

April 26, 1966

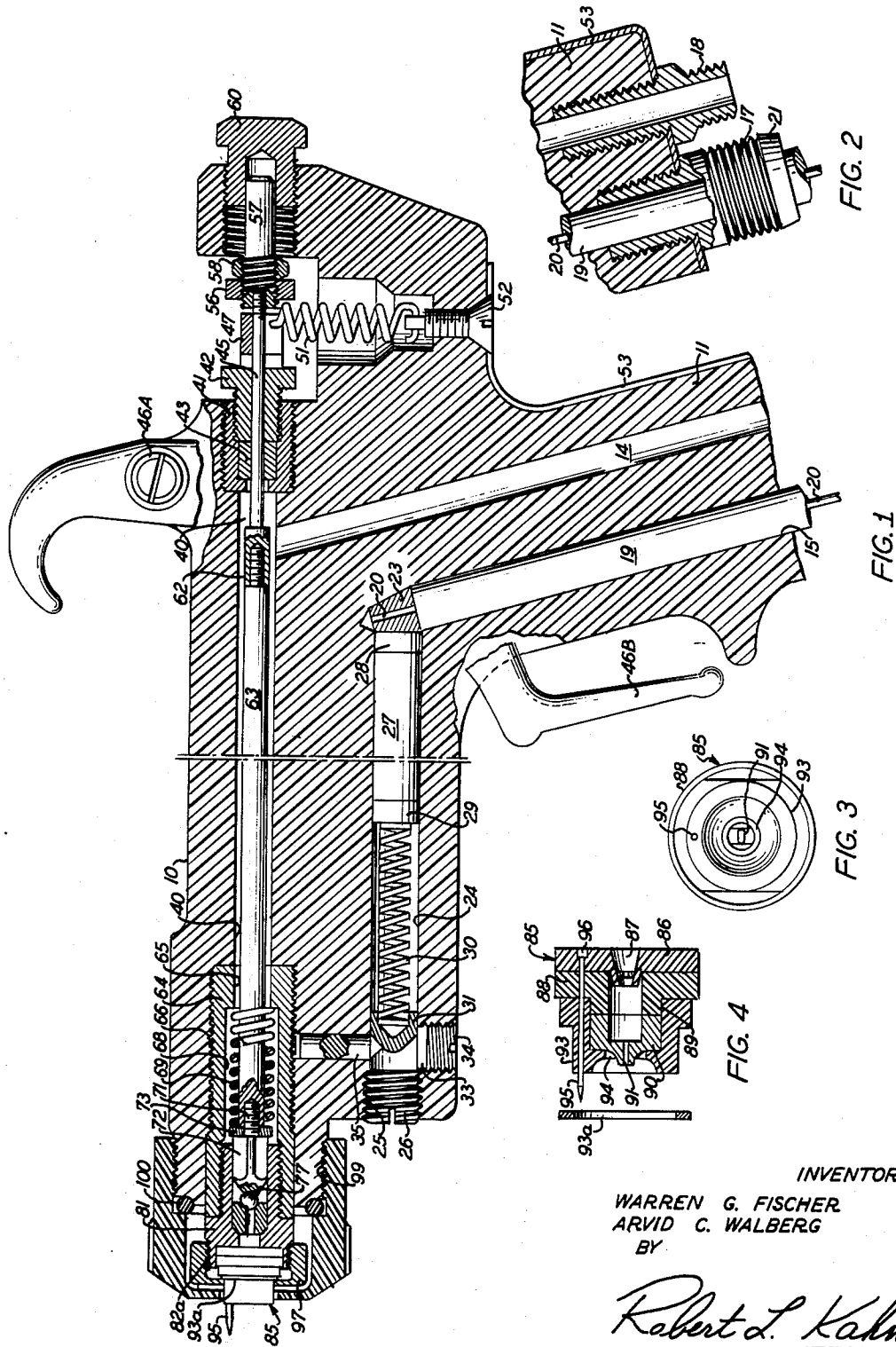
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3,248,059

