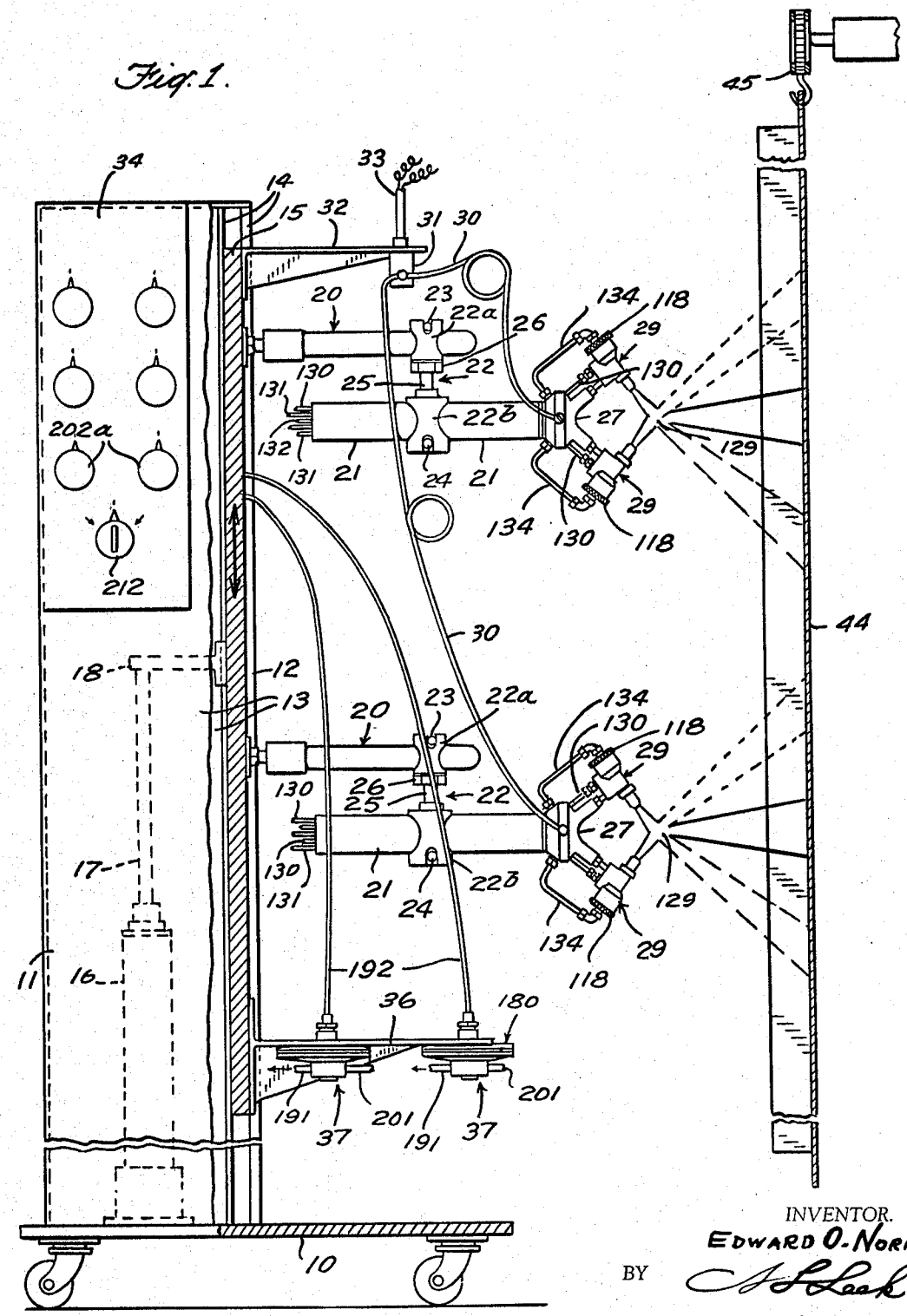
Jan. 31, 1967 E. O. NORRIS 3,301,488

SPRAY GUN

Filed Aug. 19, 1965 5 Sheets-Sheet 1

Fig. 1.



INVENTOR.
EDWARD O. NORRIS

BY

ATTORNEY

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Fig. 2.

