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2,959,353

ELECTROSTATIC CHARGER APPARATUS

Filed Oct. 4, 1954

2 Sheets-Sheet 1

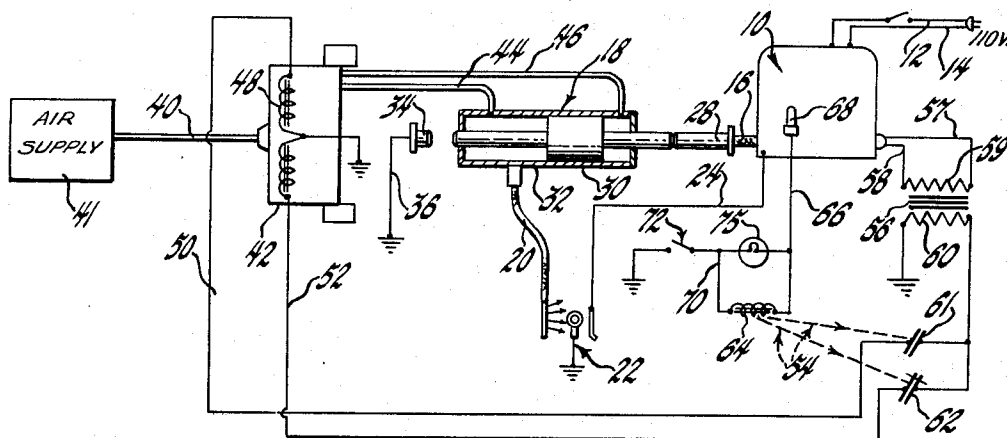


Fig. 1

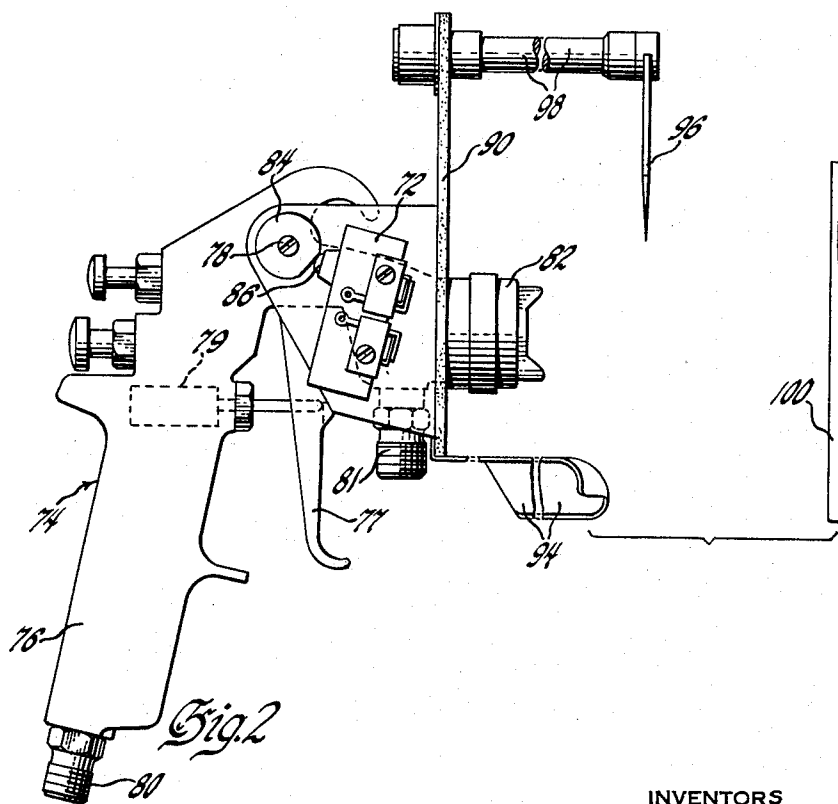


Fig. 2

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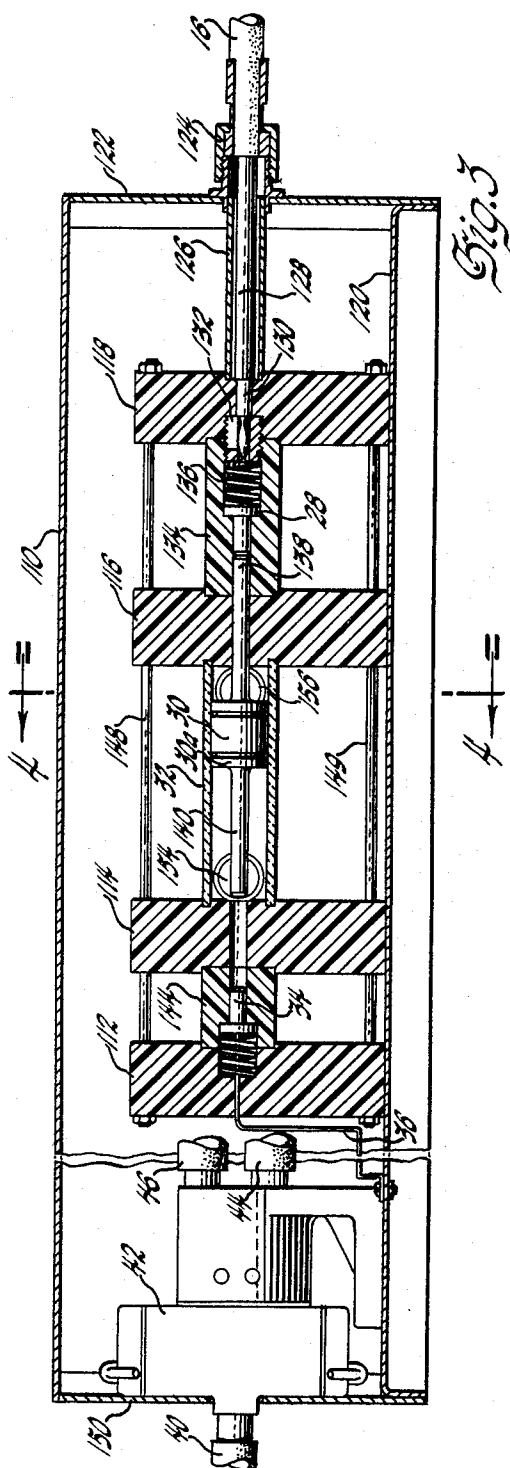


Fig. 3

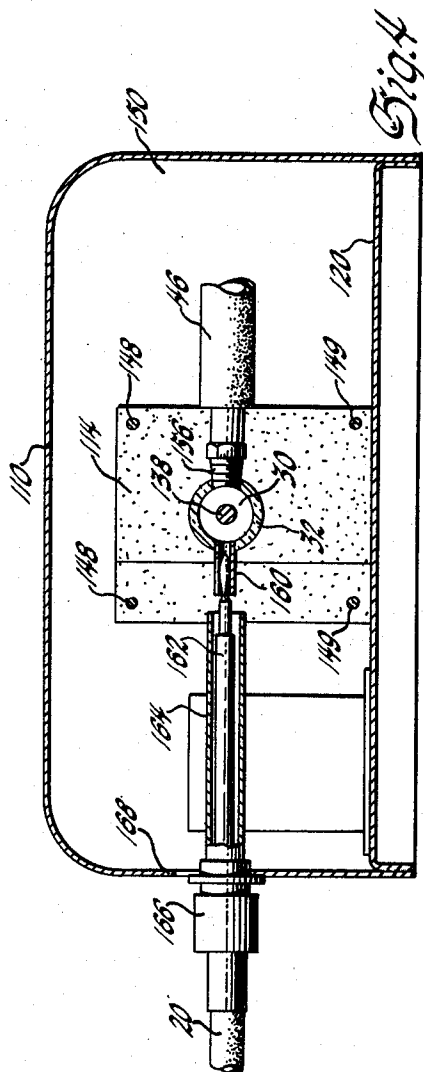


Fig. 4

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ELECTROSTATIC CHARGER APPARATUS

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8 Claims. (Cl. 239—15)

This invention relates to electrostatic charging apparatus for charging particles of coating material and, more particularly, to electrostatic hand spray coating installations and to a high tension circuit breaker and associated control therefor.

