

Nov. 23, 1965

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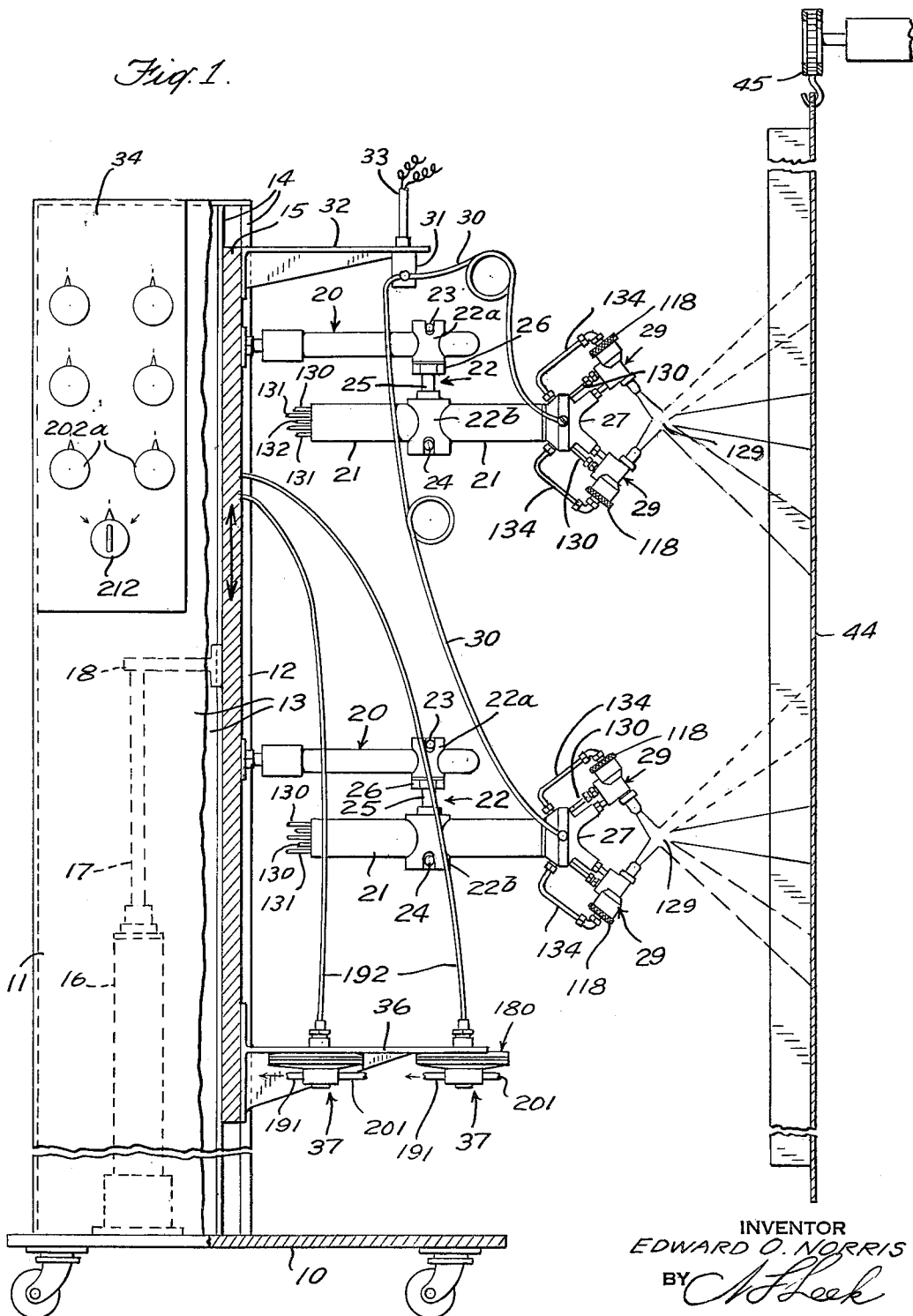
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PLURAL NOZZLES HAVING INTERSECTING SPRAY AND CONTROL THEREFOR

Filed Oct. 16, 1962

5 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

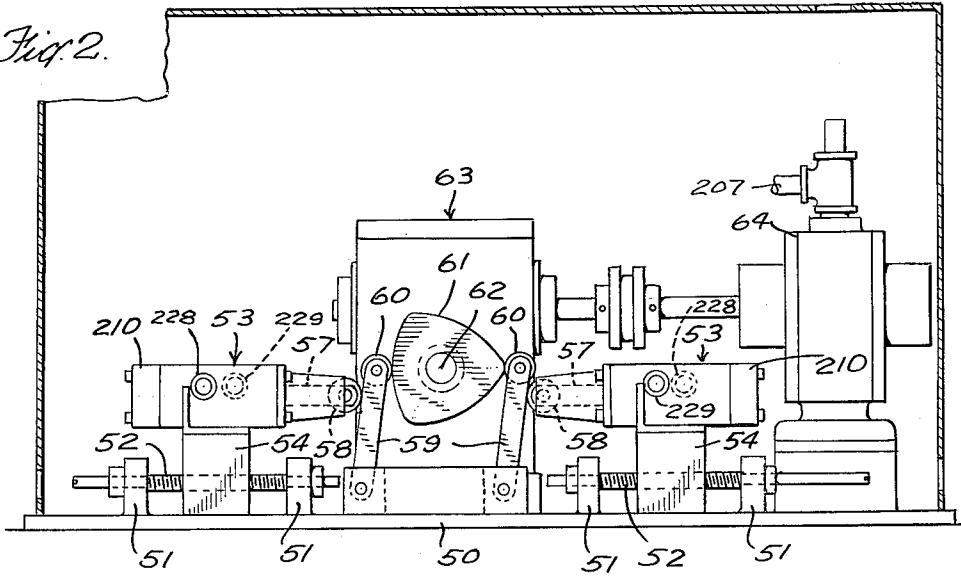


Fig. 3.

