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(54) **Low pressure air atomizing spray gun.**

(57) A low pressure atomizing spray gun, in which a paint is injected from a nozzle, an opening of the nozzle is controlled by a needle valve, air is mixed with an injected paint flow, air is injected from both sides after the air-paint mixture is sprayed from an spraying nozzle and it is mixed again and atomized. The nozzle is formed in circular hole with circular outer shape, and said spray hole is designed in a lip-like hole having different diameters in longitudinal and lateral directions and with outer shape in conical or similar shape. Lateral air holes are furnished in front of said spray hole, at opposite positions on both sides of spray flow and injecting the diffusing air flow toward the spray flow. A second injection hole is furnished to inject the secondary air from obliquely behind said injection hole and to make the air collide with the flattened spray flow.

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LOW PRESSURE AIR ATOMIZING SPRAY GUN

BACKGROUND OF THE INVENTION

The present invention relates to a spray gun to atomize and spray the spray materials such as paint by compressed air, and more particularly to a spray gun, which can sufficiently atomize the material when the pressure of compressed air is 1 kgf/cm² or less and which can avoid the splashing of paint particles and prevent environmental pollution.

A spray gun, generally called air spray gun, is used for the painting and the coating process to spray the paint materials. The air spray gun using compressed air for atomization is roughly divided into internal mixing type and external mixing type.

The internal mixing type spray gun is the one, by which the material paint and the compressed air are mixed together within an atomizing head of the spray gun, and air-liquid mixture is injected and atomized from the atomizing nozzle. In the external mixing type spray gun, a paint injection hole and an air injection hole are opened outwardly on the atomizing head, and the liquid paint flow injected from the paint injection hole is dispersed and atomized by the air flow, which is diffused and injected around the paint flow.

These spray guns utilize the suction force of the compressed air for the injection of the paint or the paint is injected by a force-feed unit such as pump at the pressure of several kgf/cm², and atomization is not achievable by merely injecting the paint material. The air is used as an energy to atomize the paint, and the pressure of 2 - 5 kgf/cm² is usually applied.

For example, in a spray gun 100 of conventional internal mixing type as shown in Fig. 11, a paint nozzle 101 is opened into an air gap 102. The nozzle hole 104 is opened and closed by a needle valve 103 to control the injection of the paint. By the compressed air supplied to around the nozzle hole 104, the paint is dispersed within an air cap 102, and the paint is sprayed out from the spray hole 105, which is placed face-to-face to the nozzle hole 104 and is opened into the center of the air cap 102.

Such conventional internal mixing type spray gun is generally used as a special spray gun to spray wall paint or adhesive in the case where strict smoothness of the painted surface is not required because the size of the sprayed particles is coarser than that of external mixing type.

In contrast, the external mixing type gun is generally used as the so-called spray gun and is known as suitable for various types of paint materials and various painting conditions. The common

features of this type spray gun are that the injection hole of the paint nozzle is located at the center, and the injection hole faces to the outside of the atomizing head. An annular air hole is provided around the injection hole, and compressed air is injected at the pressure of 3 - 5 kgf/cm² as if it surrounds the paint flow injected from said injection hole. Namely, the paint and the compressed air are injected separately and are mixed and atomized in front of and outside the atomizing head. Usually, most of the spray guns of this type are designed in such manner that a pair of lateral air holes is provided on both sides, and compressed air is sprayed from both sides to said spray flow in order to adjust the shape of the spray pattern. Therefore, the spray flow sprayed in circular pattern at the center may be flattened by changing the injection pressure and injection quantity at the lateral air holes. In the case of this spray gun, the better atomization is achieved when compressed air quantity (or pressure) is increased, and the painted surface can be finished well by spraying finer particles, but the paint is splashed more in this case.