In one aspect of the present invention, the invention has for an object to provide an improved electrostatic hand spray installation which, by reason of the form of charging system employed therein, enables the use of a comparatively low voltage and current for charging particles of coating material without danger of harm to the operator.

In another aspect, the invention has for an object to provide an improved electrostatic hand spray installation in which the intensity of the electrostatic field and the particle charging efficiency are independent of the distance of the charging electrode and/or the operator from the articles to be coated.

In a related aspect, the invention has for another object to provide an improved electrostatic hand spray installation in which the operator, spray gun and charging system may be located beyond the range of backspray from the articles and which permits the operator to be removed sufficiently from the articles so as to avoid the need for special protective structures limiting the approach of the operator to the article.

Still another object is to provide an improved electrostatic hand spray installation having a common operating source located at the gun for controlling both the flow of particles of coating material and the remote application and interruption of the high tension voltage to the charging or depositing electrodes.

A further object is to provide an improved form of high tension breaker and remote operated control therefor specially suited for use with high tension power supplies as are employed in electrostatic coating installations and which features special provisions for efficient operation of the system and adequate safeguards to protect the operator from the hazards incident to manual operation of devices of this character.

The above and other objects, together with the features and advantages attending the present invention, will appear more fully from the following detailed description and drawings wherein:

Fig. 1 is a schematic and diagrammatic illustration of a circuit breaker and associated control in accordance with the present invention for an electrostatic spray painting installation;

Fig. 2 illustrates a spray gun and a form of electrostatic paint charging system including a portion of the control apparatus of the present invention;

Fig. 3 is a sectioned elevation view of an electric circuit breaker in accordance with the present invention; and

Fig. 4 is a transverse view taken in the direction 4—4 of Fig. 3.

Referring to Fig. 1 of the drawings, there is shown a high voltage power supply unit 10, which is energized

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from a local alternating current source of supply over conductors 12 and 14. The output of the power supply may be in the order of, say, 40 kilovolts, and is applied over cable 16 through an air actuated circuit breaker, indicated generally at 18, to cable 20. Cable 20 is connected to one of the charging electrodes of an electrostatic spray painting charging system 22, the other element of which is connected back to the power supply unit over conductor 24. The power supply unit 10 may be of the R.F. oscillator type shown in copending United States application, Serial No. 234,312, filed June 29, 1951, in the names of Grayland T. Larsen and Arthur T. Lausten, assigned to the present assignee, and is preferably provided with the current limiting arc preventing feature of that application.

The circuit breaker 18 comprises, in general, a stationary high voltage contact 28, a piston or slide rod 30, a conducting cylinder 32 that surrounds the piston and a ground stop contact 34 which is connected to ground over conductor 36. The piston 30 is actuated from a source 41 of compressed air supplied through an airline 40 to a solenoid-actuated air valve 42 through which the air is selectively applied to either one of a pair of airlines 44 and 46 that communicate with the cylinder 32 on opposite sides of the piston 30.

The valve 42 is actuated by a low voltage split solenoid coil 48 which is selectively electrically energized over conductors 50 and 52 through the contacts of a low voltage control relay 54 from a step-down transformer 56 connected to the local alternating current supply. A jumper (not shown) within the housing of the power supply unit 10 connects line conductors 12, 14 to conductors 57, 58, which are shown connected to the primary winding 59 of the step-down transformer 56, the high or ungrounded side of the low voltage secondary winding 60 of which is shown connected to the branched solenoid conductors 50 and 52 through a normally open set of contacts 61 and a normally closed set of contacts 62 of the control relay 54. One side of the actuating coil 64 of the control relay 54 is connected in an energizing circuit which includes conductor 66 connected to the positive six-volt side of the filament of one of the low voltage operating tubes, such as the oscillator tube 68, contained within the power supply 10. The other side of the control relay coil is connected by conductor 70 to ground through a micro-switch 72 that is mounted on the handle of the spray gun 74 grasped by the operator. A pilot light 75 may be connected across the actuating coil of the control relay to indicate the closed condition of the switch 72, which may be of the common snap-action over-center variety.