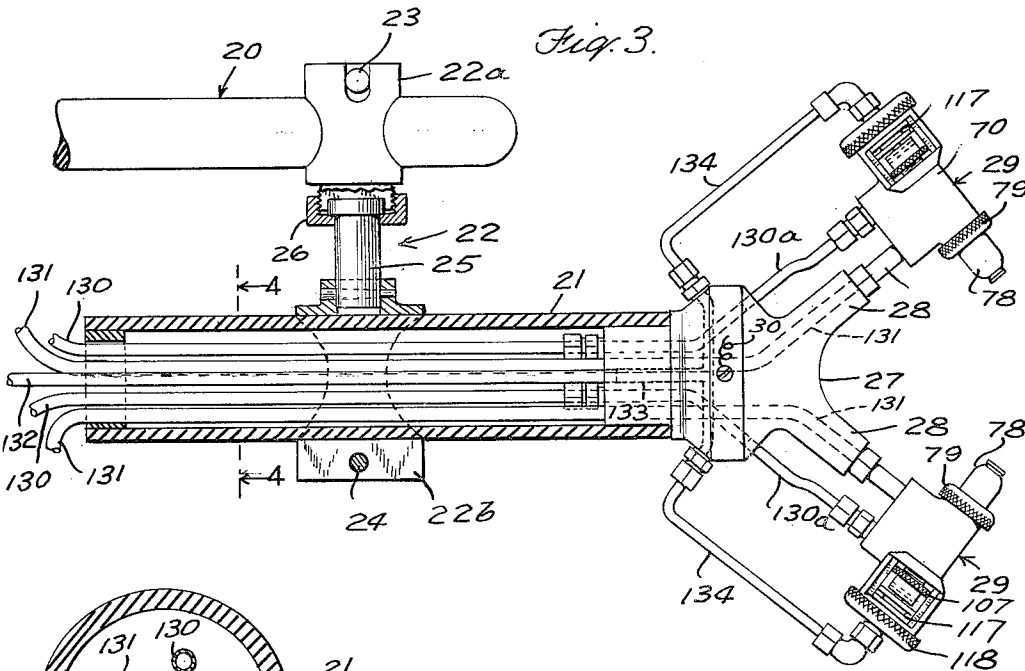
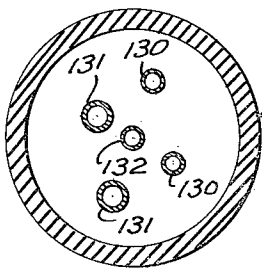


Fig. 4.