In the spray guns of conventional type as described above, there is the problem with the splashing of paint because it is atomized by air, and unfavorable results occur in terms of paint adhesion efficiency and environmental hygiene. Above all, this trend becomes more conspicuous when air spray pressure is increased, and it is desirable to spray at lower pressure. On the other hand, it is important to have finer atomized particles for the better finishing of the painted surface. For this purpose, it is necessary to atomize the paint by high pressure air, and this is contradictory to the elimination of paint splashing. At present, the spraying is performed by sacrificing the problem of splashing, paint adhesion efficiency and environmental hygiene.

However, the importance will be increasingly placed in future on the effective utilization of the material resources and the maintenance of environment, and the spray guns are wanted, which can atomize the material at low pressure. The means to atomize the paint material is not necessarily limited to the compressed air, and a method is generally practiced, in which paint material is injected at high pressure from nozzle and is atomized through its collision with atmospheric air. However, the spray gun for industrial purpose in this case requires the high pressure of 100 kgf/cm², and there is also the problem of danger because special type pump is used. For this reason, paint material pressure is decreased to several tens of kgf/cm², and a spray

gun is used, by which compressed air is simultaneously used. But, there still remains the above problem, and the air pressure is not low enough, and the satisfactory spray gun is not yet available at present.

SUMMARY OF THE INVENTION

To solve the above problems, the object of this invention is to offer a spray gun, in which the spraying air pressure is decreased as low as 1 kgf/cm² or less and which can atomize the spray particles to the same degree as the conventional type spray gun in order not to impair the finishing of the sprayed surface.

To obtain the low pressure atomizing spray gun to solve the above problems, the present invention offers a spray gun, characterized in that the paint is injected from the nozzle, that the opening of the nozzle is controlled by a needle valve, that air is mixed with the injected paint flow, that air is injected from both sides after the air-paint mixture is sprayed from the spraying nozzle and it is mixed again and atomized. To attain this purpose, said nozzle is formed in circular hole with circular outer shape, and said spray hole is designed in a lip-like hole having different diameters in longitudinal and lateral directions and with outer shape in conical or similar shape. Also, lateral air holes are furnished in front of said spray hole, at opposite positions on both sides of spray flow and injecting the diffusing air flow toward the spray flow.

A second injection hole is furnished to inject the secondary air from obliquely behind said injection hole and to make the air collide with the flattened spray flow.

By the above arrangement of this invention, the paint injected from nozzle is mixed and dispersed by the compressed air supplied from around it and is sent toward the spray hole. Because the spray hole has different opening ratios in longitudinal and lateral directions, the flow of paint-air mixture is sprayed in flattened elliptical shape. Then, compressed air is blown on this spray flow from the air holes on both sides, the spray particles are enveloped by the air, and the pattern is stabilized. The coarse particles are atomized, and particle size is equalized. Because the first atomization is performed within the cap, the material is atomized at low pressure and with less air quantity. Also, because the air supplied from the air holes on both sides is blown on to the spray flow in flattened pattern from the direction of its shorter axis, the width of the pattern can be efficiently increased and the particle size can be reduced with the air flow at low pressure.

The secondary air injected from the second

spray hole obliquely behind said spray hole works to reduce the pattern, and circular pattern with less spreading can be obtained.

The advantages and features of the present invention will be more easily understood in connection with the drawings, in which:

Fig. 1 is a cross-sectional view showing basic configuration of this invention;

Fig. 2 is an enlarged cross-sectional view of the essential part of an atomizing head;

Fig. 3 is a cross-sectional view of another embodiment of this invention;

Fig. 4 is a front view of an atomizing head of the spray gun of Fig. 3;

Fig. 5 is an enlarged cross-sectional view of the essential part of the atomizing head of the spray gun of Fig. 3 along the line A-A of Fig. 4, showing the spray flow and the injection flow from lateral air holes;

Fig. 6 (A) is an enlarged cross-sectional view of the essential part of the atomizing head of the spray gun of Fig. 3 along the line B-B of Fig. 4, showing the spreading of the spray pattern when the air is not injected from the second injection hole;

