Oct. 2, 1962 A. C. WALBERG 3,056,557

SPRAY GUN FOR ELECTROSTATIC COATING

Filed July 16, 1959 3 Sheets-Sheet 1

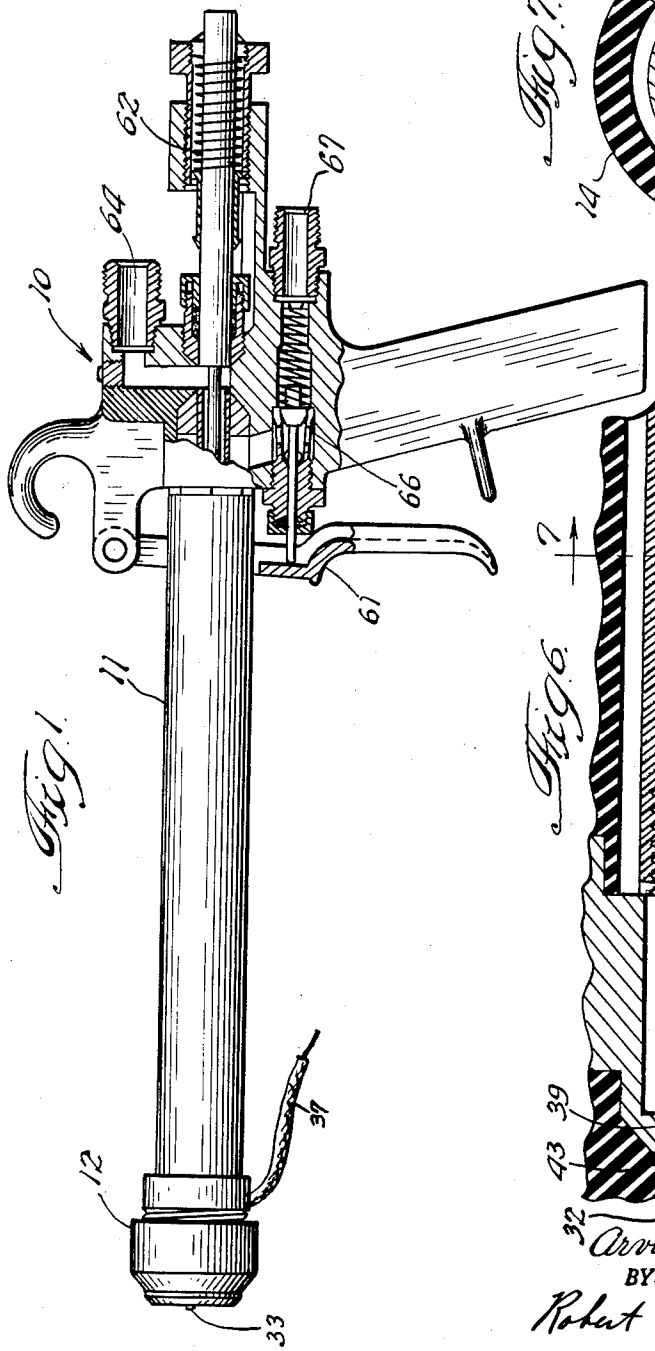


Fig. 1.

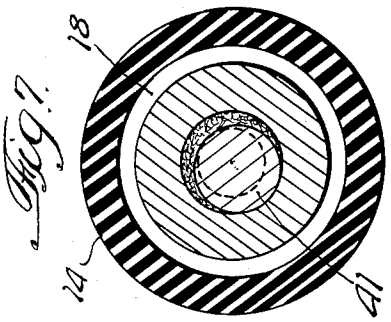


Fig. 7.

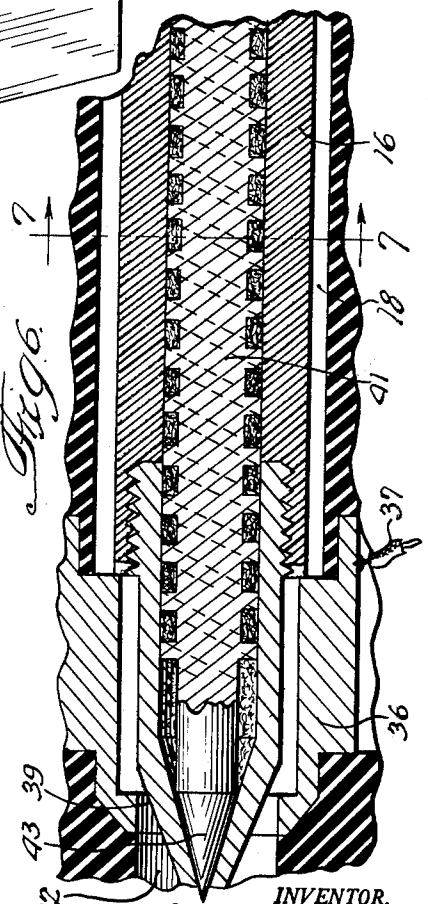


Fig. 6.