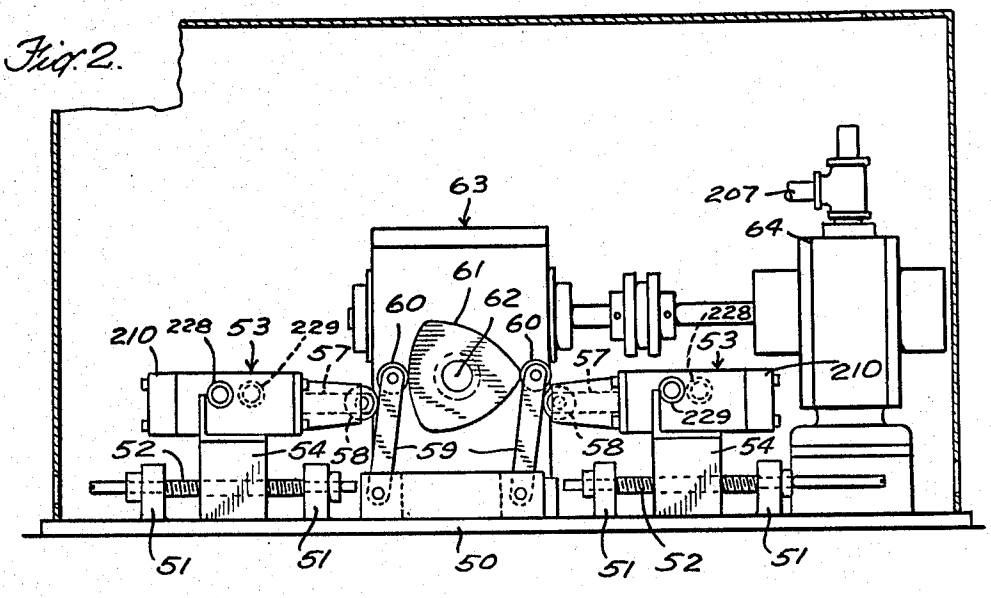
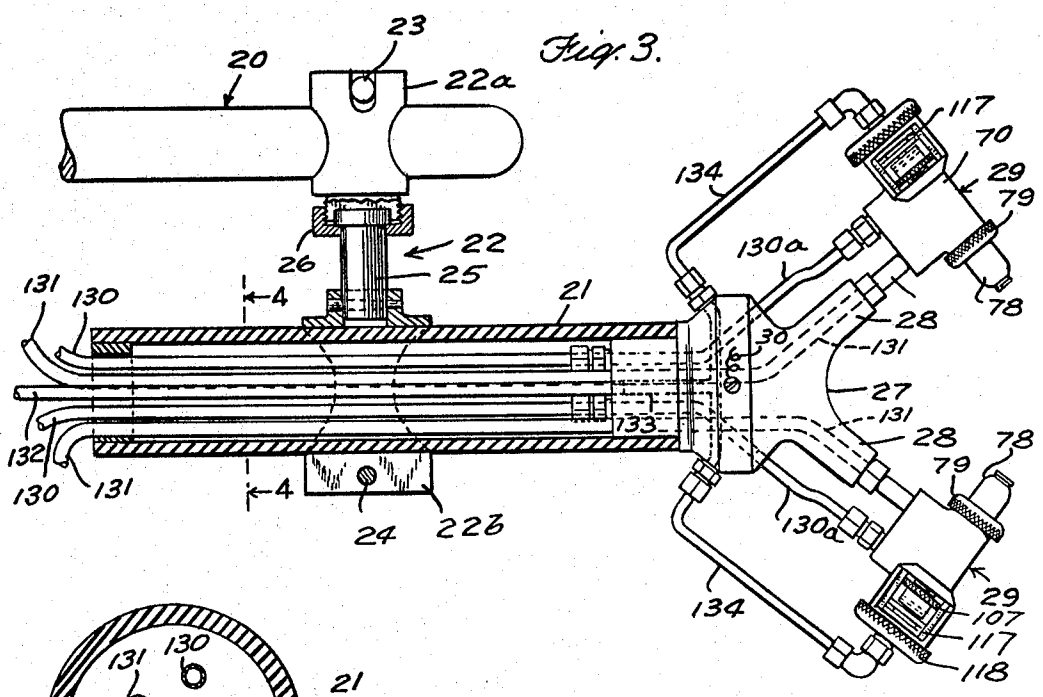


Fig. 3.



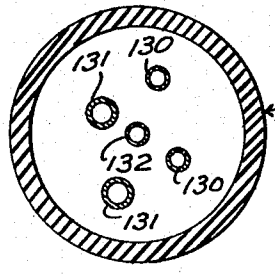


Fig. 4.