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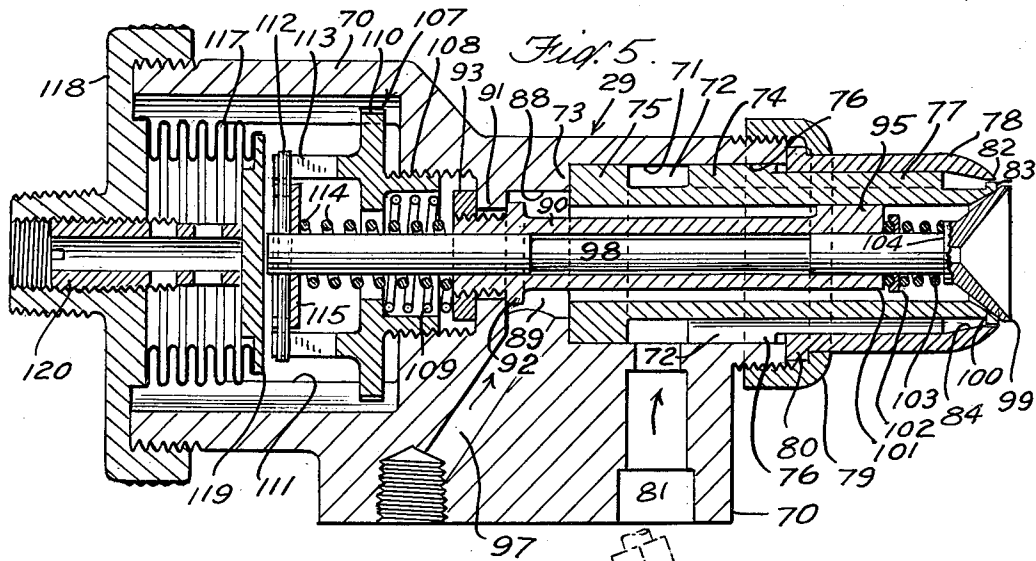
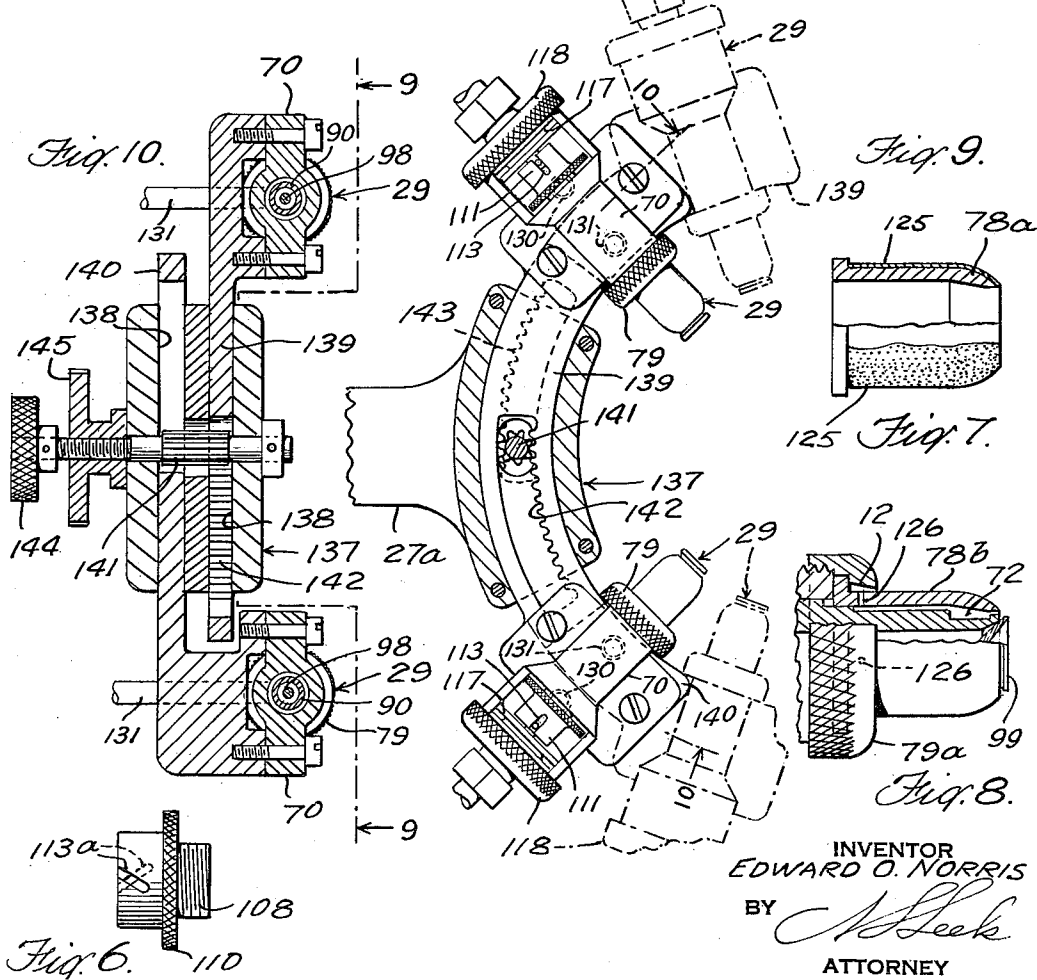
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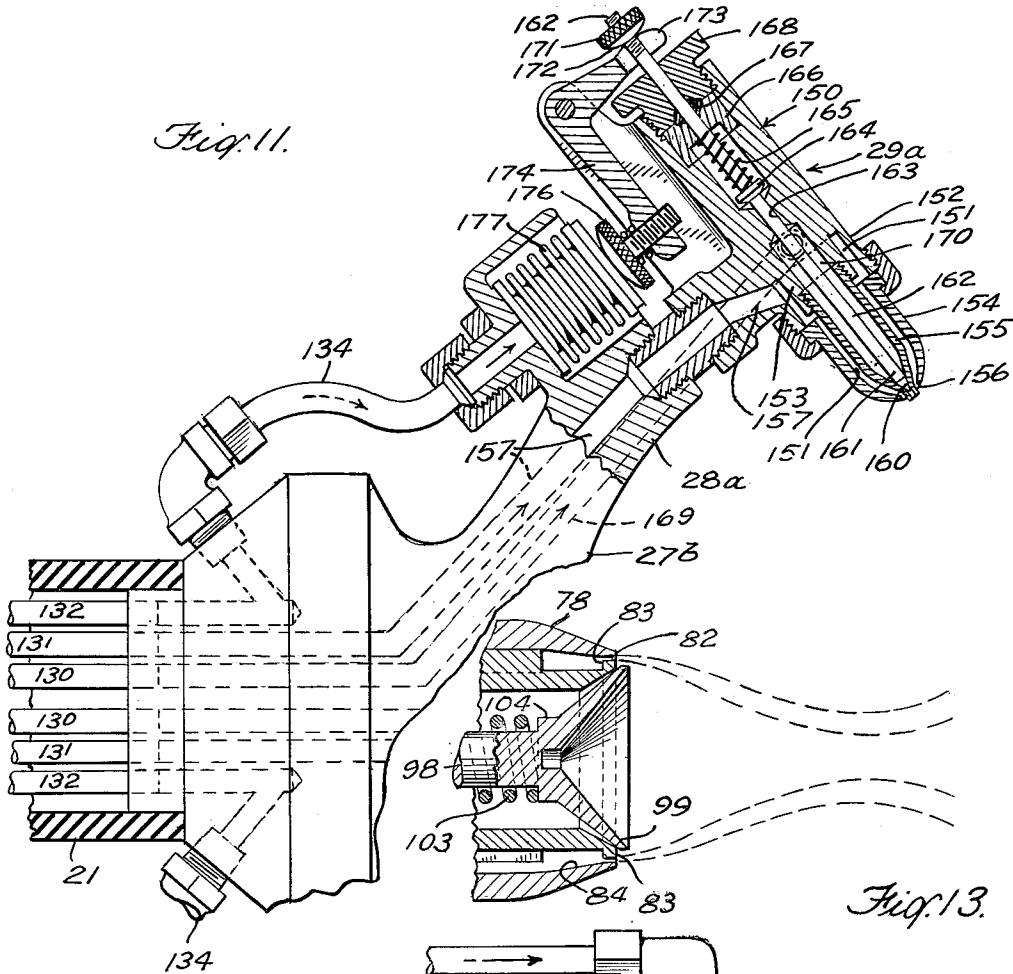
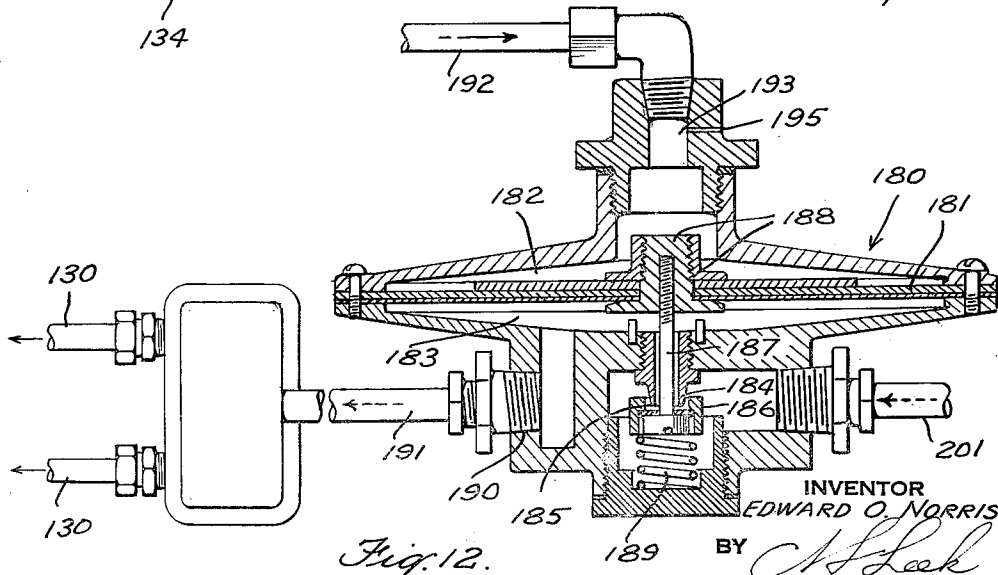


Fig. 13.