SPRAY GUN

Filed Jan. 30, 1963

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

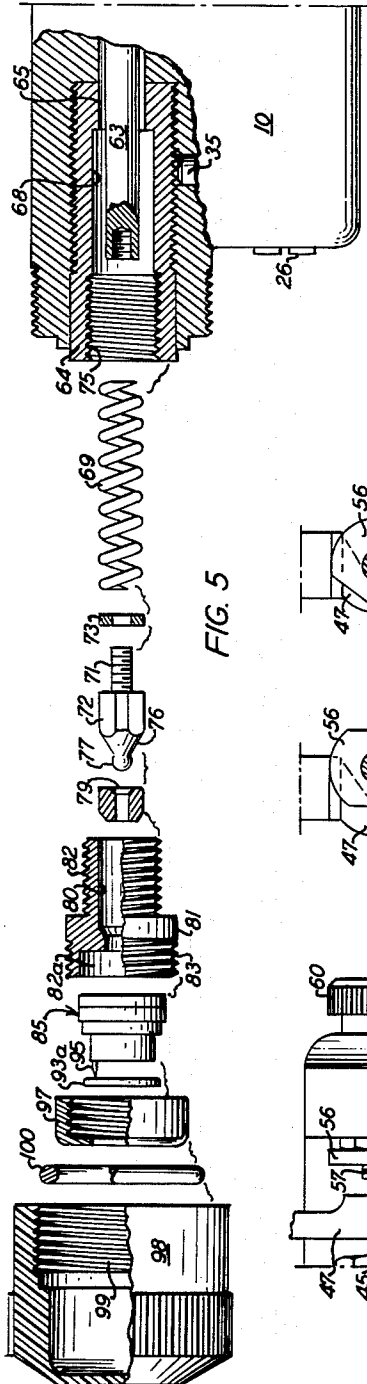


FIG. 5

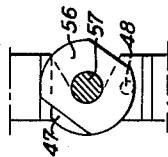


FIG. 9

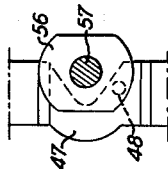


FIG. 8

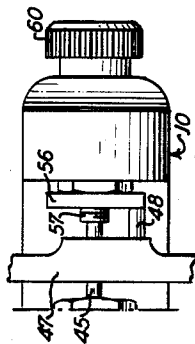


FIG. 7

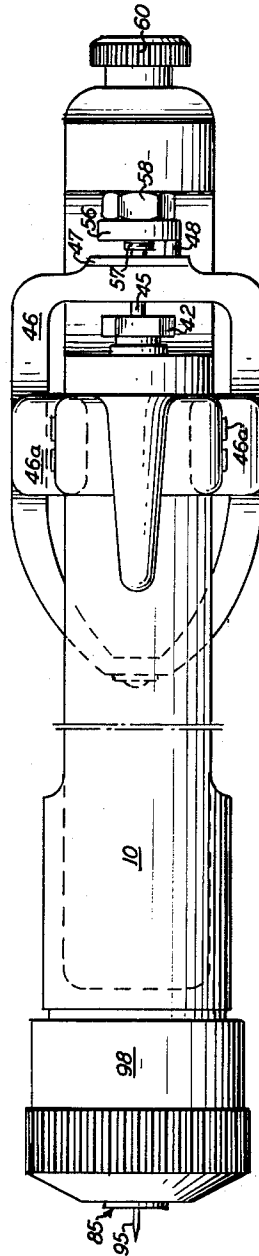


FIG. 6

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3,248,059

SPRAY GUN

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Filed Jan. 30, 1963, Ser. No. 254,899

5 Claims. (Cl. 239—15)

This invention relates to a spray gun, and more particularly to a spray gun-of the airless type. Guns of this type are old and have been used to some extent. Such guns operate on the principle that liquid coating material under high pressure of the order of a thousand pounds per square inch or more when suddenly released into atmosphere will atomize into separate particles. Such guns operate under severe handicaps.

Hydraulic pressure generating means, particularly for pressures of the order of a thousand pounds or more, are quite expensive both with regard to first cost and with regard to maintenance. Then coating material must be discharged under such high pressure through nozzles having extremely fine orifices. For example, an orifice of the order of .010" or thereabouts is quite common. Wear on the orifice increases the orifice diameter and results in a very substantial increase in the amount of coating material passed by the orifice. This impairs the operation of the gun.