INVENTOR.
EDWARD O. NORRIS
BY
ATTORNEY

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Fig. 5.

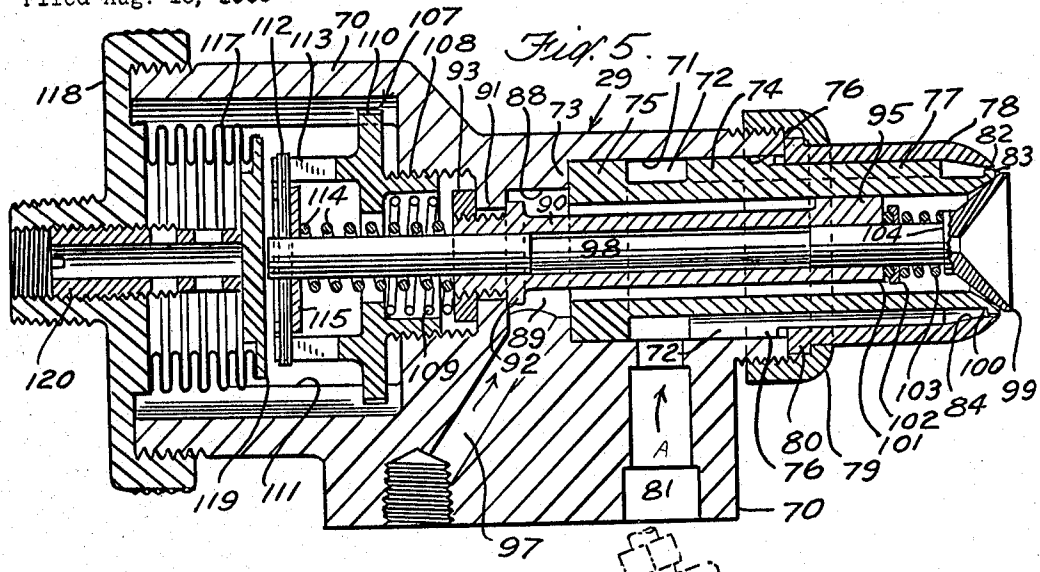


Fig. 10.

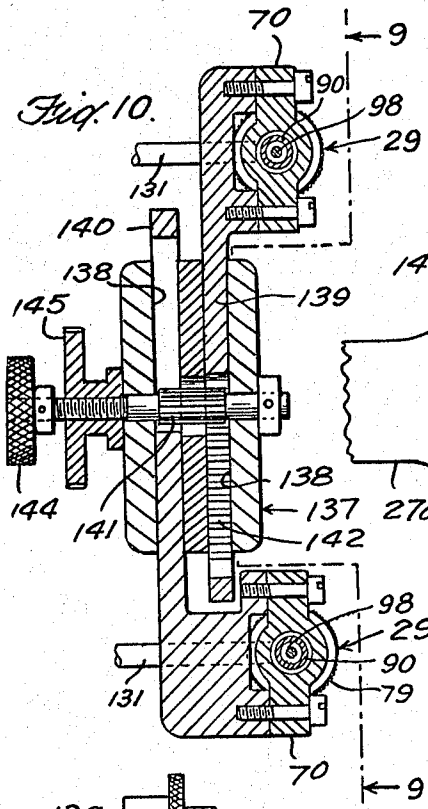


Fig. 9.