The spray gun shown in Fig. 2 is of a common commercially available variety and is provided with a handle 76 and a manually operated trigger 77 that is pivotally mounted on a pivot shaft 78 which passes through the body of the gun. Trigger 77 actuates a needle valve 79 contained within the gun and simultaneously controls the flow of atomizing air and paint which are admitted to the gun through air and paint supply lines 80 and 81, respectively. The paint or coating material is ejected in particle form from the nozzle or spray tip 82 of the gun which may be grounded.

In accordance with one aspect of the present invention, the pivot shaft 78 for the gun trigger 77 mounts a cam 84 thereon which actuates the movable actuating element 86 of the micro-switch 72 also mounted on the gun, whereby both the flow of the material to be deposited and the operation of the circuit breaker 18 are controlled from a common operating source. The cam 84 is adjustable and may be so mounted on pivot shaft 78 relative to the actuating element 86 of the micro-switch as to

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actuate the latter upon the initial movement of trigger 77 to cause the application of the high tension voltage to the electrodes of the particle charging system slightly in advance of the commencement of the flow of the particle spray from the gun.

As best shown in Fig. 2, the nozzle end of the spray gun extends through an opening in an insulating shield 90, which is detachably secured to the gun and located between the handle and the spray tip thereof. Fastened to one edge of the shield and extending in the forward direction of the spray from the gun is a broad flattened current collector electrode 94 which constitutes one of the electrodes of a portable electrostatic charger system in accordance with the present invention. The other electrode is constituted by a plurality of elongated attenuated or needle-like discharge electrodes 96 which are spaced from and are contained in a transverse plane extending generally normal to collector electrode and to the direction of the particle travel from the gun, which may be connected to ground as shown in Fig. 1. The needle electrodes are mounted in a suitable support 98, shown carried by and extending forwardly of the shield 90, and are adapted to be connected to the high tension breaker cable 20. Cable 20 may be of the rubber-covered coaxial variety and is brought into the charging system for connection to the discharge electrodes rearwardly of the gun to prevent the cable from being coated with paint from the gun. Conductor 24 may be rubber covered braided conductor that connects collector plate 94 back to the power supply unit 10 and may be at or a few volts above ground potential.

The spacing between the discharge electrodes 96 and the collector electrode 94 of the charging system employed in the present invention is in the order of some 2½ inches and permits the use of a potential for the ionizing electrostatic field that is established between these electrodes in the order of 37 to 42 kilovolts at an operating current of around 40 microamperes. This magnitude of potential is considerably lower than that required by other electrostatic depositing installations in which the electrostatic depositing field is formed between a discharge electrode located immediately forward of the gun and the article or workpiece to be coated located some 10 to 12 or more inches distance therefrom. Systems of the latter character require electrostatic field potentials upwards of 100,000 volts at operating currents in the neighborhood of 200 microamperes, which are in a range likely to cause serious bodily harm to the operator who must be located close to the discharge electrode and workpiece for satisfactory operation of systems of this character. In the present system, the workpiece 100 forms no part of and is contained entirely outside of the electrostatic charging field of the charging system employed herein so that the operator may be located sufficiently distant from the workpiece to avoid backspray from and contact therewith without loss of painting efficiency. In fact, it has been found that by locating the operator and spray gun further away from and to one side of the workpiece, the paint tends to be deposited more uniformly and to wrap more completely around the back surface of the articles to be coated.