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SPRAY GUN FOR ELECTROSTATIC COATING

Filed July 16, 1959 3 Sheets-Sheet 2

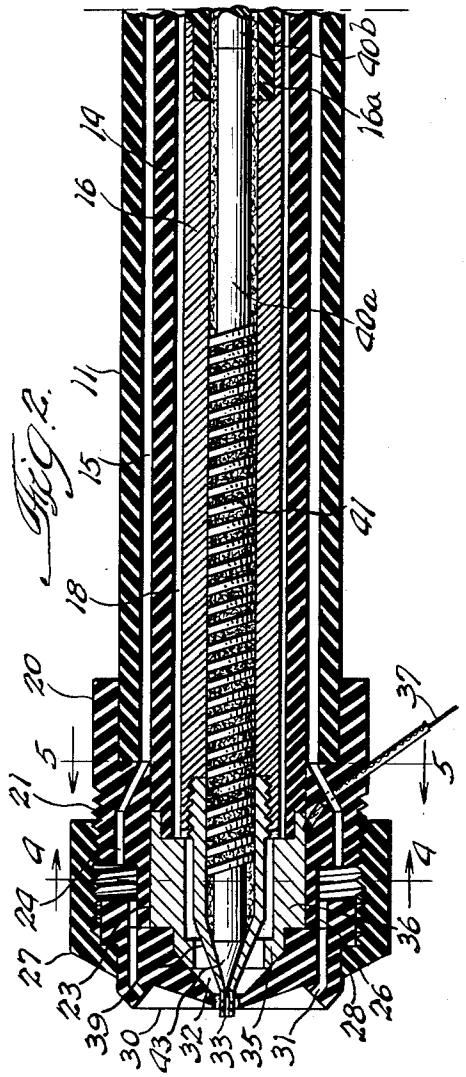


Fig. 2.

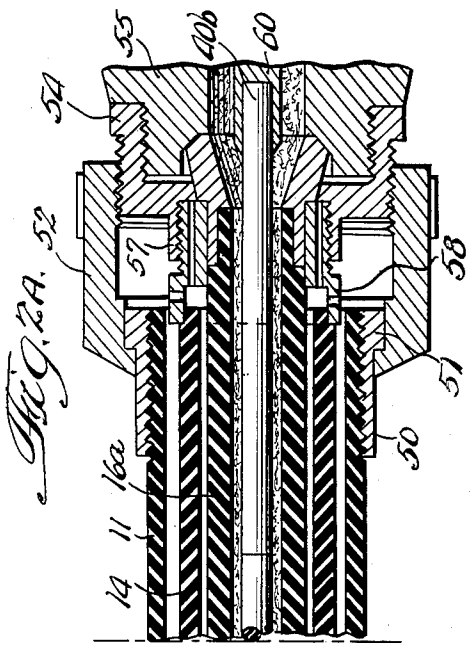


Fig. 2A.

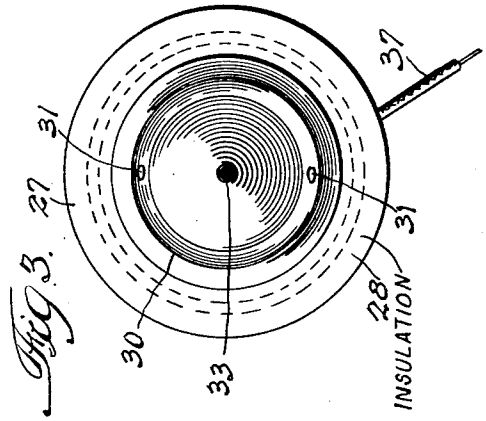


Fig. 3.

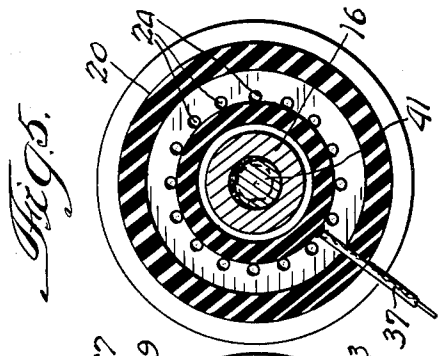


Fig. 5.