For most industrial purposes, the quantity of coating material must be carefully controlled and the thickness of the finished coating material must be uniform. Airless guns of present design can not meet these requirements. Feathering is not possible. As a rule, a coating having a desired thickness is the minimum thickness obtainable. The difficulty has been in completing the coating by additional passes without overlap.

Another handicap under which high pressure airless guns operate is based upon the angle of incidence of the coating material to the work. Due to the extremely high pressure at which the coating material must be discharged in order to be atomized substantially, the coating material has a tendency to be reflected or bounced from the work unless the angle of incidence of coating material to the work is substantially about 90°. Any departure from this angle results in a loss of coating material, with a consequent reduction in efficiency of coating.

Airless guns of this character use discharge orifices of material having a high degree of hardness. As an example, tungsten carbide is frequently used for a discharge nozzle in guns of this type. Tungsten carbide, while being very hard, is also quite brittle, and is difficult to fabricate, particularly with regard to control over the fineness of the orifice.

In order to obtain a high degree of atomization, guns of the prior art require the use of high pressures of the order of a thousand pounds or more. While electrostatic coating procedures are well known and are widely used, the advantages incident to such procedures have not accrued to airless types of guns. One reason may be due to the fact that conventional high pressure airless gun construction has been retained when electrifying spraying systems. Whatever change has been made has consisted of the superficial addition of one or more electrodes. This has consisted of the addition of large sharp spikes or spears radiating from a conventional gun and charged to high potential.

This invention provides an airless spray gun which has such great increase in the efficiency of operation as to make it possible to effect remarkable economies in the operation of the gun. Thus as one example, it is possible to reduce the amount of hydraulic pressure necessary for operating the new gun as compared to a conventional airless gun of the prior art. Such a great reduction in hydraulic pressure makes possible the use of discharge

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nozzle with a larger discharge orifice. This imposes less of a requirement upon the accuracy of the discharge nozzle and the cost of manufacture thereof. In addition, it is possible to control more closely the quantity of coating material discharged through the nozzle at lower hydraulic pressure.

The new gun not only provides for operation at lower hydraulic pressure, but also makes it possible to create a much more intense electric field adjacent the discharge region of the gun to add to the atomizing efficiency of the gun. As a rule, the major work involved in atomizing coating material is accomplished by mechanical means. The intensity of the electric field simply superimposes some additional atomization and in particular, aids in charging the atomized particles more completely so that the effectiveness of the entire coating operation is greatly enhanced. The new gun embodying the present invention provides for the creation of an electric field which greatly increases the efficiency of operation of the gun. This aids in further reduction in the value of hydraulic pressure required for successful operation and also makes it possible to increase the size of the discharge orifice or reduce the amount of paint discharged through a discharge orifice to a value of about the same order as is true of conventional air discharge guns. As is well known, air discharge guns can handle coating material so that a comparatively small quantity of such material can be discharged and the thickness of coating material sprayed on can therefore be easily controlled and the gun can be quite efficiently managed.

A spray gun embodying the present invention provides a construction which not only permits of the efficient operation of the gun as an airless type of gun, but, in addition, also permits of the application of an electric field thereto greatly to increase the operating efficiency of the gun.

The new gun resembles conventional airless guns in that a discharge nozzle or tip of refractory material such as tungsten carbide is used. In accordance with the present invention, a separate ionizing electrode having excellent electrical conductivity is provided, this electrode being located close to the discharge region of the gun. The new gun utilizes the principle disclosed in United States Patent No. 3,056,557, issued on October 2, 1962. In this patent, a gun is disclosed wherein substantially all of the metal at high potential present in the gun is electrically insulated or shielded from atmosphere by solid insulation except for a sharp tip or edge at the region of discharge. By thus minimizing highly charged metal exposed to atmosphere at the discharge region, an extremely intense field is created, this field extending from the sharp edge or point to the work. Not only is the atomization efficiency increased, but, in addition, the overall characteristics of the gun are improved.