The application of a high difference of potential between the discharge needles and the collector electrode effectively ionizes the atmosphere therebetween causing an electric wind in the form of a corona point discharge to emanate from the discharge needles. This discharge extends a short distance from the needles—toward but less than the distance from the tips of the needles to the collector electrode—and effectively places a very high charge concentration on the surface of the particles of coating material. This charge is substantially constant and independent of the location of the spray gun from the articles to be coated.

The breaker 18 of the present invention is shown more

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fully in Figs. 3 and 4 and comprises a cabinet housing 110 containing a plurality of spaced support blocks 112, 114, 116, 118 which are mounted on the base 120 of the housing, substantially as shown. The support blocks are composed of suitable insulating material such as polystyrene. Mounted in an end wall 122 of the breaker housing is a coaxial cable connector 124 for the coaxial cable 16 from the power supply unit 10. The end of the connector within the housing receives one end of a polystyrene tube 126, the other end of which is seated in a shallow counterbore provided in one face of block 118. Tube 126 surrounds a central conductor 128 which is connected at one end to the central conductor of the cable 16 and has a banana type connector plug 130 at the other end thereof contained within a bore extending through block 118. Plug 130 is received in a mating jack 132, one end of which is threadably received within a counterbore on the side of block 118 opposite tube 126 and whose other end is threadably received in a bored opening in a polystyrene tube 134 which is seated in shallow counterbores provided in the adjacent faces of blocks 116 and 118, as shown. Tube 134 contains the high voltage contact 28 of the circuit breaker, which contact is spaced from jack 132 by spring 136, and is adapted to contact one end 138 of the piston 30. The end 138 of the piston 30 extends through a bore in block 116 and into the bore of tube 134, substantially as shown.

This piston is slidably contained within the conducting cylinder 32 the opposite ends of which are seated in annular grooves provided in adjacent faces of support blocks 114, 116. Piston 30 is shown as having an enlarged central portion 30a, which is piloted within the cylinder 32, and a reduced end portion 140 which is adapted to enter and slide in a bore extending through block 114. Seated in shallow counterbores formed in adjacent faces of blocks 114 and 112 is another polystyrene tube 144 which mounts the spring biased ground contact 34 that is connected to ground over conducting bus 36. The support blocks and tubes of the breaker assembly are rigidly secured together as by tie bolts 148 and 149.

The walls 150 of the breaker housing 110 receives the air inlet line 40 through an opening therein adjacent the inlet to the air valve 42, which may be a type EV-5A Electroaire four-way valve operated from a 110 v.-10 v. step-down transformer as manufactured by the Bellows Manufacturing Company, of Akron, Ohio. The two outlets of the valve are connected by appropriate lengths of rubber hose or flexible tubing 44 and 46 to openings 154 and 156 in the cylinder 32 on opposite sides of the piston 30. The air inlet line 40 may be provided with an appropriate shut-off cock valve, filter, pressure reducer, pressure gauge and lubricator in accordance with conventional practice.

As shown in Fig. 4, the cylinder 32 is conductively connected by a banana plug and jack 160 to a conductor 162, which extends centrally through a polystyrene tube 164 and is connected to a coaxial cable connector 166 contained in the front wall 168 of the cabinet housing. Connector 166 is connected to the coaxial cable 20 leading rearwardly to the needle-like discharge electrodes 96 of the charging system located at the gun.