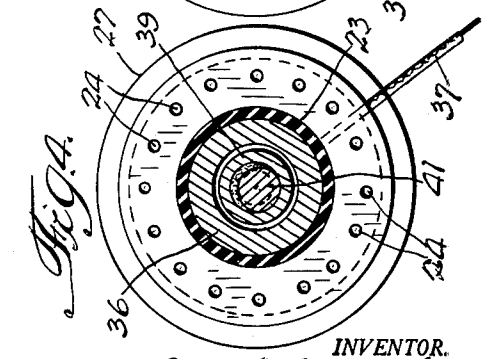


Fig. 4.

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SPRAY GUN FOR ELECTROSTATIC COATING

Filed July 16, 1959 3 Sheets-Sheet 3

Fig. 8.

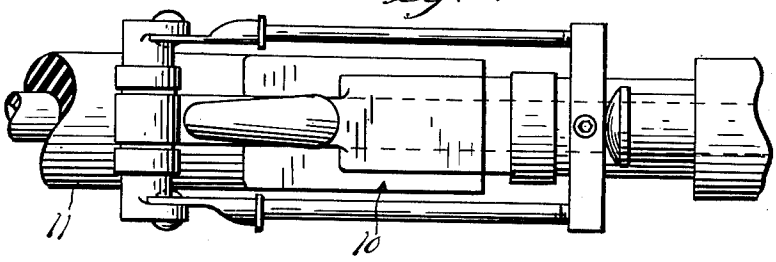


Fig. 9.

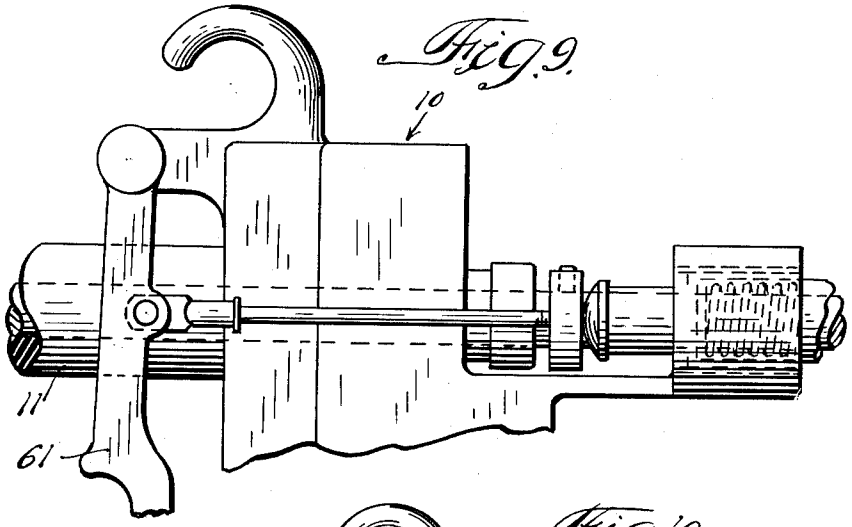
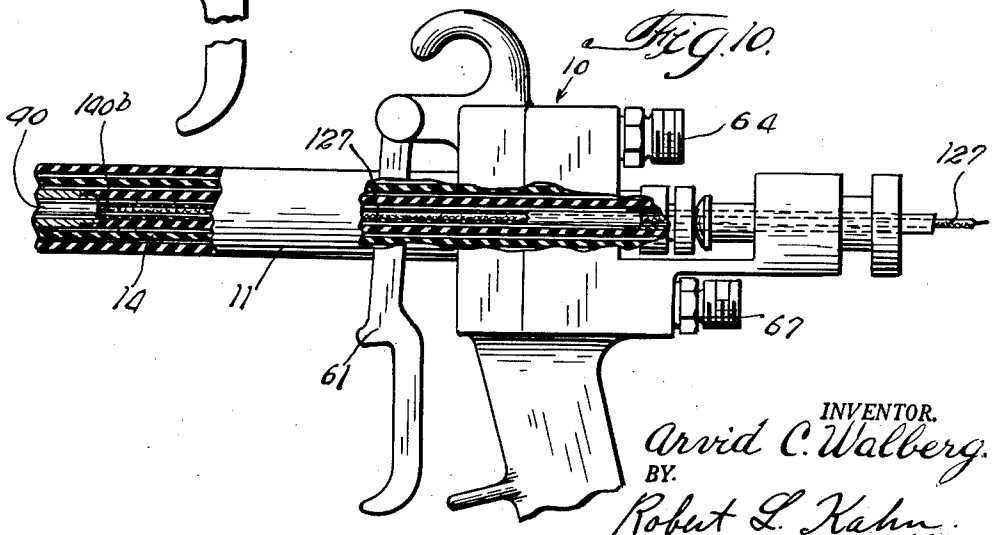


Fig. 10.