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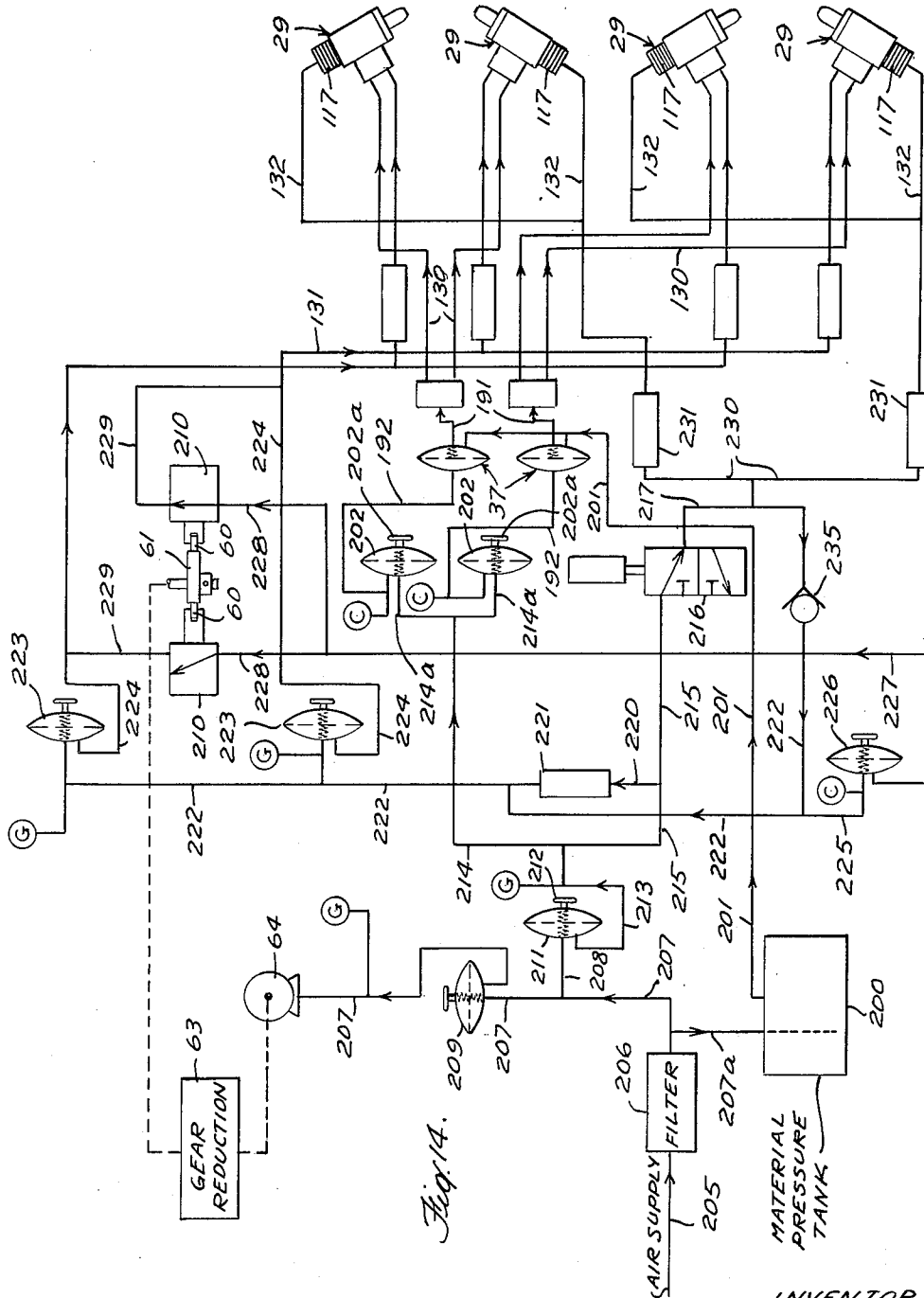
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PLURAL NOZZLES HAVING INTERSECTING SPRAY AND CONTROL THEREFOR

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3,219,276

PLURAL NOZZLES HAVING INTERSECTING SPRAY AND CONTROL THEREFOR

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6 Claims. (Cl. 239—186)

This invention relates to spraying devices and more particularly to two fluid type material atomizers.

An object of this invention is to provide a two fluid or "air gun" type atomizer with a maximum utilization of the atomizing gas energy.

Another object is to provide such an atomizer wherein the material being atomized may be simultaneously exposed to the corona of an electrostatic field.

A further object is to provide such an atomizer which produces uniformly sized and uniformly charged spray particles.

Another object is to provide such an atomizer which atomizes commercial volumes of materials to suitable particle sizes with ultra low air pressures and volumes.

A further object is to provide such an atomizer having means to controllably reduce the initial velocity of the atomized particles.

Another object is to provide such an atomizer which creates a fan-shaped spray where the spray fan may be rapidly oscillated without physical movement of the atomizer.

A further object is to provide a spray coating system with several spray heads having oscillating fans whose oscillation may be readily correlated.

Another object is to provide such an atomizer which may be precisely controlled for skip-spray operations.

A further object is to provide such an atomizer where the material to be atomized, exudes through an adjustable peripheral slot having remote means for momentarily increasing the slot opening to release any clogging particles.

Another object is to provide a system of the above type having a reciprocating spray head connected to a source of high tension electric potential wherein the head is electrically insulated from all control devices.

Various other objects and advantages will be apparent as the nature of the invention is more fully disclosed.

In accordance with this invention each air gun comprises a pair of nozzles having concentric passages for air and spray material discharging at a tip through concentric orifices to provide a cone of atomized spray. The two nozzles are mounted with their axes intersecting so that the sprays therefrom converge to form a fan-shaped spray pattern. This pattern is oscillated angularly by varying the air pressure to the respective nozzles. Also the guns may be mounted on a slide which is reciprocated vertically or horizontally so as to sweep the surface of the articles to be sprayed. The invention provides pressure control valves which are mounted to reciprocate vertically with the heads for controlling the pressure of the spray material as it is fed to the nozzles. Cam actuated valve means is provided for alternately varying the air pressure to the respective nozzles of each head for oscillating the spray pattern. Each nozzle includes a bellows actuated valve for the spray material passage. A remote controlled valve is adapted to control the supply of air to the various bellows and to the various nozzles for shutting off the jets of spray material and simultaneously interrupting the supply of atomizing air. A bleeder valve supplies bleeder air to the nozzles when the jets are shut off so as to prevent the spray material from clogging the nozzles. Remote control means is also provided for varying the material feed pressure during the operation of the heads.

