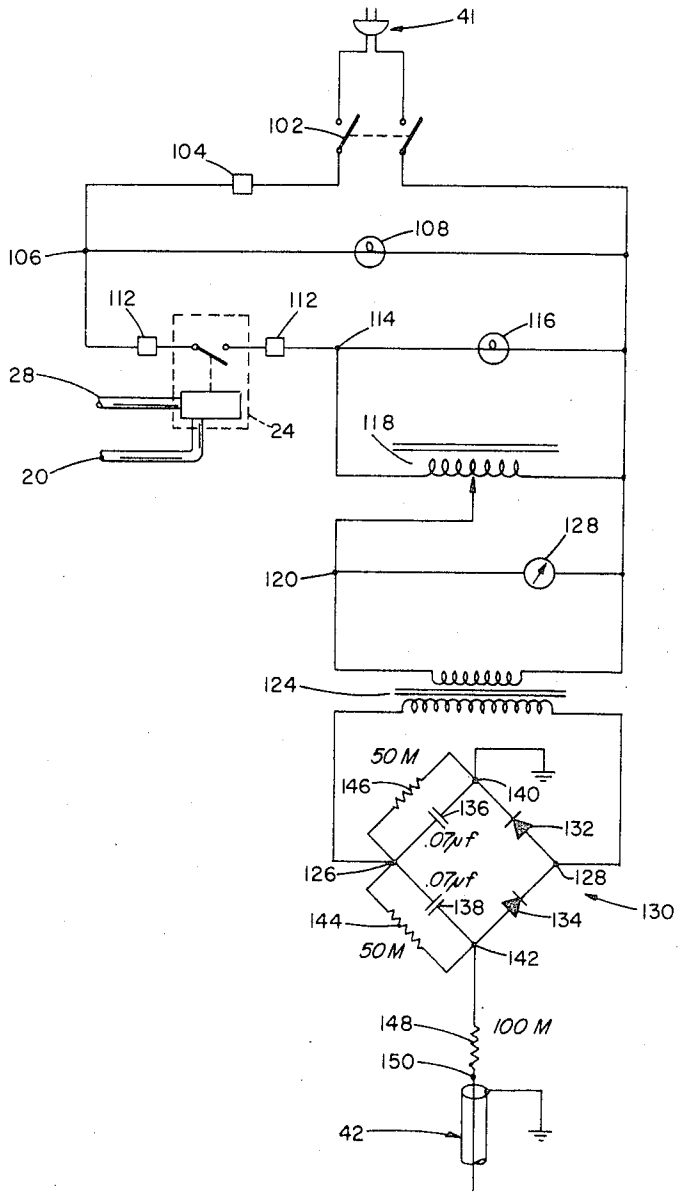


FIG 3

FIG 4


41
102
104
108
106
112
112
114
116
28
24
118
20
128
120
124
50 M
146
140
136
.07μf
132
126
.07μf
128
138
130
144
134
50M
142
148
100 M
150
42

APPARATUS FOR ELECTRIFIED SPRAYING

This application is a continuation-in-part of copending application Ser. No. 231,210, filed Mar. 2, 1972, and entitled "Apparatus For Electrified Spraying"now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to the spraying of coating materials and particularly to electrifying sprays.

Spray guns are frequently used to apply paint or other coating to ware. In this technique the paint is admitted continuously to a spray gun through a hose. The gun comminutes the paint into particles which are directed towards the ware to be coated. Some spray guns effect the comminution by emitting the paint at high pressure from an orifice, this technique often being referred to as pressure atomizing. Other spray guns operate by emitting the paint at lower pressure or by siphon from an orifice while directing at the emerging paint a high speed stream of air from one or more separate nearby orifices, this technique being often called air atomizing.

It is recognized that in certain circumstances it is advantageous to electrify the spray particles. When this is done the trajectories of the electrified particles are modified by electric forces with the result that the coating material is more effectively applied to the ware.

SUMMARY OF THE INVENTION

Objects of this invention include providing an improved electrified spray gun and providing apparatus for converting a spray gun for electrified operation.