Fig. 6 (B) is an enlarged cross-sectional view of the essential part of the atomizing head of the spray gun of Fig. 3 along the line B-B of Fig. 4, showing how the spray pattern is reduced by the injection of the air from the second injection hole;

Fig. 7 is an enlarged cross-sectional view of the essential part of the atomizing head of the spray gun of Fig. 3, showing another embodiment of lateral air holes;

Figs. 8 (A) and (B) give another embodiment of lateral air holes of the spray gun of Fig. 1;

Fig. 9 is an enlarged view along the line I-I of Fig. 3, showing the essential part of air distribution valve;

Fig. 10 is a cross-sectional view along the line II-II of Fig. 9, showing the positional relation between the air distribution valve and the secondary air passage;

Fig. 11 represents conventional internal mixing type spray gun, showing the cross-section of the essential part including the atomizing head.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The arrangement and the effects of the present invention will be more easily understood by the following embodiments.

Fig. 1 shows a general arrangement of the spray gun according to the present invention.

The spray gun main unit 1 consists of a gun

barrel 2 and a grip 3. Below the grip 3, an air nipple 4 is furnished to take the compressed air from outside, and it is connected by air hose with an air source (not shown). Inside the grip 3, a passage hole 6 is furnished to supply the compressed air into an air valve unit 5, and said air valve unit 5 comprises an air valve 9 inside an air regulation pipe 8, which is inserted into an air regulation hole 7 embedded in the gun barrel 2 from behind. The air regulation pipe 9 is provided with a hole 10, passing from outside to inside. By turning the air regulation pipe 8, air flow is changed according to the alignment of said hole 10 and the passage hole 6 furnished inside said grip 3. The air regulation pipe 8 is turned by the knob 11 provided behind and outside the gun barrel 2.

The air valve 9 is pressed on the sheet 13 of the spray gun main unit 1 by resilient force of a spring 12, and compressed air is thus stopped. The needle valve 14 extended toward the tip of the gun barrel 2 passes through the center of said air valve 9. On the back of the needle valve, a spring 15 and an opening adjusting knob 16 to control the backward movement of the needle valve 14 are furnished.

In front of the air valve 9, an air valve rod 18 is provided outside the needle valve 14, and the air valve 9 is moved backward by the operation of a trigger 17, thus sending compressed air into an air distribution chamber 19. If the trigger 17 is pulled further, the needle valve 14 retracts as the air valve rod 18 moves backward.

On the air distribution chamber 19, a distribution valve 20 is engaged by a knob 48 as it can freely rotate. Two air passages are furnished toward the front part of the gun barrel 2. One of the passages is permanently communicated with the air distribution chamber 19 and is used to atomize the paint, and the other changes its communicating area by the position of the notched recess 21 on the distribution chamber 19. Thus, it is used to control the flow rate and to adjust the spray pattern as described later.

An atomizer is furnished at the tip of the gun barrel 2. A paint nozzle 22 to inject the paint is mounted at the tip of the gun barrel 2. The tip of said needle valve 14 strikes the sheet 22a inside the nozzle hole 23 of the paint nozzle 22, and the paint is stopped. The outer portion of this paint nozzle 22 is engaged with the spray gun main unit 1 to form a passage 24. The primary air passage 27 branched off by the distribution valve 20 is communicated with the passage 24, and said passage 24 is communicated with the passage 24'.

A paint passage 30 is formed at the center of the paint nozzle 22, and it is communicated with the paint supply source (not shown) through the paint nipple 51.