The nature of the invention will be better understood from the following description, taken in connection with

the accompanying drawings in which a specific embodiment has been set forth for purposes of illustration.

In the drawings:

FIG. 1 is a vertical section through the spraying apparatus with parts in elevation;

FIG. 2 is a detail view on a larger scale of the valves for controlling the spray angle together with their operating mechanism;

FIG. 3 is a detail view on a still larger scale of the support for the spray gun with parts in section for clarity;

FIG. 4 is a transverse section taken on the line 4—4 of FIG. 3 but on a larger scale;

FIG. 5 is an axial section through a spray nozzle on an enlarged scale;

FIG. 6 is a detail view of the flanged sleeve for adjusting the needle valves;

FIG. 7 is a detail view of a coated nozzle tip;

FIG. 8 is a fragmentary view of a nozzle tip showing the bleeder hole;

FIG. 9 is a vertical section taken on line 9—9 of FIG. 10 showing the mechanism for adjusting the relative angles of the nozzles;

FIG. 10 is a curved section taken on the line 10—10 of FIG. 9;

FIG. 11 is a partial axial section similar to FIG. 5 illustrating a modified nozzle construction;

FIG. 12 is a vertical section through one of the remote controlled valves for regulating the material feed;

FIG. 13 is an enlarged sectional detail of the nozzle of FIG. 5; and

FIG. 14 is a schematic diagram of the control system for the spray mechanism.

Referring to the drawings more in detail the invention is shown as embodied in a paint spray apparatus comprising a movable platform 10 carrying a vertical cabinet 11 having a rear wall 12 and side walls 13. The rear wall 12 is provided with vertical channels 14 forming tracks on which slide 15 reciprocates. An actuating cylinder 16 mounted on the platform 10 carries a reciprocating piston having a rod 17 connected by a bracket 18 to the slide 15 for causing vertical reciprocating of the slide.

The slide 15 carries a pair of spray gun brackets 20 to each of which a cylindrical spray gun housing 21 is adjustably attached by coupling members 22. Each coupling member 22 has an upper part 22a which is slidably mounted for horizontal adjustment on the gun bracket 20 and is secured by a set screw 23. The cylindrical housing 21 is horizontally adjustable in the lower part 22b of the member 22 and is secured by a clamping bolt 24. The lower part 22b of the coupling member 22 is pivotally connected to the upper part 22a by a pin 25 and is secured in adjusted position by a nut 26.

Each cylindrical housing 21 carries a bracket 27 having diverging arms 28 on which spray nozzles 29 are secured.

The brackets 20 and the cylindrical housings 21 are made of insulating material. The bracket 27 is of metal and is connected by a line 30 to a terminal block 31 mounted on a bracket 32 secured to the slide 15 and supplied with a high electrical potential by a flexible lead line 33. A control box 34 for controlling the spray is mounted on a side wall 13. A bracket 36 carries a pair of remote controlled material feed valves 37 to be described.

Articles 44 to be sprayed are suspended on a traveling conveyor 45 which is supported by a suitable frame not shown.

In operation the slide 15 is reciprocated vertically as the articles are fed past the spray nozzles 29 so as to coat the exterior surfaces of the articles uniformly in a manner well known in the art. Suitable controls to be described are provided for regulating the spray and for shutting off the spray when the heads pass the surfaces to

be coated. The structure of the spray nozzles and the control system of this invention are more fully set forth below.

FIG. 2 illustrates the construction of the valve mechanism for controlling the spray-fan oscillation. This mechanism comprises a base 50 carrying pairs of blocks 51 in which adjusting screws 52 are journaled. Valve housings 53 are carried by blocks 54 which are threaded onto the adjusting screws 52 for lateral adjustment of the valves. Each valve housing 53 includes a valve chamber connected to an inlet pipe 55 and adapted to establish communication with an outlet pipe 56 when the valve is actuated or to break such connection when the valve is in closed position. Each valve is actuated by a plunger 57 carrying at its end a roller 58 which engages and is actuated by a pivoted arm 59. The arms 59 carry cam rollers 60 engaging opposite sides of a triangular cam 61 which is mounted on a shaft 62 driven through a reduction gear in box 63 from an air motor 64. The arrangement is such that the two valves are alternately actuated to supply air under pressure to the outlet lines 56 as the cam is driven by the motor 64.

Each spray nozzle 29 comprises a fixed housing 70 having at its forward end a bore 71 defining an air chamber 72 and terminating forwardly in a shoulder 73. An air sleeve 74 is disposed within the bore 71 and defines the inner wall of the air chamber 72. The air sleeve 74 carries at its forward end a sealing flange 75 which fits tightly within the bore 71 against the shoulder 73 to close the forward end of the air chamber 72. The sleeve 74 carries centering ribs 76 which seat within the bore 71 and projects rearwardly from the housing 70, the rearward extension carrying centering ribs 77 forming a continuation of the ribs 76. A cap 78 is disposed over the ribs 77 and is held in place by a clamping nut 79 engaging a shoulder 80 on the cap 78 and threaded onto the housing 70. Air is supplied to the air chamber 72 through an air passage 81 in the housing 70 and flows between the ribs 76 and 77 within the annulus between the air sleeve 74 and the cap 78 to an annular discharge orifice 82 defined by the end of the cap 78 and a flange 83 at the end of the air sleeve 74. The rearward end of the air passage within the cap 78 is tapered as shown at 84 to provide an increased air velocity at the discharge orifice 82.

Forwardly of the shoulder 73 the housing is formed with a bore 88 defining the outer surface of a material chamber 89. A paint sleeve 90 is disposed within the bore 88 to form the inner surface of the material chamber 89. The bore 88 terminates forwardly in a shoulder 91 against which a shoulder 92 of the sleeve 90 is clamped by a clamping nut 93. The sleeve 90 extends through the bore 88 and into the sleeve 74 and carries at its rearward end centering ribs 95 engaging the inner surface of the air sleeve 74. The housing is formed with a passage 97 for supplying material to be sprayed to the chamber 89.