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SPRAY GUN FOR ELECTROSTATIC COATING

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Filed July 16, 1959, Ser. No. 827,587
6 Claims. (Cl. 239—15)

This invention relates to a spray gun for electrostatic coating.

Spray guns for discharging a blast of atomized material, such as paint or other coating material, have long been known and used. Such guns have provided means for discharging a stream of coating material into atmosphere and jet atomizing the same at or near the point of discharge by means of compressed air. A variation of such gun has involved the discharge of a fine stream of coating material under high pressure such as 1,000 pounds per square inch or more. A liquid, either a solution or a suspension, when discharged into atmosphere will jet atomize under such conditions.

Conventional spray guns with some modifications are used in electrostatic coating. The modifications have been necessitated by the fact that at times high potential electrodes have been carried by the gun. The location of such electrodes as a rule has been arbitrary. Little if any attempt has been made to shape the electric field at the region of atomization.

In high voltage work, it has long been recognized that the geometry of an electrically charged surface is important in determining the intensity of an electric field at the electrode region. For example, it is well known that in air, the breakdown potential between two oppositely charged electrodes will vary greatly depending upon the shape of one or both electrodes. In particular, if one electrode has a sharp tip or point, the breakdown potential in air will be substantially less for a given electrode separation than if both electrodes have smooth spherical surfaces of substantial radius.

The above phenomenon has been used to a limited extent in electrostatic coating. Spray guns having charged electrodes with sharp points have been used. Such electrodes have been applies as accessories to conventional spray guns having considerable amount of highly charged metal exposed to atmosphere in the vicinity of the atomizing region. The coating efficiency of such guns is quite low.

As a rule, coating materials cannot be classed as electrical conductors and are more generally considered as electrical insulators. Because of this, all coating particles discharged from a charged metal nozzle in a gun cannot be assumed to be charged. If it were possible to charge electrically every particle of coating material emanating from a gun, then atomization of the coating material might be aided by the electrostatic forces of repulsion, in addition to mechanical atomization by high-pressure jets. With conventional spray guns having various kinds of electrodes attached thereto, the electric field pattern is not conducive to electrostatic atomization apart from field intensity.

That the charging of the atomized particles in conventional guns is inefficient is indicated by the fact that such atomized particles of coating material generally travel in straight paths and frequently pass beyond the work if misdirected. If the charging of atomized particles would be more completely effected than has hereto been the case, atomized charged particles would follow the lines of electric force and tend to congregate upon the work. This is known as the wrap-around effect whereby a coating particle, which would normally if uncharged go past the work due to its direction of travel, will instead be directed from such straight path and will

strike the surface of the work near the edge, either in front or back.

This invention is based upon the discovery that a spray gun having a highly charged electrically conducting member having a sharp tip or edge right at the region of discharge of a blast of coating material and free of any adjacent charged metal surfaces exposed to atmosphere in the vicinity of the atomizing region will greatly improve the efficiency of operation of the spray gun. In particular, a spray gun embodying the invention is so constructed as to provide what may be termed a convex charged surface, as viewed from the front of the gun, with the most forward point or edge of the charged surface being at or near the discharge orifice. Such a construction provides an intense electric field pattern at or near the region of jet atomization. This invention makes possible for the first time a high degree of atomization of a coating material obtained by combining electrical and jet atomization.

An additional feature makes possible a more effective electrical charging of the coating material prior to its atomization. This is obtained by feeding the coating material over a long, charged metallic path prior to discharge into air. This promotes a rapid transfer of electric charges to particles making up the stream of coating material just prior to atomization.

The combination of intense field at the region of atomization coupled with the pre-charging of the coating stream prior to discharge into the atomizing region provides a highly efficient spray gun which can operate with substantially less air and will deliver more of the coating material to the work than conventional guns.