It has been discovered that efficient charging of sprayed particles can be achieved by an ionizing electrode without a separate collector electrode, provided the discharge electrode is pointed at the spray at a point where the particles have been atomized substantially to their smallest size and prior to dispersal to a degree at which charging efficiency is significantly reduced. In air atomizing, employing second stage atomization, the electrode is pointed at the zone of second stage atomization. In pressure atomizing the electrode is pointed at the spray in a zone, similar to the second stage atomization zone, in which the particles have broken to substantially their smallest size but before significant dispersal.

In general the invention features the improvement in electrified spray guns wherein an electrode is supported at a proximal end on the body of the gun and supports a sharply pointed distal end in a position forward of the spray orifice and adjacent to and outside of the spray pattern pointed generally perpendicular to the direction of spray flow. The electrode is positioned from 0.25 to 1.50 inches forward of the spray orifice, preferably between 0.25 and 0.875 inches forward thereof, at the second stage atomization zone of an air atomizing sprayer with the electrode in the air stream. A preferred embodiment additionally features an adjustable electrode, a sloped portion extending from said end portion laterally and forwardly, and a looped portion for resiliently maintaining the position of the pointed end, with the electrode having an insulating coating over its greater part but with its pointed end bare.

The invention features in a preferred embodiment an integral assembly including a jig, an elongated electrode mounted on the jig to be positioned with an end adjacent to spray from the spray gun when the assembly is attached to the gun, an electric cable affixed to the jig and connected to the electrode to pass current from the cable to the electrode, and means mounted on the jig for affixing the assembly to and removing the assembly from the gun, and a power supply for supplying an electrical output for electrifying the electrode, the power supply including means for connecting the output to the cable, and a switch connected to control the output. A specific embodiment features a fluid-flow responsive switch controlling the electrical power supply, adjusting means for adjusting the electrode in its position relative to the spray, means for varying the voltage of the electrical power supply, and a current limiting resistor mounted on the jig.

In another aspect the invention features, in a preferred embodiment, a power supply with circuitry for providing electric power for electrifying a spray comprising in combination first circuit portion including a flow-responsive switch operatively connected to a flow channel to close when fluid flows in the channel and to open when fluid does not flow in the channel, the flow-responsive switch being connected in series to receive power from power mains and provide switched power to a first terminal, a variable output transformer connected to draw power from the first terminal, and providing a controllable voltage to a second terminal, a voltmeter connected to indicate the voltage across of the second terminal, a step-up transformer connected to draw power from said second terminal and provide an output across a pair of ungrounded terminals, a circuit loop comprising two diodes and two capacitors connected in a loop with the diodes head to tail, the loop connected to the ungrounded terminals at a first junction between the diodes and at a second junction between the capacitors, each of the capacitors having a resistor connected in parallel thereto, the loop having a ground connection at a third junction between a capacitor and a diode, the diode being connected to deliver current to the third junction, a negative voltage output terminal connected through a current limiting resistor to a fourth junction of the loop, a diode of the loop being connected to draw current from the fourth junction.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows partly in perspective view and partly schematically apparatus according to the invention in operation.

FIG. 2 shows at enlarged scale a front view of the spray gun and conversion assembly shown in FIG. 1, some parts being cut away to reveal interior parts.

FIG. 3 shows in partial longitudinal section the front portion of the gun and conversion assembly shown in FIG. 1, the section being that designated 3—3 of FIG. 2.

FIG. 4 shows a circuit schematic drawing of the power supply shown in FIG. 1.

DESCRIPTION OF PREFERRED EMBODIMENT

Apparatus 10 according to the invention is shown in FI. 1. The apparatus includes air atomizing spray gun 12 which is shown applying a coating of paint to ware 14. Paint from paint reservoir 16 is supplied to gun 12 through paint line 18. Compressed air, the operating fluid in this type of gun, for atomizing the paint is sup-