Where a new gun embodying the present invention is to be held by an operator, it is desirable to have metallic parts of the handle portion of the gun at ground potential. In such case, it is necessary to have a barrel for the gun of insulating material with the barrel length longer than the spacing between the discharge end of the gun and the work. This prevents coating material discharged from the end of the gun from following the electric field back toward the handle of the gun and back toward the operator. This same requirement may also be desirable with automatic guns if the mounting of the automatic gun is to be on a reciprocator or other support which is desired to be at ground potential.

As a result of the presence of a long insulating gun barrel in the airless gun, the mechanical structure of conventional airless guns has been greatly modified, particularly with regard to the location of the valve and the normal bias thereof. Conventional airless guns have used short operating rods because of the high pressures

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involved. The valve rod has been quite short and the normal bias of the valve has been to close the valve against the valve seat by means of a compression spring. In accordance with the present invention, a new structure provides a long valve rod and reverses the position of the valve rod and spring so that the valve rod is always in tension. Thus the valve rod can be much thinner than would normally be the case.

The invention will now be described in conjunction with drawings showing an exemplary embodiment. Referring, therefore, to the drawings:

FIGURE 1 shows a view partly in section and partly in elevation of a gun embodying the present invention, the handle portion thereof being cut short.

FIGURE 2 is a sectional view of the remaining handle portion of the gun of FIGURE 1.

FIGURE 3 is a front view looking toward the nozzle of the gun with the gun cap removed and a view omitting the handle and other portions of the gun.

FIGURE 4 is a partial section and partial elevation of the nozzle portion illustrated in FIGURE 3.

FIGURE 5 is an exploded view showing the various parts partly in elevation and partly in section of the valve rod and valve portions of the gun embodying the invention.

FIGURE 6 is a top view of the gun illustrated in FIGURE 1.

FIGURES 7, 8 and 9 are details illustrating the action of the valve rod rotating means.

The gun preferably consists of a casting or moulding of a suitable plastic. As examples, plastics such as polypropylene, polyethylene and nylon are three of a large number of plastics which may be used. Such plastics may be moulded quite easily, have excellent electrical resistance characteristics and are sufficiently strong mechanically for use in a gun of this character. The gun comprises barrel 10 and handle portion 11. Handle portion 11 is provided with straight ducts or channels 14 and 15 respectively. The free end of handle 11 carries metal fittings 17 and 18 which are threaded into handle 11 and constitute duct terminals for ducts 14 and 15. Fittings 17 and 18 are externally threaded as indicated and are useful respectively for adapting the ducts to be used for a high potential electric cable and for conducting coating material under high pressure. In duct 14, high potential cable 19 is fitted. This cable includes stranded conductor 20 of copper or other wire and high potential insulation of polyethylene or similar material. The high potential cable outside of handle 11 is provided with outer sheath 21 of braided copper or the like for grounding and this outer sheath is electrically connected to metal fitting 17. Grounded sheath 21 does not extend inside of duct 14.

Metal fitting 18 is adapted to be connected to a flexible high pressure hose, not shown, for providing a supply of coating material to the gun. Inasmuch as guns of the character considered are operated at pressures considerably higher than conventional air guns, the fitting and coating material hose should be of the pressure type capable of resisting pressures of the order of about 1000 pounds per square inch.

Cable duct 14 in the handle terminates in the general region where the handle merges into the gun body. Conductor 20 of the cable is provided with terminal tip 23 of brass or other metal, this consisting of a conical shell with a spike which may be pushed into conductor 20. Intersecting duct 14 is a resistor duct 24 which extends longitudinally of the gun at the lower portion of gun barrel 10. Duct 24 extends forwardly of the gun body and terminates in threaded portion 25 adapted to receive threaded plug 26 of insulating material, preferably of the same material used in the gun body. Disposed within resistor duct 24 is dropping resistor 27 having terminal 28 in electrical contact with terminal tip 23 of the cable and the resistor having remaining

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terminal 29 in contact with metal coil spring 30 within the duct. Metal coil spring 30 carries conical metal terminal tip 31, this being, in the assembled position of the gun, at a position within the duct near threaded plug 26. Laterally of duct 24 is short transverse passage 33 suitably threaded for access from the exterior of the gun body to the duct. Access passage 33 is normally closed by threaded plug 34 also of electrically insulating material which may be of the same plastic as the gun body.