Since mechanical work has to be performed upon coating particles to atomize the same and to propel such atomized particles toward an object to be coated, it follows that the more efficiently the work is performed on the atomized particles, the more efficient is the entire coating operation. A spray gun embodying the present invention provides an intense electric field which radiates from what is practically a point source at a region of atomization outwardly toward work to be coated.

By virtue of this electrode arrangement, the electric field not only has maximum intensity but has substantially no component pointing in any direction except toward the work generally. This does not necessarily mean that all the lines of force extend geometrically straight toward the work. Many of the lines of force will tend to bow outwardly. However, in distinction to other gun constructions, in the general region where atomization is to occur, the field pattern in the new gun has minimum distortion from what might be termed a point source.

The importance of the above resides in the fact that the coating particles are discharged from the gun toward the work and thus have considerable kinetic energy. It is true that the blast which atomizes the particles tends to divert atomized particles from the original direction of travel of the jet. However, the combination of jet energy plus the blast of compressed air provides a mass of atomized particles which are generally directed toward the work apart from electrical considerations.

In conventional guns, the electric field, apart from being less intense for the same voltage, frequently works at cross purposes with the kinetic energy of the atomized particles resulting from the gun discharge. It frequently occurs that the electric field in conventional guns will tend to move particles in a different direction from the discharge direction. This wastes the energy of the particles and results in a cloud of atomized particles which will hover around the gun and drift to surfaces other than the work to be coated.

In order that the invention may be understood, reference will now be made to the drawings where an exemplary embodiment is illustrated.

FIGURE 1 is a side view with certain parts broken away of a gun embodying the present invention.

FIGURE 2 is an enlarged longitudinal section of the electrode end of the gun.

FIGURE 2A is an enlarged transverse sectional detail of the rear of the barrel showing the barrel support.

FIGURE 3 is a front view of the discharge end of the gun only.

FIGURES 4 and 5 are respectively sectional details on lines 4—4 and 5—5 of FIGURE 2.

FIGURE 6 is an enlarged sectional detail of the precharging and discharge part of the gun barrel.

FIGURE 7 is a transverse sectional view on line 7—7 of FIGURE 6.

FIGURE 8 is a top plan view of the trigger portion of the gun.

FIGURE 9 is a side elevation of the trigger portion of the gun and

FIGURE 10 shows a modification wherein the high voltage cable is axially of the gun and emerges from the rear.

The invention is generally adaptable to any type of gun and is concerned with the barrel and discharge or nozzle part of the gun principally. The remainder of the gun, such as the trigger mechanism and the like, may generally be of conventional construction.

Referring to the drawings, an atomizing gun consists of a handle portion, generally indicated by **10**, to be described in detail later, carrying barrel **11** terminating in a nozzle or cap assembly, generally indicated by **12**. Barrel **11** is of rigid, electrically insulating material and may for example be of fibre, Bakelite, suitable plastic or the like. If there is no objection to having part **10** of the gun at high potential, then barrel **11** may be conducting.

In general, the potentials used in electrostatic coating systems may range up to as high as 150,000 volts. The current drain as a rule is small, of the order of several milliamps. It is therefore necessary that insulating barrel **11** have a high electrical resistance. Barrel **11**, which may be considered as an outer barrel, has disposed within the same intermediate sleeve **14** also of electrical insulating material. Between barrel **11** and sleeve **14** is annular space **15** for accommodating compressed air. Within sleeve **14** is still another sleeve **16** separated from sleeve **14** by annular space **18**. Sleeve **16** near the discharge end of barrel **11** is of metal such as brass, stainless steel or the like. Sleeve **16** forms an extension of sleeve **16***a* of insulating material. Insulating sleeve **16***a* extends back toward handle portion **10** of the gun and will be described in detail later. Sleeves **16** and **16***a* are rigidly jointed together in any suitable fashion such as by cement or by providing cooperating threads.

Referring now to the nozzle or cap assembly **12**, barrel **11** at the outer end thereof carries insulating sleeve **20** of suitable rigid material. Insulating sleeve **20** has outer threaded portion **21** at the front thereof. Sleeve **20** is provided with inside cylindrical surface **23** which telescopes over the free end of sleeve **14**. Sleeve **20** is rigidly attached to the end of barrel **11**, as by cement, and is provided with a number of air passages **24** generally longitudinally of the collar. Each air passage in this particular instance consists of two small bores at an angle to each other. The air passages provide communication between annular region **15** at one end of sleeve **20** and region **26** at the other end of the sleeve.