On the other hand, paint nozzle 22 forms the paint passage 30 at its center so that the tip of the needle valve 14 touches the sheet 22a inside the nozzle hole 23, thus controlling the injection of the paint. The paint nozzle 22 is covered with an air cap 40, and it is fixed on the tip of the spray gun main unit 1 by a cover 41. The nozzle hole 23 is arranged inside and on the same axial line with the spray hole 32, which is opened to the center of said air cap 40. Said spray hole 32 forms a lip-like opening with the cylindrical inlet 33, providing conical or approximately spherical inner surface 34 and a V-shaped groove 35 outward from its center. The front portion of the inlet 33 has the tapered surface 37, forming a primary air chamber 39, and it is arranged in such manner that the compressed air flows from said passage 24 and the passage 24' between this tapered surface 37 and the tip 38 of said paint nozzle 22. The compressed air is mixed with the paint injected at the tip of the nozzle hole 23, is dispersed in foggy status and is sprayed from the spray hole 32. Because the spray hole 32 is formed in V-shaped groove 35 with a lip-like opening as described above, the spray flow is blown out in approximately elliptical shape.

It is known that, when the communicating area between said tapered surface 37 and the tip 38 of the paint nozzle 22 is increased, the size of the atomized particles is reduced. Thus, it is preferably at least equal to or larger than the opening of said V-shaped groove 35.

Conical outer surface 36 is provided outside and inside the spray hole 32, and the thickness of the opening is fabricated as thin as possible.

In the air cap 40, a passage 44 communicating with said secondary air passage 29 is formed. At the corner 42, lateral air holes 43 to inject the flattened air flow are furnished at opposite positions to maintain the injecting direction toward the center of spraying. In the embodiment, the lateral air hole 43 having the same opening shape as the spray hole 32 is shown. To the flattened spray flow from the spray hole 32, the flattened air flow spreading toward the same direction is supplied from the opening. Thus, the flattened air flow collides with the flattened spray flow injected from the spray hole 32 almost totally. To inject the flattened air flow, the lateral air hole 43 is provided with a lip-like opening, by placing a V-shaped groove into a hole having conical or spherical inner surface just as in the case of the spray hole 32. Fig. 7 shows an example, in which lateral air hole 43 is designed in separate structure and is incorporated separately.

Fig. 8 (A) shows another example, in which the lateral air hole 43 is designed in elliptical shape, i.e. in oblong shape extending toward the direction perpendicular to the spraying direction. Fig. 8 (B)

represents an example, in which the lateral air hole 43 is designed in tapered fan-shaped circular hole. Particularly, in case of a circular hole as in Fig. 8 (B), the injection with wider spreading can be achieved by maintaining the ratio of the opening area to the area of passage base at 1 or more, and extreme deformation of the spray pattern can be prevented.

Fig. 3 shows a spray gun according to another embodiment of this invention. The same number refers to the same component as in the above embodiment.

The paint nozzle 22 is covered with the tip cap 31, and the nozzle hole 23 is provided on the same axial line in a spray hole 32, which is opened to the tip center of the tip cap 31. As in the embodiment already described, said spray hole 32 comprises a cylindrical inlet 33, and a conical or approximately spherical inner surface 34. A V-shaped groove 35 is formed at the center, and an approximately lip-like opening is provided.

The frontal portion of the inlet 33 has the tapered surface 38', and the primary air chamber 39 is formed. It is arranged in such manner that the compressed air from air passage 24 and the passage 24' flows between said tapered surface 38' and the tip outer diameter 38 of said paint nozzle 22.

Conical outer surface 36' is provided outside the spray hole 32 similarly to inside. An air cap 40', engaging with said conical outer surface 36' and having air injection holes at symmetrical positions to the spraying axis, is furnished and is integrated with said tip cap 31. It is removably fixed on the tip of the spray gun main unit 1 by the cover 41.