Passage 33 extends within the interior of the gun body from resistor duct 24 to a recess within the gun barrel proper. Passage 33 contains a metal rod connector 35 of brass or other metal for electrically connecting terminal tip 31 with the metal parts of the gun at the discharge portion thereof.

Plugs 26 and 34 are provided so that the dropping resistor and spring may be inserted in duct 24 and metal connector 35 may be disposed within the interior connecting passage previously referred to.

Now referring to duct 14 in handle 11 of the gun, this duct extends into the rear end of the barrel of the gun body and intersects cylindrical bore 40 of the gun. At the rear, or what might be termed the breech end of bore 40, metal fitting 41 is provided, this fitting being threaded into the body material of the gun. Fitting 41 is somewhat larger in diameter than bore 40 and is cup-shaped and has a portion of the interior threaded to receive packing nut 42. Between packing nut 42 and the bottom of the chamber defined by fitting 41 is a region filled with soft packing material 43 such as felt, or the like. Packing nut 42 and the bottom of fitting 41 are provided with coaxial apertures therethrough to accommodate operating rod 45 of metal. This arrangement provides a packing gland for rod 45. This operating rod is used for operating the valve member in the forward part of the gun and is adapted to be moved longitudinally of the gun by suitable trigger means.

Various means for operating rod 45 may be provided. The means illustrated here function to move rod 45 longitudinally and at the same time turn the rod about its axis. Thus yoke 46 is pivotally secured by bolts 46A on opposite sides of the gun body. Yoke 46 includes as a part thereof trigger handle 46B. Yoke 46 has operating portion 47 which is at all times above (as seen in FIGURE 1) rod 45. Portion 47 of the yoke carries pin 48 parallel to and laterally offset from rod 45. The yoke is biased to a valve closing position by coil spring 51 extending between yoke portion 47 and bolt 52 threaded into a portion of the gun body. In order to ground all metallic parts which may be handled by an operator, metal strap 53 is rigidly secured to the end of handle portion 11 by fittings 17 and 18, this strap 53 also extending up and being secured to the gun body by bolt 52.

Backward travel of valve operating rod 45 is secured by yoke portion 47 moving pin 48 (see FIGURE 6), this pressing against disk 56 locked on threaded rod 57 by nut 58. Threaded rod 57 is coupled to operating rod 45 by cooperating threaded portions. The backward travel of operating rod 45 is limited by metal fitting 60 threaded into the gun body material, this last named fitting being coaxial with threaded rod 57 and having a recess within the fitting for permitting the rod to move longitudinally therein. As is explained later, valve operating rod 45 is normally spring biased toward the discharge end of the gun. This bias results in disk 56 being urged against offset pin 48. When trigger handle 46B is pressed toward gun handle 11, pin 48 not only moves against disk 56 to open the valve, but the upward component of the movement of pin 48 (as illustrated in FIGURE 8) creates a turning force for moving disk 56 clockwise as seen in FIGURE 8, this resulting in turning the valve operating rod. When the trigger is released, reverse turning of rod 45 results.

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In the normal condition of the gun, valve operating rod 45 is biased to a forward position so that normally the valve for the gun is closed. Pressing trigger 46B will result in longitudinal movement of rod 45 rearwardly of the gun, this opening the valve to permit coating material under high pressure to be discharged.

Valve operating rod 45 has portion 62 threaded into one end of valve operating rod portion 63 of electrically insulating material. This material may be of any material which can stand tension. For example, the rod may be of Bakelite, fiber, or any other material. Rod 63 is subject to tension—the amount need not be very great—so that this rod need not be very heavy or large in cross section. Rod 63 fits loosely within bore 40 of the gun barrel, leaving enough space around the rod within bore 40 to permit the flow of coating material under pressure when the gun is discharging.