Threaded over sleeve **20** at threaded portion **21** is cap **27** also of insulating material. Cap **27** has inwardly directed shoulder **28** to provide a reentrant region within which is disposed nozzle cap **30** of insulating material. Nozzle cap **30** has a number of air passages **31** there-

through which provide communication between region **26** and the space in front of the gun.

Nozzle cap **30** has general conical region **32** and is provided with sharp edged discharge tip **33** at the center of the cap, coincident with the axis of the barrel assembly and projecting forwardly of the cap a slight distance. Nozzle cap **30** is adapted to rest against stepped end **35** of metal sleeve **36**. Metal sleeve **36** fits snugly within face **23** of sleeve **20**, and has a stepped end for centering the complementarily shaped end of insulating sleeve **14**. Nozzle assembly **12** can be disassembled by unscrewing cap **27**. Collar **20**, metal sleeve **36**, barrel **11** and sleeve **14** are preferably cemented together. Clearances are provided for air from space **18** to reach region **32** and be discharged as a blast around metal discharge tip **33** through a clearance in the cap. The annular clearance around tip **33** provides a desirable gun action.

High potential lead **37** is connected to metal sleeve **36**, this lead passing through suitable passages in sleeve **20**. Lead **37** is insulated where it emerges from sleeve **20** into the air and as is clearly visible in FIGURE 2, lead **37** is attached to the rear portion of sleeve **36** and extends rearwardly of the gun.

Metal sleeve portion **16** carries at the forward end thereof nozzle tip **39** of metal. Nozzle tip **39** is of generally conventional construction and fits within metal sleeve **36**. Nozzle **39** is preferably provided with a threaded portion at the rear end for coupling to the cooperating end of metal sleeve **16**.

Disposed within metal sleeve **16** is metal rod portion **40***a* carried by insulating rod portion **40***b*. Rod portion **40***b* extends backwardly toward the trigger mechanism of the gun and is of electrically insulating material. Metal portion **40***a* is at the forward end of the gun barrel and has portion **41** provided with one or more helical grooves to provide a tortuous path within sleeve **16**. Portion **41** of the rod smoothly fits the inside of sleeve **16** and the helical grooves on the outside of portion **41** thus constitute the only practical path for paint or other coating material. Portion **41** may be conveniently obtained by cutting one or more coarse threads in the metal. The smaller the pitch, the greater the distance to be traveled by the paint in transversing portion **41**.

Portion **41** terminates within nozzle tip **39** and carries at the end thereof metal needle **43**. Needle **43** cooperates with nozzle **39** to control the flow of coating material therethrough. Apart from the insulating and conducting materials, the structural details for the nozzle end of the gun and the various paths for air may be modified to obtain different spray patterns.

The general barrel and nozzle arrangement so far described may be applied to any desired type of gun body and in this particular instance are carried by handle portion **10**. Various ways for supporting the barrel assembly may be provided. One example is illustrated here. The inner end of barrel **11** is provided with external threads which cooperate with collar **50** having shoulder **51** rearwardly (toward the gun body). Collar **50** may be of metal and after threading upon barrel **11**, may be cemented in place.

Disposed around collar **50** is ring nut **52** also of metal which engages threaded metal fixture **54** bolted to portion **55** of gun portion **10**. Threaded fixture **54** has shoulder portion **57** internally threaded for the reception of centering nut **58** having a shoulder extending over the inner end of sleeve **14** and within barrel **11** for support. Nut **58** does not fill the entire space between the two long sleeves so that compressed air can pass into region **15** from around portion **57** within nut **52**. Nut **58** may also have air passages for feeding air to region **18**.

Portion **40***b* of the central rod is carried by metal plunger **60**. Metal plunger **60** is coupled by links shown in FIGURES 8 and 9 to trigger arm **61** suitably pivoted on body **10**. Plunger **60** is normally biased by spring **62** so that needle **43** closes against nozzle aperture **33**

under normal conditions. When trigger arm **61** is pulled back to the right as seen in FIGURE 1, plunger **60** and the rods, together with the needle at the end, is withdrawn to permit coating material to be discharged. This trigger arrangement is conventional. Coating material is supplied through fitting **64** from a suitable pipe, not shown, fitting **64** permitting material to flow into the region around rod **40***b*. It is understood that the coating material is under some pressure so that material will be discharged through nozzle **33** upon withdrawal of the nozzle valve rod. Suitable packing is provided to prevent leakage of materials.