In this embodiment, 3 air passages are provided in the gun barrel 2 from the air distribution chamber 19 to the frontal portion of the gun barrel 2. One of the passages is placed, as the primary air passage 27, at the portion with smaller diameter 47 of the distribution valve 20, is permanently communicated with the air distribution chamber 19 and is used to supply compressed air, which is mixed with the paint injected from the nozzle hole 23 and is sprayed from the spray hole 32. In the other two air passages, the communicating area is changed according to the turning position of the notched recess 21 on the distribution valve 20, and flow rate is thus adjustable. As shown in Fig. 9, the air distribution valve 20 is engaged with the air distribution chamber 19 by the externally mounted knob 48 in such manner that it can be freely rotated. Therefore, it is possible to control the distribution quantity by determining the change of the communicating area at the rotating contact portion by the notched recess 21 of the distribution valve 20. These two air passages are used as the secondary air passages. One air passage 28 is

communicated with the passage 25, and the other air passage 20 is communicated with the passage 44, which is provided inside the air cap 40.

On the atomizer at the tip of the gun barrel 2, a second air injection hole 45 is furnished with the central axis on the spray hole 32 and at opposite positions orthogonally to the lateral air hole 43 of the air cap 40. Thus, compressed air is injected obliquely toward the front.

As shown in Figs. 6 A and B, air is injected toward the spray flow from the spray hole 32 at the end of longer axis, and it reduces the spray pattern. The second injection hole 45 is communicating with the air passage 25 provided outside said paint nozzle 22 through the passage 46 on the tip cap 31.

Therefore, of the two secondary passages 28 and 29 from said air distribution valve 20, one passage injects from the second injection hole 45, and the other from lateral air hole 43. Thus, the secondary air is communicated with either one of these passages by the distribution valve 20. If it is supplied to the lateral air hole 43, it is sprayed in a larger spray pattern, and if it is supplied to the second injection hole 45, it is sprayed in a nearly circular and smaller spray pattern.

In the figure, 49 represents an auxiliary air hole provided on the tip cap 31, and it is communicated with said primary air chamber 39.

As described above, it is possible according to this invention to inject the paint at low pressure in the air cap, to mix and disperse the paint by utilizing lower pressure compressed air, to inject the spray flow from a lip-like opening furnished at the center of the air cap and to spray it in flattened pattern. By injecting air flow to this spray flow from the direction of the flattened plane with shorter axis, the pattern can be stabilized and the pattern width can be adjusted. Because each air flow works effectively, the same atomizing performance can be achieved with far lower air pressure than the conventional type, and it is possible to prevent the splashing of paint particles and to avoid the environment pollution because spraying is performed at lower pressure.

Further, it is possible by this invention to mix and atomize the paint with compressed air within the spray hole. The atomized spray pattern suitable for paint coating can be obtained at the pressure as low as 1/5 of that of the conventional air spraying because compressed air flow is collided with the spray flow by re-atomizing and by forming and adjusting the pattern. Since no hydraulic atomizing means is employed, paint may be fed by low pressure air as described above, and no special pressurizing means for the paint is required. Accordingly, the new spray gun can be used as easily as the conventional type air spray gun, and the

better effects can be obtained.

In case of atomized particles, which are atomized in flattened spray pattern according to the shape of spray hole, it is generally difficult to adjust the size of the pattern and the width of the pattern. On the other hand, it is possible according to this invention to adjust to a larger spray pattern in case the air is injected from lateral air hole and to adjust to a nearly circular and smaller spray pattern in case the air is injected from the second injection hole. Thus, the pattern width can be adjusted widely and the suitable spray pattern can be easily selected.

In addition to the primary air for spraying, two independent secondary air for pattern formation or for pattern adjustment are provided, and the primary air is permanently supplied. Moreover, the primary air must be permanently supplied, and one of the secondary air must be supplied with adjustment. On the air distribution valve of this invention, a plurality of passages can be provided, which are communicated permanently with the passage by small diameter portion not changeable by rotating and by notched recess changeable according to mutual position with inner surface of air distribution chamber. It is also possible to supply compressed air necessary for each passage by operating a single distribution valve.