The forward end of operating rod portion 63 enters into heavy metal insert 64 which cooperates with other metal members, to be described, to form a housing for the control valve. Metal insert 64 is generally cylindrical in shape and has passage 65 through the end wall thereof for accommodating operating rod portion 63. Inasmuch as coating material must pass around the outside of rod portion 63 into the interior of metal insert 64, it is desirable to provide sufficient clearance between the operating rod and passage 65 for accommodating the flow of coating material. Metal insert 64 has a substantial portion thereof, beginning from the rear end, externally threaded at 66 so that this insert may be turned into a correspondingly threaded recess within the gun barrel.

In view of the high pressures involved, it is understood that the wall thickness of the gun barrel between the exterior thereof and bore 40 will be sufficiently large to withstand the pressure and it is also understood that the length of threaded portion 66 of metal fitting insert 64 is sufficiently long so that a pressure-tight seal will be provided. It will be noted that electrical connecting member 35 of metal is adapted to engage externally threaded portion 66 for applying a high potential to the various metal parts of the gun at the discharge end. Metal insert 64 has cylindrical chamber 68 into which the forward end of operating rod portion 63 projects. Disposed within cylindrical chamber 68 is helical coil spring 69 which has its coils around operating rod portion 63. The forward end of operating rod portion 63 is recessed and threaded, as illustrated in FIGURE 5, to accommodate externally threaded shank 71 of metal forming part of metal ball valve retainer 72. Metal collar 73 is disposed around threaded shank 71 and collar 73 is large enough so that the forward end coil of spring 69 can rest against collar 73. Coil spring 69 biases valve retainer 72 to a valve closing position. When trigger handle 46B is removed to open the valve, the pressure of pin 48 against disk 56 results in the valve operating rod being tensioned to pull retainer 72 toward the rear of the gun against the compression of spring 69.

Collar 73 is disposed forwardly of cylindrical chamber 68 and is surrounded by the threads of internally threaded portion 75 of the forward portion of metal insert 64. This internally threaded portion 75 has a somewhat larger diameter than chamber 68 so that in the open or closed valve position, collar 73 will have some clearance around the outside by way of threads 75 to permit flow of coating material under pressure. Ball valve retainer 72 may have any desired shape and is here shown as having a generally square cross section with rounded edges. Ball valve retainer 72 has its forward end tapering at 76 and set in this tapered end is ball valve 77, of hard material. This ball may be of tungsten carbide or other refractory tough material and is cemented into the end of the retainer to be firmly attached thereto. Ball valve member 77 cooperates with the end of cylindrical valve seat 79 of hard material such as tungsten carbide. The end of the valve seat is tapered and is adapted to cooperate with

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ball 77 to form a tight closure. Both valve parts are ground to smooth finishes. Valve seat 79 is secured to cylindrical chamber 80 of metal valve retainer 81. Valve retainer 81 has externally threaded portion 82 which is outside of chamber 80. Externally threaded portion 82 cooperates with internally threaded portion 75 of metal insert 64. The forward end of insert 64 has a conically tapered seat which can cooperate with a correspondingly shaped seat on retainer 81 to form a high pressure seal.

Ball valve retainer 72 operates within chamber 80 of the valve seat retainer. In view of the generally square shape of ball valve retainer 72, there will be regions where coating material can flow past ball valve retainer 72 toward the valve seat when the valve is opened. By having a square shape with the corners of ball valve retainer 72 rounded, and making the large diameter of the resistor just a bit smaller than the inside diameter of chamber 80, a smooth valve action can be obtained with ball valve retainer 72 supported against transverse movement but freely movable longitudinally of the valve. Valve seat retainer 81 when threaded snugly against the forward end of metal insert 64 will form a smooth joint.