In accordance with customary practice, trigger handle **61** is also coupled to operate air valve **66** in body **10**. Valve **66** controls the flow of compressed air from fitting **67** to the region around part **57** within nut **52**. The various parts are so arranged that compressed air is fed into annular region **15** between sleeves **11** and **14**, annular region **18** and substantially little if any air gets into the region around rod **40***b* where the coating material is supposed to flow. In some instances, a certain amount of air may be permitted to leak into this region, so that flow of coating material is promoted.

As previously pointed out, the details of portion **10** of the gun are conventional. In the construction illustrated, the high potential impressed upon the metal parts at the nozzle end of the gun are prevented from going back to the gun body **10** by virtue of insulation material used for sleeves **11**, **14**, rod **40***b* and sleeve **16***a*. However, if body portion **10** of the gun is not held by an operator or if there is no objection to having metal portion of **10** at high potential, then the various insulating means can be eliminated. However, even in such case, it should be noted that the insulation at the nozzle assembly **12** of the gun which is retained in all cases, concentrates the electric field as hereinbefore pointed out. It is preferred to have the insulating sleeves and rods as described so that the amount of highly charged metal exposed to atmosphere is reduced to a minimum insofar as the entire gun is considered.

Instead of having high potential lead **37** extending outwardly from nozzle portion **12** of the gun as illustrated in FIGURE 1, it is possible to have the high potential lead extend rearwardly from metal rod **40***b* axially of the gun. This is illustrated in FIGURE 10 wherein portion **140***b* of insulating material is a sleeve rather than a solid rod. High potential wire or lead **127** extends backwardly from rod **40** within sleeve **140***b* and emerges from the rear of the gun as an insulated cable.

If the coating liquid is under high pressure, and no compressed air is used then it will be understood that the compressed air supply can be eliminated. In such case sleeves **11** and **14** can be combined into one and the ducts for air in nozzle assembly **12** may be entirely eliminated.

With regard to the grooves on the outside of metal rod **40**, these may be readily cleaned. If desired, helical grooves may be provided on the inside surface of metal sleeve **16** although such grooves may be harder to clean. Any tortuous paths for coating material may be provided instead of helical grooves. These paths should expose maximum metal surface to the coating material for easy charging.

What is claimed is:

1. In a gun of the type used in electrostatic coating for discharging coating material in a liquid carrier, a gun handle portion, a straight cylindrical tube of rigid electrically insulating material having the rear end of said tube attached to said handle portion, a metallic assembly and nozzle structure at the forward end of said cylindrical tube, said nozzle structure including a hollow, conically shaped, metal valve portion terminating in a short nozzle discharge tip having a sharp free annular edge, said metallic assembly and nozzle structure including the nozzle edge being coaxial with said tube and providing a sharp decrease in outside transverse dimensions beginning with the assembly structure and ending with the nozzle discharge edge so that the metallic assembly and nozzle structure are convex forwardly of the gun with the discharge tip projecting forwardly a short distance only, a straight valve rod within said tube and coaxial therewith and terminating in a metallic conical valve member for needle valve operation within said hollow conical valve portion, said valve rod including as a part thereof an insulating actuating rod portion extending back to said handle portion, said conical valve member being movable by said valve rod longitudinally in said valve portion to open and close said needle valve, means for feeding coating material along the rod and valve member into said conical valve portion and through said nozzle discharge tip, a cap structure of solid, electrically insulating material covering said metallic assembly, said cap structure including a part at the front end covering the metal with insulation, said metal being at the forward end of the gun except for a cap aperture through which only the short metal nozzle discharge tip projects, the thickness of the front end part of the insulating cap structure as measured along lines parallel to the tube axis being substantially no greater at the region adjacent the discharge tip than at the other portions of the front end part of the insulating cap structure, due to the shortness of the nozzle discharge tip, and means extending from said metallic assembly and nozzle structure for impressing a high electric potential on said metallic assembly during gun operation, said convex shape of the metal assembly with the solid insulation and the short nozzle discharge tip and annular sharp nozzle edge cooperating when the gun is electrically charged to concentrate electric charges at the sharp nozzle edge so that coating material and the electric field appear to stream from a common source, the metallic assembly and nozzle structure of said gun being otherwise free of any charged metal projections whereby efficient gun operation is secured.

2. The gun according to claim 1 wherein said metallic assembly and nozzle structure includes a metallic cylindrical sleeve portion extending rearwardly from the hollow conical valve portion, said valve rod including a metallic cylindrical rod portion extending rearwardly from the conical valve member, said metallic valve rod portion fitting snugly within the metallic sleeve portion, one of the opposed cylindrical metallic surfaces having at least one helical groove in which coating material can travel and become electrically charged on its way to the nozzle tip.