In the operation of the system, inward movement of the trigger 77 by the operator initiates the flow of paint in atomized spray form from the gun and completes an energizing circuit for the coil 64 of the control relay 54 from the low voltage section of the power supply. Energization of the relay closes contact 61 and opens contact 62 thereof to complete a low voltage energizing circuit from the secondary of transformer 56 over conductor 50 to the advance coil or upper section of the solenoid 48 in valve 42, which is then actuated to supply air from line 40 to air hose 44 communicating with the left side of the

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piston 30 in the cylinder 32 and causes the piston to move rapidly to the right to engage high voltage contact 28. This completes the high potential circuit for the electrodes of the particle charging system from the output of the power supply 10, conductor 16, breaker contact 28, piston 30, cylinder 32, coaxial cable 20, the discharge needles 96, the ionized zone between discharge needles and the collector plate 94, and back to the power supply over conductor 24. When the trigger of the spray gun is released, the actuating coil of relay 54 is de-energized, which causes relay contacts 61 to open and contacts 62 to close, the latter establishing an energizing circuit for the retract or lower section of the solenoid coil 42. Air is then supplied to the right side of the breaker piston which then moves to the left to break the circuit at contact 28.

Since the coaxial cable 20 from the breaker to the discharge electrodes of the particle charging system carried by the spray gun may be of considerable length, a substantial amount of high potential energy will be stored within the coaxial cable by the capacitance effect thereof. This energy will remain on the cable for some time even after the system has been disconnected from the 110 v. line. So that the operator may safely handle the electrodes, as for example when it is desired to disassemble the charger from the gun for cleaning after a period of use, the breaker of the present invention provides for rapid dissipation of the energy stored on the cable by connecting the cable 20 to ground through the cylinder 32, piston 30 and ground contact 34 when the trigger 77 is released.

It will be noted also that the breaker 18, which is of the S.P.D.T. variety, is located in the output of the high tension power supply 10 and that its operation will not affect the condition of energization of the power supply which will be ready to deliver its full-rated output at all times and differs from those installations in which the entire power supply unit is de-energized to control the application and interruption of the high tension voltage to the electrodes of the charging or depositing system.

What is claimed is:

1. In an electrostatic coating installation for spraying an article to be coated and including an electrically grounded spray gun projecting particles of coating material for deposition on said article, means enhancing the deposition of said particles including discharge electrode means between said spray gun and said article and power supply means supplying a high tension output voltage to maintain said discharge electrode means at a high absolute potential relative to ground, the combination of a high tension circuit breaker having a movable operating member directly electrically connected to said discharge electrode means and operable between a pair of contact positions one of which is electrically connected to the output of said power supply means and the other to ground, and means controlling the operation of said circuit breaker.

2. In an electrostatic coating installation for spraying an article to be coated and including an electrically grounded spray gun projecting particles of coating material for deposition on said article, means enhancing the deposition of said particles including discharge electrode means between said spray gun and said article and power supply means supplying a high tension output voltage to maintain said discharge electrode means at a high absolute potential relative to ground, the combination of a high tension circuit breaker having an operating member movable between a pair of contact positions and a coaxial cable directly connecting said movable operating member to said discharge electrode means, said operating member being connected in one of said contact positions to the output of said power supply means and in the other contact position to ground.

3. In an electrostatic spray coating installation for spraying an article to be coated, the combination of a spray gun projecting particles of coating material in a

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path directed generally toward said article for deposition thereon, means enhancing the deposition of said particles on said article including discharge electrode means and current collector electrode means on the opposite sides of the path of said particles projected from said spray gun and located between the spray gun and the article to be coated, power supply means supplying a high tension output voltage for application between said discharge electrode means and said current collector electrode means, high tension circuit breaker means connected in circuit controlling relation in the output of said power supply and connected directly to said discharge electrode means, control means for said circuit breaker including a remote control element located at said gun and a common operating member on said gun for controlling both the flow of particles projected from the gun and the remote operation of said circuit breaker.

4. In an electrostatic spray coating installation for spraying an article to be coated, the combination of a spray gun projecting particles of coating material in a path directed generally toward said article for deposition thereon, means enhancing the deposition of said particles on said article including discharge electrode means and current collector electrode means on opposite sides of the path of said particles projected from said spray gun and located between the spray gun and the article to be coated, power supply means supplying a high tension output voltage for application between said discharge electrode means and said current collector electrode means, a high tension circuit breaker having a movable member electrically connected directly to said discharge electrode means and operable between a pair of contact positions one of which is electrically connected in the high tension output of said power supply and the other to ground.