Metal valve seat retainer 81 has its forward end provided with cylindrical chamber 82a, this portion of the retainer having external threading 83. Resting within cylindrical chamber 82a is discharge nozzle assembly, generally indicated by 85 and shown in detail in FIGURE 4. This assembly provides a fine discharge bore coaxial with the bore through valve seat 79 and functions to discharge coating material under high pressure to atmosphere. The discharge nozzle assembly includes disk 86 of metal or plastic. Disk 86 is apertured at 87 at the center to form part of the bore. Disk 86 is disposed against cylindrical member 88 having reduced cylindrical portion 89. Disposed against reduced cylindrical portion 89 is nozzle block 90 of refractory material such as tungsten carbide, this having fine discharge opening 91 therethrough. Refractory nozzle block 90 can have any desired construction and is here shown as having a general cup shape. The discharge nozzle is through the bottom of this cup. Cup-shaped retainer 93 of plastic is disposed around the outer surface of refractory nozzle block 90 and has opening 94 therethrough to provide clearance for the nozzle tip part of block 90. The assembly of three parts 86, 88 and 93 is kept intact by metal pin 95 which is laterally offset from the axis of the nozzle assembly and is generally parallel to the axis thereof. Pin 95 has a sharp pointed end projecting beyond the nozzle discharge opening. Pin 95 has flat head 96 which normally is pressed against the adjoining metal of valve seat retainer 81. The plastic discharge nozzle assembly is maintained in position by metal retaining nut 97 and suitably shaped internally to fit the shoulder portion of part 93 of the assembly.

Metal washer 93a is provided as a seat for retaining nut 97. The plastic discharge nozzle assembly can be replaced with a conventional all-metal nozzle assembly as an emergency repair measure when necessary to keep the spray gun in production. This provides impaired but continuing operation in an emergency.

Cup-shaped cap 98 of electrically insulating material is provided to cover all exposed metal parts which are at high potential but is open to expose pin 95 and nozzle tip 90. Cap 98 may be of the same insulating material as body 10 of the gun or may be of different material, depending upon mechanical considerations. In any event, cap 98 has high electrical resistance and should be thick enough to provide both mechanical and electrical protection necessary. Cap 98 has internally threaded portion 99 which cooperates with a correspondingly threaded portion on gun body 10. O-ring 100 is disposed between opposing shoulders of the cap and gun body to provide a seal.

In the use of the gun, it is desirable to have the value of resistor 27 suitable for the potential to which the gun electrode is charged. Thus resistor 27 preferably has a

value of 25 megohms per 10,000 volts of applied voltage. As a rule, the minimum potential is of the order of 40,000 or 50,000 volts and the potential can go up as high as 100,000 volts.

The amount of lateral offset of high potential needle 95 from the axis of discharge nozzle is small and will generally be of the order of about $\frac{3}{16}$ of an inch. The needle itself can be about $\frac{1}{16}$ or $\frac{3}{16}$ of an inch. In general, the needle is long enough to project into the cloud of atomized material after it emerges from the nozzle. With the needle well within the cloud of atomized particles, excellent charging effects are obtained.

Atomization mechanically is promoted by the provision of the discharge nozzle and separate control valve arranged in tandem. The valve causes some initial atomization of the discharged material prior to the time that this material reaches the discharge nozzle. Thus, by the time the initially atomized material reaches the second discharge nozzle, the reduction in pressure at the discharge nozzle greatly adds to the atomization. This type of two-stage atomization is particularly effective for high pressure airless work.

The shielding of all highly charged metallic parts from atmosphere except for needle 95 promotes atomization and also makes the gun operation safe to handle for substantially the same reasons present in the copending application of A. C. Walberg, Serial No. 211,006, filed July 19, 1962.

What is claimed is:

1. In an electrostatic spray gun having discharge and rear ends, a barrel of electrically insulating material, said barrel having a bore therethrough, means for supplying coating material to said bore, valve operating rod means extending in said bore from the rear end thereof toward the discharge end thereof with clearance around said rod means within said bore for accommodating flow of coating material toward the bore discharge end, a valve structure including a valve seat within said barrel adjacent the discharge end thereof, said valve structure also including a valve member attached to the forward end of said valve operating rod means for cooperation with said valve seat, a helical spring disposed around said valve operating rod means and having its forward end cooperating with said valve member, means engaging the rear end of said spring for maintaining the same compressed and urging said valve member toward the gun discharge end to a valve closing position, means adjacent the rear end of said barrel for pulling the rear end of said valve operating rod means to open said valve against the compression of said helical spring, a nozzle assembly at the discharge end of the barrel for receiving coating material passing through said valve when the latter is open, said nozzle assembly including a nozzle and electrically conductive material having a sharp tip portion exposed to atmosphere and located in the discharge region of the gun for electrical charging of coating material discharged by said gun, said sharp tip portion extending forwardly beyond the nozzle, means insulated from atmosphere for charging all the electrically conductive material in said gun adjacent the discharge end of the barrel to a high potential with respect to work to be coated and solid insulation covering everything at the gun discharge end except said sharp tip portion and gun nozzle, said valve rod means being usable for any desired length of gun barrel and permitting substantial valve closing force to be used and the insulation of highly charged electrically conductive material permitting said sharp tip to create an intense electric field for highly efficient gun operation.