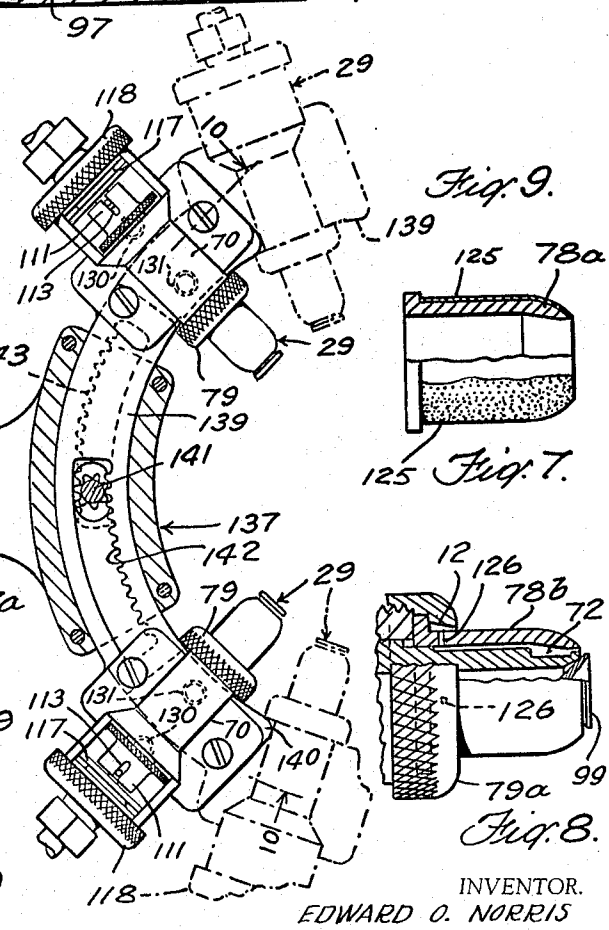
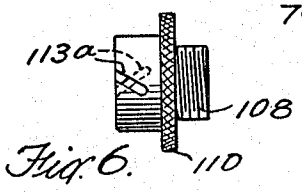


Fig. 7.

Fig. 8.

Fig. 6.



INVENTOR.
EDWARD O. NORRIS

BY

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ATTORNEY

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Fig. 11.

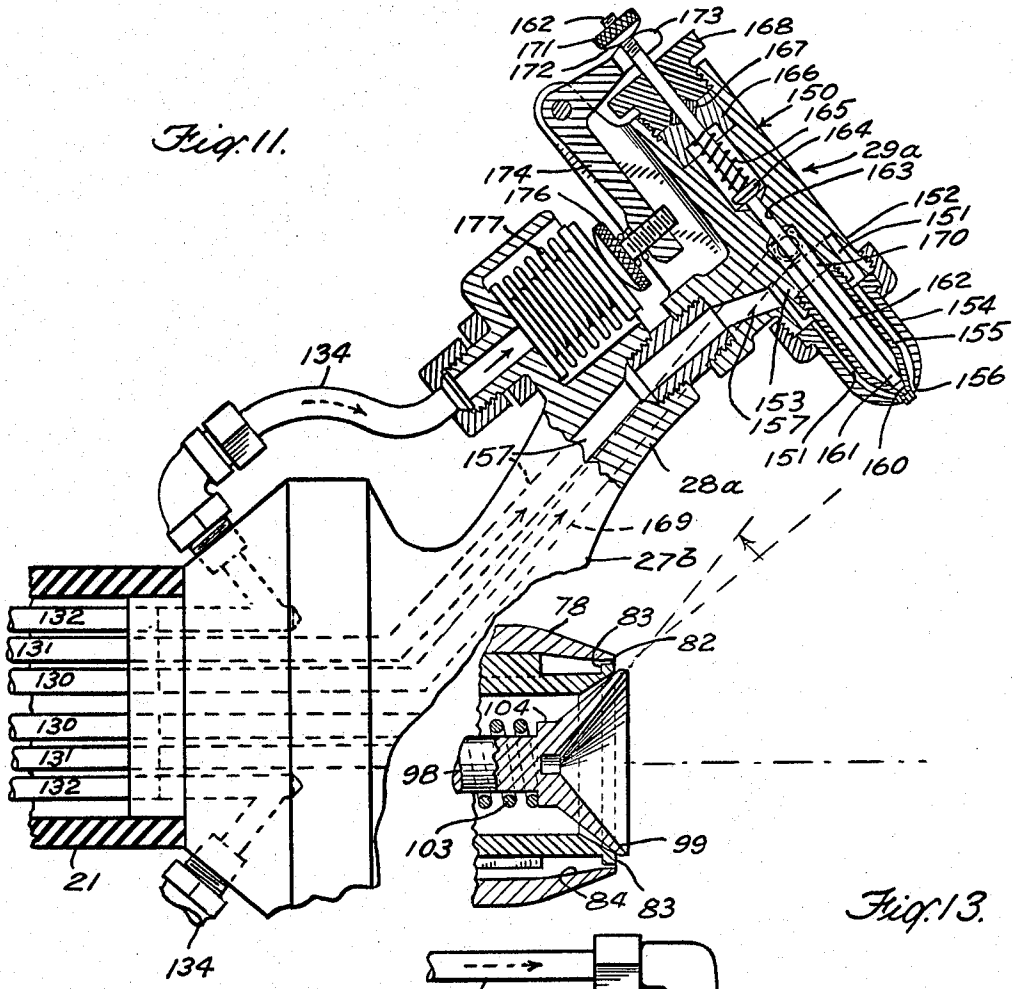

Fig. 13.