A valve stem 98 carrying at its rearward end a valve flange 99 slides axially within the sleeve 90. The valve flange 99 is of conical form and is adapted to seat against a conical valve seat 100 formed in the end of the sleeve 74, as shown in FIG. 13. The portion of the valve stem 98 within the sleeve 90 is sealed against the spray material by a packing ring 101 which bears against the end of the sleeve 90 and engages a cup-shaped washer 102 which is held by a spring 103 disposed around the stem 98 and bearing against a shoulder 104 on the stem.

A flanged adjusting sleeve 107 is threaded into the housing 70 by loosely fitting threads 108 which permit limited axial movement of the sleeve 107. The sleeve 107 is biased forwardly by a spring 109 and is manually adjustable by a knurled flange 110 which is accessible through openings 111 in the housing 70. A cross pin 112 at the forward end of the valve stem 98 is adapted to slide axially in slots 113 formed in the adjusting sleeve 107. As shown in FIG. 5 these slots extend axially and

permit the valve to be rotated for adjustment by sleeve 107.

In operation, this combination functions, in conjunction with the outwardly opening valve, which forms the material feed slot, to permit clearing the slot during operation, by remote control.

This is done by causing the nozzles to "skip spray" by momentarily releasing air pressure from the bellows to cause spring 114 to close the valve and then again feeding compressed air to the bellows to cause the valve to open.

The fast rearward motion at disc 119 forces the valve open until the disc is stopped by the end of the flanged adjusting sleeve 107. However, its momentum causes sleeve 107 to momentarily move forward against the pressure of spring 109 due to the loose fitting threads 108. This causes the valve 99 to momentarily move forward and thus increase the width of paint feed slot to permit any clogging particles to be ejected. The valve slot then returns to its normal opening.

In FIG. 6 the slots 113a are shown as slightly helical so as to cause a slight rotation of the valve stem for cleaning purposes to prevent the valve seat from becoming contaminated. The type of slot used will depend upon the nature of the material being sprayed.

A valve spring 114 is disposed between a cup 15 on the valve stem 98 and the forward end of the sleeve 90.

The valve stem 98 is controlled by a bellows 117 the forward end of which is secured to a cap 118 which is threaded onto the forward end of the housing 70. The rearward end of the bellows 117 carries a disc 119 which is adapted to engage the end of the valve stem 98 for opening the valve when the bellows is extended. The disc 119 also engages the end of the adjusting sleeve 107 which forms a cushion stop to limit the opening of the valve. An adjustable hollow stop member 120 is disposed within the bellows 117 to bear against the inner surface of the end wall 119 to limit the contraction of the bellows. This stop member is adjusted to provide a small clearance with the end of the valve stem when the valve is in closed position.

In operation the spray material is supplied through the passage 97 to the chamber 89 thence along the annular passage between the sleeves 74 and 90 to the annular orifice between the valve flange 99 and the seat 100. This valve is normally closed by the spring 114 but is opened when air under pressure is supplied to the bellows 117.

Air under pressure for atomization of the spray material is supplied from the air passage 81 in the housing 70 to the air chamber 72, thence along the annular passage between the air sleeve 74 and the cap 78 to the annular orifice at the end of the cap 78 where it commingles with the spray material to form a cone-shaped spray. It will be noted that the air orifice at the end of the cap 78 lies in substantially the same plane as the inner orifice through which the spray material is supplied. This construction reduces the tendency of spray material to be deposited on the outer surface of the cap.

FIG. 7 shows a cap 78a similar to the cap 78 but with a coating 125 of an insulating and antiadherence material such as Teflon. This coating prevents spray particles from collecting on and adhering to the outer surface of the cap and also serves to concentrate the electric charge at the orifice end of the nozzle.

FIG. 8 illustrates a cap 78b having bleeder holes 126 which discharge air from the air chamber 72 against the under surface of a flange 127 on the clamping nut 79a. This flange is adapted to deflect the air rearwardly toward the nozzle tip so as to prevent collection of spray particles on the outer surface of the cap 78b. Either of these embodiments may be used in the nozzle construction of FIG. 5.

As illustrated in FIG. 3 the housings 70 of a pair of nozzles 29 are mounted on the diverging arms 28 of the bracket 27 in such position that the jets from the nozzles

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impinge on each other and form a flat, fan-shaped spray pattern 129 as shown in FIG. 1.

As illustrated in FIG. 3 the material to be sprayed, such as paint, is supplied to the two nozzles by pipes 130 extending through the cylindrical housing 21 and to passages in the bracket which communicate with the material passages 97 in the housings 70. Air under pressure for spraying is supplied through pipes 131 which pass through the cylindrical housing 21 and the bracket 27 to communicate with the air passage 81 in the housings 70. Control air for the bellows 117 is supplied by a single pipe 132 which communicates with a passage 133 in the bracket 27. This passage 133 divides to communicate with a pair of pipes 134 which communicate with the interiors of the respective bellows 117. The pipes 130, 131, and 132 may be formed of flexible tubing of electrical insulating material such as nylon or a polyethylene material.

FIGS. 9 and 10 illustrate an embodiment wherein the angle between the two nozzles is made adjustable. In this form bracket 27a corresponds to the bracket 27 of FIGS. 1 and 3. The bracket 27a terminates in a transverse, arcuate member 137, having a pair of arcuate channels 138 in which arcuate racks 139 and 140 slide. Each of these racks carries a housing 70 of the type described, which housings are disposed on opposite sides of the axis of the bracket 27a. A pinion 141 journaled in the walls of the member 137 engages teeth 142 and 143 on concave and convex arcuate surfaces respectively of the two racks so that the racks are actuated in opposite directions by the pinion 141. The pinion carries an actuating knob 144 and a locking knob 145. The arrangement is such that upon rotation of the actuating knob the two racks are shifted in opposite directions so that the two nozzles 29 are spaced apart and angularly rotated from an inner position as shown in full lines in FIG. 9 to an outer position as shown in dotted lines, with a consequent increase in the relative angles of the jets. The shape of the fan of spray 129 can thus be controlled as desired.