2. An electrostatic gun for spraying liquid coating material, said gun comprising a body provided with a passage for connection to a source of liquid coating material, said passage having an outlet, a valve structure and nozzle assembly secured to said body at said outlet, said valve structure including a valve seat and a valve member at

a forward end of valve operating rod means, a helical spring disposed around said valve rod means and having a forward end cooperating with said valve member, means engaging the other spring end for compressing the spring to urge said valve member to a closed valve position, means remote from the nozzle end of the gun for pulling on said valve rod operating means to open said valve against the compression of said spring, said nozzle assembly including a nozzle with a tip through which coating material passes into atmosphere, means for mechanically atomizing said coating material on nozzle discharge, said gun having some parts thereof adjacent the nozzle assembly of electrically conductive material through which coating material passes on its way to the nozzle, means connected to such electrically conductive material parts for charging the same to a high potential thereon with respect to work to be coated, electrical insulation for withstanding such high potential clearing the nozzle tip but covering all electrically conductive material in said gun charged to such high potential and a pin-shaped charging electrode connected to such high potential charged electrically conductive material, said charging electrode terminating in one sharp point exposed to atmosphere forwardly of the nozzle tip.

3. The construction according to claim 2 wherein said nozzle assembly includes a refractory nozzle proper, a plastic housing for said nozzle proper, said plastic housing consisting of at least two separate pieces, said electrical insulation having an opening for accommodating the end portion of said plastic housing, said electrically conductive material having the sharp tip being a pin passing through the plastic housing parts and being laterally offset from the discharge nozzle by a distance of the order of about $\frac{1}{4}$ " and extending into atmosphere for a short distance of the same general order as the lateral offset.

4. An electrostatic gun for spraying liquid coating material and gun comprising a body provided with a passage for connection to a source of liquid coating material, said passage having an outlet, a nozzle assembly secured to said body at said outlet, said nozzle assembly including a nozzle with a tip through which coating material passes into atmosphere, means for mechanically atomizing said coating material on nozzle discharge, said gun having some parts thereof adjacent the nozzle assembly of electrically conductive material through which coating material passes on its way to the nozzle, means connected to such electrically conductive parts for charging such parts to a high potential with respect to work to be coated, electrical insulation for withstanding such high potential clearing the nozzle tip but covering all such charged electrically conductive parts in said gun and a charging electrode connected to such charged electrically conductive parts extending through such insulation and providing a single pin laterally offset from the nozzle tip by a distance of the order of about $\frac{3}{16}$ " and terminating in one sharp point exposed to atmosphere located beyond the nozzle tip.

5. An atomizing spray gun for electrostatic coating having discharge and rear ends, said spray gun including a barrel of electrically insulating material, electrically insulating material covering the discharge end of the barrel but apertured to permit gun discharge into atmosphere, said barrel having a bore therethrough for coating material to travel toward the discharge end of the gun, valve means for controlling the flow of coating material through said gun for discharge therefrom, coating material discharge nozzle means including a nozzle at the discharge end of the gun through which coating material passes and is discharged into atmosphere, only one charging metal electrode separate from said nozzle carried by said gun and extending from within the gun insulation to atmosphere, the portion of said electrode exposed to atmosphere being a short pin having a sharp tip, said exposed electrode portion being laterally offset from the nozzle by a distance of the order of about $\frac{3}{16}$ " and ex-

tending forwardly of the gun generally parallel to the bore axis, the sharp tip being beyond the nozzle.

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