3. In a gun of the type used in electrostatic coating for discharging coating material in a liquid carrier, said gun including a gun handle portion, a straight cylindrical tube of rigid insulating material having the rear end of said tube attached to said handle portion, a solid insulating cap structure closing the end of said gun, said solid insulating cap structure having an opening therethrough in axial alignment with said insulating tube, a tapering needle valve structure at the forward end of said tube and disposed back of said insulating cap structure, said needle valve structure terminating in a short, sharp edged metallic tip portion projecting through the aperture of said insulating cap structure, the projecting metallic part extending forwardly from a substantially larger mass of metal within the insulating structure and the wall of the cap structure having no greater thickness axially of the tube at the opening than elsewhere because of the short tip, said needle valve structure including a hollow, conically shaped, valve portion terminating in a discharge nozzle and a metallic conical needle valve member within the hollow conical valve portion and longitudinally movable relative thereto for needle valve operation, said conical needle valve member forming part of a straight valve rod within said insulating tube and extending rearwardly toward said handle, said entire needle valve being coaxial with said insulating tube, means for impressing a high potential upon the metal projecting through said aperture in said

insulating cap structure, a second tube within said first named tube extending from said needle valve member providing a passageway for coating material from the gun handle portion around the valve rod and into said needle valve, the space between said two tubes providing an air chamber to said insulating cap structure, said cap structure having an annular clearance around the charged metal part at the center and having air discharge ports laterally offset from the tube axis, said region behind the cap structure communicating with the air chamber and the laterally offset air discharge ports directing air blasts during gun operation which converge axially in front of the gun, said entire gun having no metal at high potential exposed to atmosphere except for the metal in the apertured part of the cap structure whereby when the gun is electrically charged and is discharging coating material from the nozzle tip, the origin in space of the coating material and electric field appear to be the same.

4. In a gun of the type used in electrostatic coating for discharging coating material in a liquid carrier, said gun including a gun handle portion, a straight cylindrical tube of rigid insulating material having the rear end of said tube attached to said handle portion, a solid insulating cap structure closing the end of said gun, said solid insulating cap structure having an opening therethrough in axial alignment with said insulating tube, a tapering all metal needle valve structure at the forward end of said tube and disposed back of said insulating cap structure, said needle valve structure terminating in a short, sharp edged metallic tip portion projecting through the aperture of said insulating cap structure, the projecting metallic part extending forwardly from a substantially larger mass of metal within the insulating structure and the wall of the cap structure having no greater thickness axially of the tube at the opening then elsewhere because of the short tip, said needle valve structure including a hollow, conically shaped, valve portion terminating in said short metallic nozzle discharge tip and having a conical needle valve member within the hollow conical valve portion and longitudinally movable relative thereto for needle valve operation, said conical needle valve member forming part of a straight valve rod within said insulating tube and extending rearwardly toward said handle, said entire needle valve being coaxial with said insulating tube, means for impressing a high potential upon the metal projecting through said aperture in said insulating cap structure, a second tube within said first named tube extending from said needle valve member providing a passageway for coating material from the gun handle portion around the valve rod and into said needle valve, said valve rod being disposed within said second tube, and the second tube having its outer surface spaced from the inner surface of the first named tube, the space between said two tubes providing an air chamber to said insulating cap structure, said cap structure having an annular clearance around the charged metal part at the center and having air discharge ports laterally offset from the tube axis, said region behind the cap structure communicating with the air chamber and the laterally offset air discharge ports directing air blasts during gun operation which converge axially in front of the gun, said entire gun having no metal at high potential exposed to atmosphere except for the metal in the apertured part of the cap structure whereby when the gun is electrically charged and is discharging coating material from the nozzle tip, the origin in space of the coating material and electric field appear to be the same.

5. The construction according to claim 4 wherein metallic means having a large surface area is provided within said second tube along the passageway for coating material, said metallic means being charged to the same high potential as the gun tip and serving to change the coating material on its way to the discharge nozzle.

6. The construction according to claim 4 wherein said second tube has a portion extending rearwardly from the valve member of metal and wherein the valve rod portion within said metallic tube portion is also of metal, the two fitting snugly and wherein one of the metallic members has at least one helical thread therein providing a passageway for coating material flowing within said second tube to the interior of the needle valve for charging the coating material.

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