plied to gun 12 through operating fluid conduit 20, flow-responsive switch 24 of electrical supply 26, and operating fluid conduit 28 from air plenum 22 supplied by compressor 30. Trigger 21 controls the flow of both paint and air through gun 12. Air plenum 22 is also connected to supply reservoir 32 with compressed air to propel paint through line 18. Electrifying conversion assembly 40 is affixed to the front portion of gun 12. Electrical supply 26 draws power from conventional power mains through plug 41 and supplies power to assembly 40 through cable 42. The flow of power to cable 42 is controlled by flow sensitive switch 24. An atomized spray of electrified paint particles is propelled from the front of gun 12 through space 44 to ware 14. The forward portion 56 of gun 12 as shown in detail in FIGS. 2 and 3, includes central paint orifice 57 supplied by paint passage 58, concentric, annular air orifice 59 supplied by air passages 61, and side air orifices 63 on air horns 65. Containment orifices 67 in line with air horns 65 and angular converging orifices 69, 90° from orifice 67, are also provided on the forward portion 56 of gun 12 and are supplied by passages 61. Orifices 69 are directed at a converging angle to the axis of orifice 57. The rearward portions of gun 12 are conventional, and since they are well known to those skilled in the spraying equipment art they need not be further described here. When gun 12 is in operation, paint issues from orifice 57 and is initially broken up in zone 70 by the influence of an air jet issuing from orifice 59, zone 70 sometimes being referred to as the zone of first stage atomization. The paint is then further broken up in zone 72 by the influence of air issuing from orifices 69, zone 72 sometimes being referred to as the zone of second stage atomization. The second stage atomization zone is defined by the zone of impingement of air from orifices 69 on the spray of paint. The air from orifices 63 contributes to second stage atomization and also shapes the spray into a fan pattern with a plane generally perpendicular to that of the paper as viewed in FIG. 3.

Converter assembly 40, shown in detail in FIGS. 2 and 3, includes jig 46 made of electrically nonconductive material such as nylon. Jig 46 has a generally ring-like form and fits in a generally concentric spaced relation around the front portion of body 48 and gun 12. The spacing between jig 46 and body 48 permits necessary airflow along the forward portion 56 of gun 12. Cinch screws 50, 52, and 54, of which at least screw 50 is metallic, are threaded through jig 46 and permit assembly 40, including jig 46 and all components mounted thereon, to be attached as an integral unit to gun 12. Conductive metallic friction tube 60 is mounted on jig 46, extending forwards therefrom. Electrode 62 has a shank portion 64 that fits within and frictionally engages tube 60 so that, while generally supported in the tube, the electrode may be slid forward or backward, tube 60 and electrode shank 64 together comprising adjusting means for the electrode 62, Electrode 62 has a sharply pointed distal end 79 positioned forward of paint orifice 58 opposite to the second stage atomization zone 72 and advantageously in a jet from an orifice 63. The adjusting means permits adjustment of pointed distal end 79 forward of orifice 57 to maintain its position opposite the second stage atomization zone and for optimizing the position thereof at such zone, the position of distal end 79 being adjustable between about 0.25 and 1.50 inches forward of orifice 57 and preferably between about 0.25 and 0.875 inches forward thereof. Electrode 62 has a distal end portion 80 extending and directing pointed distal end 79 perpendicularly to the direction of flow of the spray, this orientation having been found to give the best results in coating ware. A sloped portion 82 extends laterally and forwardly from portion 80. The end portions 80 and 82 are attached to shank portion 64 through a resilient looped portion 84. The major portion of electrode 62, but not end 79, which is left bare, is covered with an insulating coating 86, which minimizes the chance of inadvertant contact by operating persons with the electrode. Tube 60 is similarly covered. Cable 42 is secured to jig 46. Resistor 88 (100 megohms in preferred embodiment) is mounted on jig 56 in cavity 90 with one terminal connected to the bottom of tube 60 and the other terminal connected to the central conductor 86 of cable 42. The resistor 88 is placed close to the electrode to minimize the effective capacitance of the cable 42 that can discharge without the limiting effect of the resistor. Conductive link 92 is electrically connected between ground shield 94 of cable 42 and screw 50 so that an electrical path is maintained from the ground shield through link 92 and screw 50 to the body 48 of the spray gun.