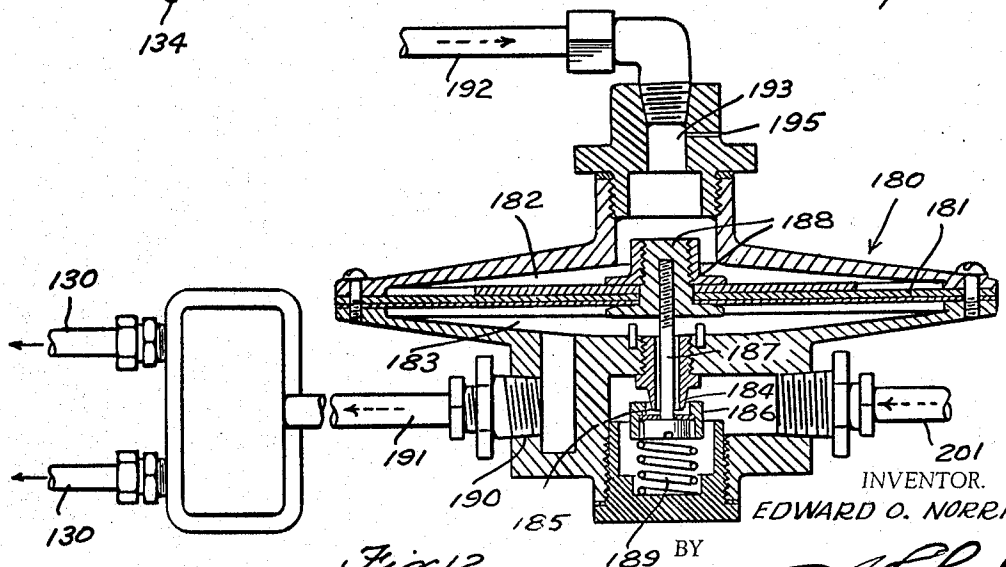

Fig. 12.

INVENTOR.
EDWARD O. NORRIS
BY
ATTORNEY

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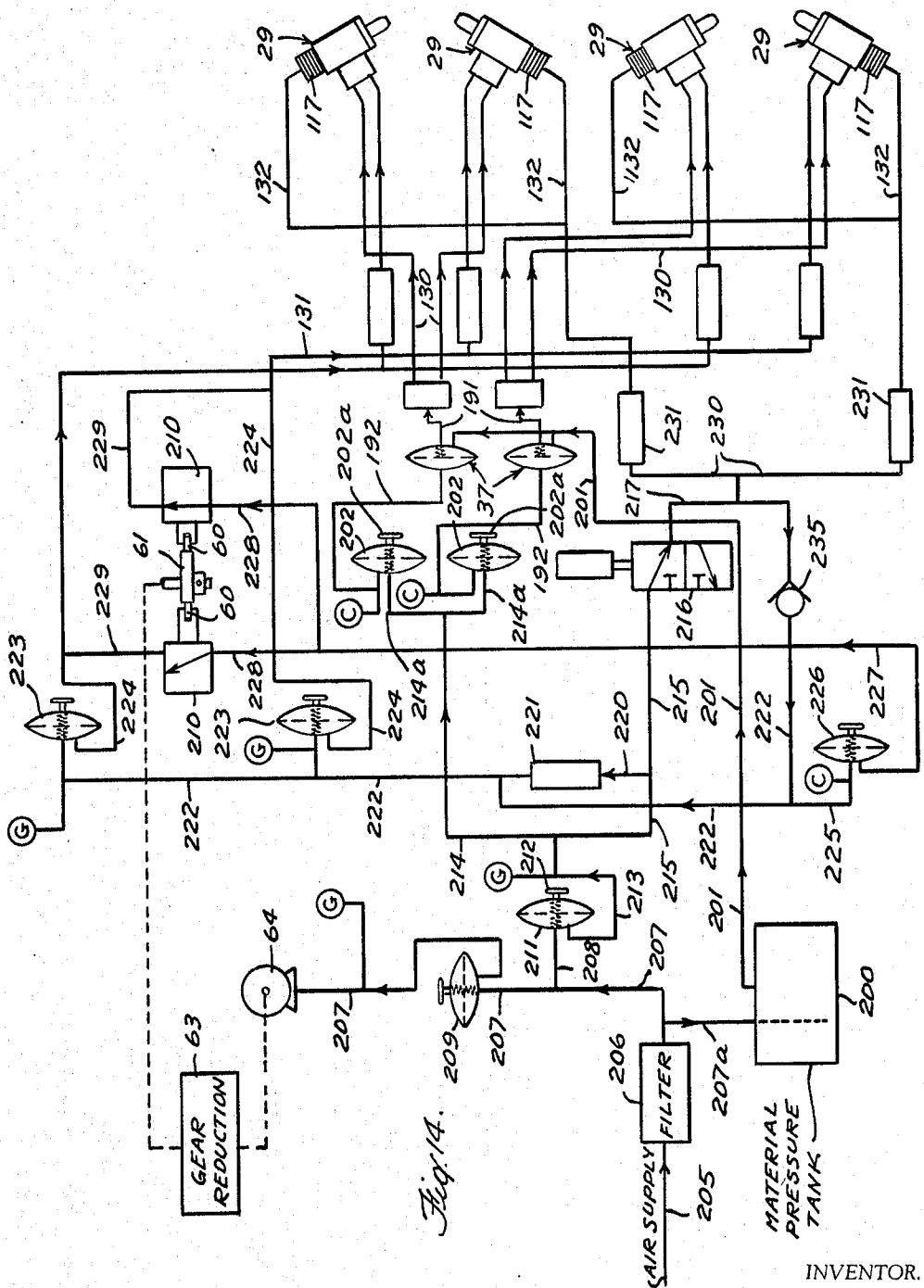