5. In an electrostatic spray coating installation for spraying an article to be coated, the combination of a hand spray gun manually operable to project particles of coating material in a path directed generally toward said article for deposition thereon, means enhancing the deposition of said particles on said article including discharge electrode means and current collector electrode means on the opposite sides of the path of said particles projected from said spray gun and located between the spray gun and the article to be coated, insulator means mounting said discharge electrode means and said current collector electrode means on said spray gun, power supply means supplying a high tension output voltage for application between said discharge electrode means and said current collector electrode means, high tension circuit breaker means connected in circuit controlling relation in the output of said power supply to said discharge electrode means, control means for said circuit breaker including a remote control element located at said gun and a common operating member on said gun for controlling both the flow of particles projected from the gun and the remote operation of said circuit breaker.

6. In an electrostatic spray coating installation for spraying an article to be coated the combination of a spray gun having a gun body portion with a handle on one end and a spray tip nozzle on the other end for projecting particles of coating material in a path directed generally toward said article for deposition thereon, means enhancing the deposition of said particles on said article including discharge electrode means and current collector electrode means on the opposite sides of the path of said particles projected from said spray gun and located between the spray gun and the article to be coated, power supply means supplying a high tension output voltage for application between said discharge electrode means and said current collector electrode means, a high tension circuit breaker connected in circuit controlling relation in the output of said power supply and connected directly to said discharge electrode means, control means for said circuit breaker including a remote control element located at said gun and a common oper-

ating member on said gun for controlling both the flow of particles projected from the gun and the remote operation of said circuit breaker, and an insulating shield mounted on the body of the gun between the handle and spray tip thereof and supporting said discharge electrode means and said current collector electrode means therefrom.

7. Electrostatic spray coating apparatus of the character described, comprising: spray discharging means having a portable body provided with a gripping handle, a spray control trigger member adjacent the handle, and a spray discharge portion spaced from the handle for projecting spray particles in a forwardly extending path; support means of electrically insulating material mounted on said portable body adjacent the spray discharge portion thereof and extending on opposite sides of said spray discharge portion; discharge electrode means mounted on said support means forwardly of said spray discharge portion on one side of the path of particles projected therefrom; current collector electrode means mounted on said support means forwardly of said spray discharge portion and opposite said discharge electrode means on the other side of the path of projected particles; a power supply for providing a high voltage electrical field between the discharge electrode means and the collector electrode means; a high tension circuit breaker having a movable operating member directly electrically connected to said discharge electrode means and operable between a pair of contact positions, one of which is electrically connected to the output of said power supply and the other to ground; and control means for said circuit breaker including a remote control element mounted on the body of the spray discharging means and operably connected to said trigger member whereby said trigger member controls both the flow of particles projected from the spray discharging means and the remote operation of said circuit breaker means.

8. Electrostatic spray coating apparatus of the character described, comprising: a pistol-shaped spray gun having a portable body provided with a gripping handle, a

5 spray control trigger member adjacent the handle, and a spray nozzle spaced from the handle for projecting spray particles in a forwardly extending path; support means of electrically insulating material mounted on said portable body adjacent the nozzle and extending on opposite sides of the nozzle; discharge electrode means mounted on said support means forwardly of said nozzle on one side of the path of particles projected therefrom; current collector electrode means mounted on said support means forwardly of said nozzle and opposite said discharge electrode means on the other side of the path of particles projected from the nozzle; a power supply for providing a high voltage electrical field between the discharge electrode means and the collector electrode means; a high tension circuit breaker having a movable operating member directly electrically connected to said discharge electrode means and operable between a pair of contact positions, one of which is electrically connected to the output of said power supply and the other to ground; and control means for the circuit breaker including a remote control element supported on the body of the spray gun and operably connected to said trigger whereby said trigger controls both the flow of particles projected from the spray gun and also controls the operation of the circuit breaker.

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