Power supply 26, the wiring diagram for which is shown in FIG. 4, includes main switch 102 connected to the power line and fuse 104 connected in series with switch 102 to provide fused switched power at terminal 106. Light 108 indicates excitation of terminal 106. Flow responsive switch 110 and current limiting resistors 112 are series connected from terminal 106 to supply operationally switched power to terminal 114. Switch 24 is connected (in a piping rather than an electrical sense) to conduits 20 and 28, and operates to close its electrical contacts when flow occurs from conduit 28 to conduit 20, and open them when there is no such flow. Light 116 indicates excitation of terminal 114. Adjustable autotransformer 118 is connected to terminal 114 to provide adjustable voltage output to terminal 120. Meter 122 indicates the voltage present on terminal 120. Step-up transformer 124 is connected to terminal 120 to provide a high voltage output across terminals 126 and 128. The voltage across terminals 126–128 may be adjusted by manipulating transformer 118 to any value less than 10 KV. Circuit loop 130, made up of diodes 132 and 134 and capacitors 138 and 136 connected serially in a loop with the diodes head to tail, is connected across terminals 126 and 128, terminal 126 being at the junction between capacitors and terminal 128 being at the junction between diodes. The diodes are connected to draw current from junction 142 and to deliver current to junction 140. Resistors 144 and 146 are connected in parallel across capacitors 138 and 136 respectively. Junction 140 is grounded and junction 142 is connected through limiting resistor 148 to output terminal 150 connecting with and supplying a high voltage of negative polarity to the center conductor of cable 42, the outer conductor of which is grounded.

In operation, conversion assembly 40 is affixed to gun 12 by placing it around the forward portion of the gun and advancing screws 50, 52, and 54 to lock jig 46 to body 48 of the gun. The assembly should be oriented so that electrode 62 opposes the flat side of the spray if there is such. Operating fluid conduits 20 and 28 are connected so as to pass air through switch 24 on its way

from the air supply plenum to the gun. Gun **12** is then put in a spraying condition, and with visual inspection the position of tip **79** of electrode **62** is adjusted by sliding the electrode shank **64** in tube **60** so that the electrode tip is outside the spray opposite the second stage atomization zone and in a jet from an orifice **63.** In no event should the electrode be closer to orifice **57** than about 0.25 inches to avoid shorting the system. Preferably, the electrode is from 0.25 to 0.875 inches forward of the orifice at the second stage atomization zone where the particles of paint are smallest but before they have dispersed to the point where electrification efficiencies are reduced. Ordinarily the electrode position will be adjacent that portion of the second stage atomization zone closest to orifice **57,** but in some instances greater distances, as much as 1.5 inches from orifice **57,** may be used, such greater distances having been found useful in siphon feed systems. After this adjustment the power supply is connected to the line and switched on. It may be noted that prior to actuation of the gun by depressing trigger **21** air does not flow, so that switch **110** is open and no electrical output is delivered to cable **42** by the power supply. Upon depression of trigger **21** by an operator, valves are opened in the gun to permit the flow of paint and air and a spray is formed in region **44.** (Usually in an air atomizing gun the valves are arranged so that the air begins to flow slightly before the paint.) The flowing air causes switch **110** to close, applying power to terminal **114** with the result that a negative voltage in the kilovolt range is applied through cable **42** to electrode **62.** When thus electrified, electrode end **79** discharges electrons which become attached to particles of the spray giving them a net negative charge. Electric forces arising from the charges on the particles modify the spray particle trajectories to increase the coverage of the ware. The electrode, being positioned wholly outside the spray collects little of the sprayed material and such as does collect from stray drops is blown away from end **79** along sloped portion **82** so that the point remains clean and any material impinging on the electrode finally drops off the electrode from a region out of the air blast and is not carried to the ware. The space between assembly **40** and gun body **48** permits a flow of air therethrough induced by the spray motion. It has been found that this airflow is beneficial to the electrification of the spray and improves operation of the apparatus.

The voltage control of transformer **118** and the position of electrode **62** can be readily adjusted to obtain optimum coating results and to accommodate to the properties of various paints and other coating materials.

What is claimed is:

1. In a spray gun for producing an atomized spray in a pattern forward of said gun, said gun including a body with first passages therethrough for supply of material to form said spray, said gun including second passages for emission of jets of air impinging on said spray to effect a fan-shaped spray pattern and defining at the positions of impingement of said air on said spray a zone of second stage atomization, an orifice in said body for the issue of said material from said gun, and an elongated electrode adapted for connection to electrification means for electrifying particles of said spray,

that improvement in which said electrode is supported at a proximal end by said body and supports a distal end portion having a sharply pointed distal end in a position spaced adjacent a flat portion of said fan-shaped spray pattern pointed at said zone of second stage atomization between about 0.25 and 1.50 inches forward of said orifice, said pointed distal end adjacent to and outside of said spray pattern and pointed generally perpendicular to the direction of flow of said spray.