Fig. 14.

INVENTOR.
EDWARD O. NORRIS
BY
ATTORNEY

United States Patent Office

3,301,488
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3,301,488

SPRAY GUN

Edward O. Norris, Ledgemoor Lane,
Westport, Conn. 06880

Filed Aug. 19, 1965, Ser. No. 481,025
20 Claims. (Cl. 239—186)

This application is a continuation-in-part of my copending applications Serial No. 85,312 filed January 27, 1961 and Serial No. 230,867 filed October 16, 1962.

This invention relates to spraying devices and more particularly to fluid type material atomizers. The invention is particularly applicable to two-fluid type atomizers, for electrostatic paint spray systems and the like, although the invention is not necessarily limited thereto.

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 produce 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 head for controlling the pressure of the

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spray matreial 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 embodiend 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 reciprocation 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 **22***a* which is slidably mounted for horizontal adjustment on the gun bracket **20** and is secured by a set screw **23**. The cylindrical hous-

ing 21 is horizontally adjustable in the lower part 22*b* of the member 22 and is secured by a clamping bolt 24. The lower part 22*b* of the coupling member 22 is pivotally connected to the upper part 22*a* 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 bracket 27 and nozzle 29 constitutes a spray head

The bracket 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 over a predetermined path which corresponds in length to the spacing between adjacent spray heads so that adjacent spray heads coat contiguous areas of the surface which is being sprayed. 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 journalled. 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 will 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 first 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 113*a* 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 115 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 **78***a* similar to the cap **78** but with a coating **125** of an insulating and anti-adherence material such as Teflon. This coating prevent 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 **78***b* having bleeder holes **126** which discharge air from the air chamber **72** against the under surface of a flange **127** on the clamping nut **79***a*. 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 **78***b*. 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 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 brackets 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 passages **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 **27***a* corresponds to the bracket **27** of FIGS. 1 and 3. The bracket **27***a* 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 **27***a*. A pinion **141** journalled 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 or spray **129** can thus be controlled as desired.

In the embodiment of FIG. 11 the nozzle **29***a* 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 adjusting 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 **28***a* attached to the bracket **27***b*. 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.

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 **207***a* 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 **214***a* 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 **202***a* 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 **202***a* 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 shut-off 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.

The spray fan normally lies in a plane bisecting the angle between the nozzles. This plane is oscillated in response to variations in the air pressure supplied to the respective nozzles. In the case of a plurality of spray heads mounted to reciprocate in unison the nozzles are preferably so arranged that the plane of the spray fans lies parallel to the path of reciprocation. The spray fans are then oscillated in unison by the controlled high pressure air which is supplied alternately to the respective nozzles of each head. In this way a substantial area is coated uniformly by the various heads.