In the embodiment of FIG. 11 the nozzle 29a comprises a housing 150 having an annular air chamber 151 formed by an outer wall 152 and an inner concentric wall 153. An outer cap 154 is attached to the rearward end of the wall 152 and an inner concentric cap 155 is attached to the inner wall 153. The caps 154 and 155 are spaced to form a rearward continuation of the air annulus 151 terminating rearwardly in an annular air orifice 156. The housing 150 contains an air supply passage 157 opening into the air chamber 151. The inner cap 155 is formed with a conical valve seat 160 against which a needle valve 161 seats. The needle valve 161 has a stem 162 mounted to slide in a bore 163 in the housing 150. Forwardly of the bore 163 the stem 162 carries a shoulder flange 164 which is pressed rearwardly by a spring 165 for closing the valve opening. The spring 165 bears against a cup 166 which contacts a packing ring 167 disposed in a packing gland closed by a nut 168 threaded into the housing 150. A passage 169 for the spray material communicates with the annulus 170 between the stem 162 and the wall 153 through which the spray material is fed to the needle valve 161. The stem 162 extends forwardly beyond the housing 150 and carries at its forward end an adjustment nut 171 having a spherical rear surface 172 against which a bifurcated arm 173 presses for opening the valve. The arm 173 is pivoted to the housing 150 and at its other end carries an adjusting screw 176 engaging the end of a bellows 177. The bellows is secured to an arm 28a attached to the bracket 27b. The bellows is supplied with air for expanding the bellows to open the needle valve by pipe 134.

In this embodiment the operation is similar to that of FIG. 5 except that the needle valve is shifted rearwardly to open position.

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FIG. 12 illustrates a remote controlled valve of the type used for regulating the feed of spray material to the nozzles. This valve comprises a housing 180 carrying a diaphragm 181 dividing the housing 180 into an air chamber 182 and a material chamber 183. A bleeder hole 195 in the housing 180 communicates with the chamber 182 to facilitate air release. Spray material enters through 201 and is supplied to the chamber 183 through an orifice 184 in the housing 180 having a valve seat 185 adapted to be closed by a valve head 186 on a stem 187 attached to the diaphragm 181 by clamping members 188 and pressed into closed position by a spring 189.

Spray material is discharged from the chamber 183 through an outlet opening 190 connected to a pipe 191. Air is supplied to the chamber 182 by a pipe 192 through a port 193. The arrangement is such that an increased air pressure in the chamber 182 tends to open the valve 186 to cause the pressure of the material in the chamber 183 to build up until the air pressure is balanced by the pressure of the material in the latter chamber. Hence the pressure of the material fed to the nozzles is varied by a corresponding variation in the air pressure supplied to the air chamber 182.

Referring to the system shown in FIG. 14 the material to be sprayed is fed from a material tank 200 under pressure through a pipe 201 to a pair of remote controlled material feed valves 37, the type of which is shown in FIG. 12. From the valves 37 the material is supplied by pipes 191 to the material feed pipes 130 of FIG. 3 which feed the material to the nozzles 29 of each head.

Air under pressure is supplied from a supply line 205 through filter 206 to a T having branches 207 and 208. Branch 207 is connected through a pressure regulator valve 209 to supply air to the air motor 64 which is connected to drive cam 61 of the spray angle control valves 210 which are shown in detail in FIG. 2. A branch line 207a supplies pressure to the material tank 200 through a pressure regulator (not shown). The branch 208 leads to a pressure regulator valve 211, the output pressure of which is controlled by a control knob 212. The outlet side of the valve 211 is connected by a pipe 213 to a T having branches 214 and 215. The branch 214 connects to lines 214a leading to a pair of pressure control valves 202 which are mounted on the cabinet 34. The output pressure of the valves 202 which is controlled by knobs 202a is fed by lines 192 to the pressure regulating chamber of the material feed valves 37. Hence the pressure of the material fed to the nozzles can be controlled by suitable actuation of the knobs 202a while the nozzles are reciprocating.

The branch 215 connects to a remote control, solenoid-operated, three-way valve 216 having an outlet pipe 217. The valve 216 normally connects the inlet pipe 215 to the outlet pipe 217 but is adapted when energized to shutoff inlet pipe 215, and to vent the pipe 217 to the atmosphere.

From the line 217 air is supplied through check valve 235 and line 222 to a pair of low pressure regulator valves 223, the outputs of which are connected by lines 224 to the air supply pipes 131 of the various nozzles. From the line 222 air is supplied by line 225 to high pressure regulator valve 226 having an output line 227 connected by lines 228 to the angle control valves 210. The outlet sides of angle control valves 210 are connected by lines 229 connected to the nozzle lines 131. From lines 217 branch lines 230 lead to a pair of needle valves 231 the outlet sides of which are connected by lines 132 to the bellows 117 of the various nozzles. A needle valve 221 is connected between the line 215 and the line 222 to supply bleed air to the nozzles when the solenoid valve 216 is closed so as to prevent spray material from collecting on and clogging the nozzles.

In the operation of this system the spray is controlled by the solenoid operated valve 216 which may be actuated automatically by the slide 15 when the spray heads pass the upper or lower edges of the articles being sprayed.

They may also be actuated either automatically or manually to shut off the spray between articles. When the solenoid valve 216 is opened air under pressure is supplied to the various bellows 117 to open the nozzle valves 99 in the material feed orifices. Air for atomization at a given low pressure is also supplied from valves 223 and 224 to the nozzles and air under a higher pressure is fed to the cam actuated angle control valves 210 which supply pulses of such high pressure air to the respective nozzles for oscillating the spray pattern.

When the solenoid valve 216 is closed the air supply to the bellows 117 is cut off and the bellows are vented to the atmosphere to close the nozzle valves 99. Atomizing air is also cut off except for the bleeder air through the needle valve 221 which supplies sufficient air to prevent the nozzles from clogging.

By mounting the material feed valves 37 on the slide any variation in pressure of the material due to a change in relative height is eliminated. This pressure can be readily adjusted by the manual knob 212 which varies the air pressure to the pressure chambers 182 of the valves 37. The spray is instantly shut off without drip when the solenoid valve 216 is closed and is instantly restored when this valve is again opened.

One major feature of this invention is the manner in which the initial air jet and spray particle velocities are retarded by the impingement of the converging spray jets.

Relatively slow, controlled velocity, highly charged, spray particles are of great importance to high efficiency electrostatic coating operations.

One of the major reasons why electrostatic air spray (two fluid type) operations have not been considered very efficient in the past, has been due to a very considerable extent, to the relatively high air and particle velocities in the coating area.