2. Apparatus as claimed in claim **1,** said improvement including adjusting means supported by said body for adjusting said pointed distal end along the direction of spray motion in its said position forward of said orifice.

3. Apparatus as claimed in claim **2** in which said position of said pointed distal end is between about 0.25 and 0.875 inches forward of said orifice.

4. Apparatus as claimed in claim **2,** said adjusting means including a hollow tube supported on said body with a portion of said electrode fitting therewithin and frictionally engaged thereto to permit sliding motion between said tube and said electrode portion.

5. Apparatus as claimed in claim **4** in which said position of said pointed distal end is between about 0.25 and 0.875 inches forward of said orifice.

6. Apparatus as claimed in claim **1,** said electrode including contiguous to said distal end portion a sloped portion extending from said end portion laterally and forwardly.

7. Apparatus as claimed in claim **1,** said electrode including a looped portion for resiliently maintaining the position of said pointed distal end.

8. Apparatus as claimed in claim **1,** said electrode having an insulating coating around a major portion thereof, said distal end being bare.

9. Apparatus as claimed in claim **1,** said pointed distal end being positioned to be in one said jet pointed at said zone of second stage atomization.

10. Apparatus as claimed in claim **9** in which said position of said pointed distal end is between about 0.25 and 0.875 inches forward of said orifice.

11. Apparatus as claimed in claim **10,** said pointed distal end being pointed at the portion of said zone of second stage atomization adjacent said orifice.

12. In apparatus for converting a spray gun for electrified spraying operation, said spray gun having an orifice adapted for issuing atomized spray from said gun, said gun also having passages for emission of jets of air impinging on said spray to effect a fan-shaped spray pattern and defining at the positions of impingement of said air on said spray a zone of second stage atomization, said apparatus comprising an integral assembly including a jig, an elongated electrode mounted on said jig for positioning an end thereof adjacent to spray from said spray gun when said assembly is attached to said gun, an electric cable affixed to said jig and connected to said electrode to pass current from said cable to said electrode, and means mounted on said jig for affixing said assembly to and removing said assembly from said gun,

that improvement in which said electrode is supported at a proximal end by said jig and supports a distal end portion having a sharply pointed distal end adjacent to and outside of said spray pattern adjacent a flat portion thereof and pointed generally perpendicular to the direction of flow thereof and in which adjusting means is supported by said jig for adjusting the position of said pointed distal end along the direction of spray motion to a dis-

tance between about 0.25 and 1.50 inches forward of said orifice pointed at said zone of second stage atomization adjacent said flat portion of said spray pattern.

13. Apparatus as claimed in claim **12** including a power supply for supplying an electrical output for electrifying said electrode, said power supply including means for connecting said output to said cable and a switch connected to control said output, a conduit connected to said gun for supplying said gun with an operating fluid, said switch being a fluid-flow responsive switch and including means for connecting said switch to said conduit to make said switch responsive to flow in said conduit.

14. Apparatus as claimed in claim **12** in which said distance is between about 0.25 and 0.875 inches forward of said orifice.

15. Apparatus as claimed in claim **12,** said adjusting means including a hollow tube affixed to said jig with a portion of said electrode fitting therewithin and frictionally engaged thereto to permit sliding motion between said tube and said electrode portion.

16. Apparatus as claimed in claim **12,** said electrode including contiguous to said distal end portion a sloped portion extending from said end portion laterally and forwardly.

17. Apparatus as claimed in claim **12,** said electrode including a looped portion for resiliently maintaining the position of said pointed distal end.

18. Apparatus as claimed in claim **12,** said electrode having an insulating coating around a major portion thereof, said distal end being bare.

19. Apparatus as claimed in claim **12,** including a resistor mounted on said jig and connected to said cable and said electrode to pass current from said cable to said electrode.

20. Apparatus as claimed in claim **12,** said jig being of ring-like form and of a size to be radially spaced from said gun when said assembly is attached to said gun.

21. Apparatus as claimed in claim **12,** said cable including a metallic shield, and including an electrical connector mounted on said jig to establish grounding contact between said shield and said gun when said assembly is affixed to a metal gun.

22. Apparatus as claimed in claim **13** said power supply including means for varying the voltage of said electrical output.

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