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.

It has now been determined that when a pair of nozzles are so associated that the spray jets converge at included angles in the order of 100° to 140°, the resulting particle velocities in the spray fan are reduced to a value suited for electrostatic deposition purposes.

A preferred range of 125° to 135° has been found to result in excellent deposition efficiency. While an increased angle of convergence produced a lower spray velocity in the fan, the angle of convergence is limited by 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 build-up, 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 particle 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.

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. A spray head arrangement of the two-fluid type for a paint spray system or the like, comprising a pair spray nozzles, each of said nozzles having means to discharge a jet of spray material suspended in carrier gas, at a given velocity, means supplying carrier gas to both of said nozzles under a predetermined pressure sufficient to finely atomize the jets of spray material issued from each nozzle, said nozzles being mounted at a relative angle of from 100 degrees to 140 degrees to cause the jets therefrom to converge and impinge on each other and form a fan of spray which lies in a plane dividing the angle between said nozzles and in which the spray particle velocity is significantly low compared to the spray particle velocity in said jets.

2. A spray head comprising a pair of spray nozzles having spray discharge openings through which jets of spray material are discharged, at a given velocity, said nozzles being disposed at a relative angle to cause said jets to converge and impinge on each other and thereby form a flat fan of spray which lies in a plane dividing and typically bisecting the angle between said nozzles and in which the spray particle velocity is low compared to the velocity in said jets, means supplying a spray material under pressure to both of said nozzles, and means varying the relative velocities of the jets discharged

from the respective nozzles for thereby varying the displacement of the plane of the fan of spray with respect to said nozzles.

3. A spray head of the gas jet type comprising a pair of spray nozzles, each of said nozzles having means to discharge a jet of spray material suspended in carrier gas, at a given velocity, means supplying carrier gas under a predetermined pressure to both of said nozzles, said nozzles being mounted at a relative angle to cause the jets therefrom to converge and impinge on each other and form a fan of spray which lies in a plane dividing and typically bisecting the angle between said nozzles and in which the spray particle velocity is low compared to the velocity in said jets, and means varying the relative gas pressures supplied to the respective nozzles for thereby varying the angular displacement of said fan with respect to said plane.

4. A spray head comprising a pair of spray nozzles, each of said nozzles having an axial material passage for spray material and a gas passage concentric therewith for gas under pressure, said passages terminating in concentric discharge openings disposed to discharge a jet of said spray material and a concentric jet of said gas which impinges on said first jet to form a jet of spray material suspended in said gas having a given velocity, said nozzles being angularly disposed in a direction to cause the jets discharged therefrom to impinge on each other and to combine in a flat spray fan lying in a plane dividing and typically bisecting the angle formed between said nozzles and in which the spray particle velocity is low compared to the velocity in said jets, means connected to supply spray material to the material passages of both of said nozzles, means connected to supply a gas under pressure to the gas passages of both of said nozzles, and means connected to vary the relative pressure of the gas supplied to the respective nozzles in a sense to vary the angular position of the plane of said spray fan with respect to the first mentioned plane.

5. A spray head as set forth in claim 3 in which said last means comprises ducts supplying gas under a given pressure to both of said nozzles, a line carrying gas at a given higher pressure and valve means connected to supply said last gas alternately to said nozzles for thereby varying the angle of said spray fan, said valve means comprising a rotating valve cam having a plurality of raised sections and a pair of valve members disposed on opposite sides of said cam and having valve stems contacting said cam to be alternately actuated thereby, each of said valves being adapted to supply said higher pressure gas to said nozzles when actuated.

6. A spray head as set forth in claim 5 in which said valve cam is triangular in shape and said valve stems are diametrically opposed.

7. Spraying apparatus comprising a plurality of spray heads mounted in fixed relative relationship, each of said heads comprising a pair of spray nozzles, each of said nozzles having means to discharge a jet of spray material suspended in carrier gas, means supplying carrier gas under a predetermined pressure to both of said nozzles, said nozzles being mounted at a relative angle to cause the jets therefrom to converge and impinge on each other and form a fan of spray which lies in a plane dividing and typically bisecting the angle between said nozzles and means simultaneously varying the relative gas pressures supplied to the respective nozzles of each head for thereby varying in unison the angular displacement of said fans.