The following particle velocity figures, determined by actual tests, will illustrate this feature.

The particle and air velocity measured at 11 inches from one of these nozzles, with 5 p.s.i. of atomizing air pressure has been measured to be in the order of 1100 ft./min. When one of these dual nozzle sprayheads has the nozzle so mounted that their spray jets converge at an included angle of 101 degrees, the resultant air and particle velocities have been measured to be in the order of 630 ft./min. While this compares favorably with the measured air and particle velocity of 1100 f.p.m. at 11 inches from a standard low pressure air spray gun at 15 p.s.i. atomizing air pressure and also with the above described velocity of a single nozzle, it still compares unfavorably with the measured velocity at 11 inches from a rotating atomizing disc, of 250-350 f.p.m.

The effect of these relative velocities on the electrostatic deposition, attraction and "wrap around" was determined by actual coating tests, the high velocities resulting in definitely poorer efficiencies and coating results.

It has now been determined that when a pair of these nozzles are so associated that the spray jets converge at included angles in the order of 130 to 140 degrees, the resulting particle velocities are in the order of 130 to 170 f.p.m. This has been found to result in excellent deposition efficiency. However, one factor limiting this type of convergence angle, is the necessity for avoiding the coating of the nozzles and air caps by the opposing spray stream.

One important factor in the avoidance of this air cap coating buildup, is the equal, similar, high voltage charges on both the exterior areas of the nozzles and the spray particles, so that the particles from one nozzle are repelled and deflected away from the exterior of the other nozzle.

This requires a type of atomizing nozzle which imparts high, uniform charges to all the spray particles. Another requirement in the performance characteristics of these nozzles, is that the spray jets assume and maintain a relatively tightly bunched aspect, in spite of the mutual par-

ticle repulsion, until they reach the point where the jets impinge. Excessive jet spread will result in undesirable nozzle coating.

It is also important that the size of the particles be relatively uniform, as excessively large particles appear to spread and collect on the opposing nozzle.

The type of nozzle shown herein appears to most closely meet the above requirements. Here, the physical arrangement of the components with the hollow cone in the center surrounded by a sharp atomizing and charging rim, imparts a uniform size and charge to the particles. The central concave cone appears to be particularly effective in causing the spray stream to converge and to maintain a relatively narrow stream.

At a given fan-oscillation rate and pulse differential pressure, a 104 degree angle head, at 12 inches from the workpiece, fully covered an area 12 inches wide, a 135 degree angle head, under identical conditions, covered an area 18 inches wide.

The material spray rate at each nozzle tends to be slightly increased at the moment when a higher air pressure oscillating pulse is fed to the nozzle. This is considered to be due to the increased Venturi action of the higher air velocity. It results in a more uniform coating across the oscillation stroke by compensating for the normally lower deposition rate toward the ends of the stroke caused by the angle at which the fan strikes the work surface in these end stroke areas.

In some instances as when the spray reaches the end of the surface to be sprayed the material feed of one of the nozzles may be cut off while retaining the oscillating air pressure so that the spray fan is reduced in intensity and over-spray is reduced at this point. Alternate nozzles of each pair may be cut off in this way when the spray reaches opposite edges of the surface to be sprayed.

What is claimed is:

1. Apparatus for spraying articles comprising a slide, means mounting said slide for vertical reciprocation, a horizontal bracket on said slide, an arm pivoted to said bracket for adjustment about a vertical axis, and a pair of spray nozzles carried by said arm, said nozzles being positioned to project intersecting spray patterns adapted to commingle to form a spray fan, a stationary source adapted to supply spray material at a predetermined pressure and means including a constant pressure valve mounted on said slide and connected to supply said material from said source to said nozzles at a constant pressure while the input pressure at said valve varies according to change in pressure head as the valve reciprocates vertically.

2. Apparatus as set forth in claim 1 including a coupling member connecting said bracket and said arm for relative axial adjustment, said coupling member having means for effecting pivotal movement of said arm about a vertical axis.

3. Spraying apparatus comprising a vertical support, means causing vertical reciprocation of said support, a spray head carried by said support, a control valve on said support connected to said nozzle and having means supplying spray material to said nozzle at a predetermined constant pressure, a stationary source supplying spray material at a predetermined pressure, and means supplying said spray material from said source to said control valve at a pressure determined by the pressure of said source and by the pressure head between the source and said control valve which varies according to the elevation of said reciprocating valve.

4. Spraying apparatus according to claim 3 in which said control valve includes means for adjusting the predetermined pressure at which the spray material is supplied therefrom to said nozzle.

5. Apparatus as set forth in claim 4 in which said adjusting means comprises a pressure actuated diaphragm and means including a remote pressure control valve connected to control the pressure applied to said dia-

phragm for thereby varying the pressure supplied by said first control valve to said nozzle.

6. Apparatus as set forth in claim 5 in which said pressure control valve is connected to said first control valve by a flexible coupling having insulating characteristics and an electrostatic potential is applied to said nozzle for charging the spray material ejected therefrom.

References Cited by the Examiner

UNITED STATES PATENTS

1,752,923	4/1930	Mueller	239—292
2,342,757	2/1944	Roser	239—536
2,588,125	3/1952	Knowland et al.	118—315
2,610,092	9/1952	Thompson	239—295

2,683,626	7/1954	Wahlin	239—536
2,696,449	12/1954	Ericks et al.	118—313
2,728,238	12/1955	Paasche	239—186
2,823,143	2/1958	Upperman.	
2,864,649	12/1958	Adams	239—411
2,879,947	3/1959	Siefen	239—411
3,008,648	11/1961	Brady et al.	239—186
3,035,776	5/1962	Klemp	239—186
3,040,701	6/1962	Minnick et al.	118—315
3,053,461	9/1962	Inglis	239—411

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EVERETT W. KIRBY, *Examiner*.

Disclaimer and Dedication

3,219,276.—*Edward O. Norris*, Westport, Conn. PLURAL NOZZLES HAVING INTERSECTING SPRAY AND CONTROL THEREFOR. Patent dated Nov. 23, 1965. Disclaimer and dedication filed Apr. 2, 1969, by the assignee, *The Gyromat Corporation*.

Hereby enters this disclaimer and dedication to the Public to claims 3 and 4 of said patent.

[*Official Gazette December 9, 1969.*]