8. Spraying apparatus comprising a reciprocating member, means causing said member to reciprocate over a stroke of predetermined length, a plurality of spray heads mounted on said member, said spray heads being spaced apart in the direction of said stroke a distance approximately equal to the length of said stroke whereby adjacent, contigous areas of an object are sprayed by the respective heads simultaneously as said heads are reciprocated with said member.

9. Spraying apparatus as set forth in claim 8 in which said heads have means to eject a flat fan of spray and are disposed to cause said fan to lie in a plane perpendicular to the direction of said stroke.

10. A spray device of the two-fluid, atomizing type comprising a pair of nozzles having gas passages and spray material passages communicating at a tip to eject a spray of atomized particles, said nozzles including valve means to open and close the spray material passages, gas pressure-responsive actuating means in each nozzle adapted to actuate said valve means, and gas supply line connected to supply control gas to both of said actuating means, and a remote control valve connected to control the gas pressure in said last line, for opening and closing said nozzles in unison, means supplying spray material under pressure to said spray material passages, said last means including a pressure regulating valve, said valve including a gas chamber and means responsive to the gas pressure in said chamber for controlling the pressure of said material, and remote controlled means for varying the gas pressure in said chamber.

11. A spray device as set forth in claim 10 in which said remote control valve is connected to control the supply of gas to said gas passages, a reversing valve is connected to supply gas under a higher pressure alternately to said gas passages and said remote control valve is connected to control the supply of gas to said reversing valves whereby said remote control valve when actuated interrupts the supply of both gas and spray material to said nozzles.

12. A spray device as set forth in claim 11 including a bleeder valve connected to supply gas to said gas passages when said remote control valve is in closed position for thereby preventing the clogging of said passages when the spray is shut down.

13. A spray head arrangement according to claim 1, further including means imparting to said atomized particles and to at least the tip areas of said nozzles electrostatic charges of like polarity.

14. A spray head arrangement for an electrostatic paint spray system or the like comprising, a pair of spray nozzles arranged to form spray jets disposed at an angle of from about 100 degrees to about 140 degrees, said spray jets converging and impinging on each other to form a relatively flat fan of spray lying in a plane dividing the angle between said spray jets, means to supply spray liquid to said nozzles at a pressure and under conditions whereby the individual spray jets are issued from the respective nozzles at a sufficiently high velocity to be finely atomized, the atomized particles of spray material being significantly decelerated by the convergence and impingement of said streams, and means for effecting an electrostatic attraction between the decelerated particles and an object to be spray coated thereby.

15. A spray head arrangement according to claim 14 further characterized by, said means for effecting electrostatic attraction comprising means to place electrostatic charges of a first polarity on the atomized particles of the spray material and means for placing an electrostatic charge of opposing polarity on the object to be spray coated.

16. A spray head arrangement according to claim 15, further characterized by, means being provided for placing an electrostatic charge of said first polarity on the tips of said nozzles to exert a repelling effect on said particles.

17. A spray head arrangement according to claim 16 further characterized by, said nozzle tips being conductively associated with the spray material to impart thereto said electrostatic charge of first polarity.

18. A spray head arrangement according to claim 14 further characterized by, said nozzles being arranged to form spray jets disposed at an angle of from 125 degrees to 135 degrees.

19. A spray arrangement for a paint spray system or the like comprising, a pair of spray nozzles disposed to form jet streams converging and intersecting at an angle of from about 100 degrees to about 140 degrees, means to supply spray liquid to each nozzle under sufficient pressure to finely atomize the spray liquid in the separate jet streams, said jet stream of finely atomized particles impinging on each other and forming a fan of spray which lies in a plane dividing the angle between said nozzles, and an object to be spray coated positioned in front of said nozzles, in a position generally inclusive of said plane and beyond the region of convergence and impingement of said atomized jet streams, whereby said object is contacted and coated by atomized particles moving at significantly lower velocity than the atomized particles of said jet streams.

20. A spray head arrangement according to claim 19

further characterized by, said nozzles being arranged to form spray jets disposed at an angle of from 125 degrees to 135 degrees.

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M. HENSON WOOD, JR., *Primary Examiner.*

R. S. STROBEL, *Assistant Examiner.*

Disclaimer

3,301,488.—*Edward O. Norris*, Westport, Conn. SPRAY GUN. Patent dated Jan. 31, 1967. Disclaimer filed Mar. 22, 1974, by the assignee, *The Gyromat Corporation.*

Hereby enters this disclaimer to claims 8 and 9 of said patent.

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