Claims

1. A spray gun, by which paint flow injected from nozzle with its opening controlled by a needle valve is mixed with the air from around it, this mixture flow is sprayed from a spray hole, the air is then injected from both sides at opposite positions toward the spray flow, and these are again mixed and atomized, characterized in that the inner surface of said nozzle is formed in circular hole and outer shape thereof is circular, that said spray hole is formed in an approximately lip-like opening with different opening ratios in longitudinal and lateral directions, that its outer surface is formed in conical shape, that an atomizing head is provided, and that said atomizing head is provided with lateral air holes furnished on both sides of spray flow in front of said spray hole and to inject diffused air flow toward spray flow.

2. A spray gun, by which paint flow injected from nozzle with its opening controlled by a needle valve is mixed with the air from around it, this mixture flow is sprayed from a spray hole, the air is then injected from both sides at opposite positions toward the spray flow and these are again mixed and atomized, characterized in that an air hole is provided to oppose toward the direction of shorter axis of the flattened paint sprayed from said spray

hole, and that a means is provided to adjust the injection pressure or the injection quantity from said air hole.

3. A spray gun as set forth in Claims 1 and 2, wherein paint flow injected from nozzle with its opening controlled by a needle valve is mixed with the air from around it, this mixture flow is sprayed from a spray hole, the air is then injected from both sides at opposite positions toward the spray flow, and these are again mixed and atomized, a pair of lateral air holes is provided on both sides of spray flow at opposite positions in front of said spray hole and to inject toward spray flow, and said lateral air holes are in oblong shape and extending toward the direction perpendicular to the spraying direction.

4. A spray gun as set forth in Claims 1 to 3, wherein said lateral air holes are formed in circular holes having the opening area equal to or more than the cross-sectional area of lateral air passage upstream of it.

5. A spray gun, comprising a single circular hole nozzle opened into an air cap having a lip-like spray opening, the secondary air flow is collided with the flattened spray flow of injected paint mixed and sprayed with the primary air flowing around outer periphery of said nozzle, and the pattern of spray flow is adjusted, characterized in that a secondary air passage is provided to distribute said primary air from the air passage, and that said secondary air passage is furnished with a means to adjust the air quantity.

6. A spray gun, comprising a single circular hole nozzle opened into an air cap having a lip-like spray opening, the secondary air flow is collided with the flattened spray flow of injected paint mixed and sprayed with the primary air flowing around outer periphery of said nozzle, and the pattern of spray flow is adjusted, characterized in that the secondary air flow collided with said flattened spray flow in front of it is injected from a pair of lateral air holes opened obliquely toward the front from behind the both sides of the flattened surface, and that said secondary air flow is the flattened air flow diffused and dispersed to the same direction as said flattened spray flow.

7. A spray gun, comprising a single circular hole nozzle opened into an air cap having a lip-like spray opening, the secondary air flow is collided with the flattened spray flow of injected paint mixed and sprayed with the primary air flowing around outer periphery of said nozzle, and the pattern of spray flow is adjusted, characterized in that the secondary air is injected and collided with said flattened spray flow at longer axis, injected from the injection hole provided obliquely behind said spray opening.

8. A spray gun, comprising air holes to inject a first

secondary air flow, which is injected and collided with the flattened spray flow injected by the primary air flow from spray hole of lip-like opening and diffusing in the same direction as said flattened spray flow, and a second secondary air flow, which is injected and collided with the flattened spray flow perpendicular at longer axis, characterized in that an independent secondary air passage is communicating with each of said air holes, and that a distribution means is provided to supply compressed air to either one of these secondary air passages from said primary air passage.

9. A spray gun, comprising an air distributing means, in which compressed air introduced into spray gun is sent to an air distribution chamber, the distribution air quantity to each of said branching passages is changed, the air is sent through a plurality of branched passages from said distribution chamber, the injected air quantity is changed and spray status is adjusted, characterized in that a notched portion furnished on a part of outer periphery of the distribution chamber and an open end of said plurality of branched passages opened to wall surface of the distribution chamber adjacent to outer periphery of said distribution chamber are arranged in such manner that they are communicated with each other at specified relative positions.

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FIG. 1

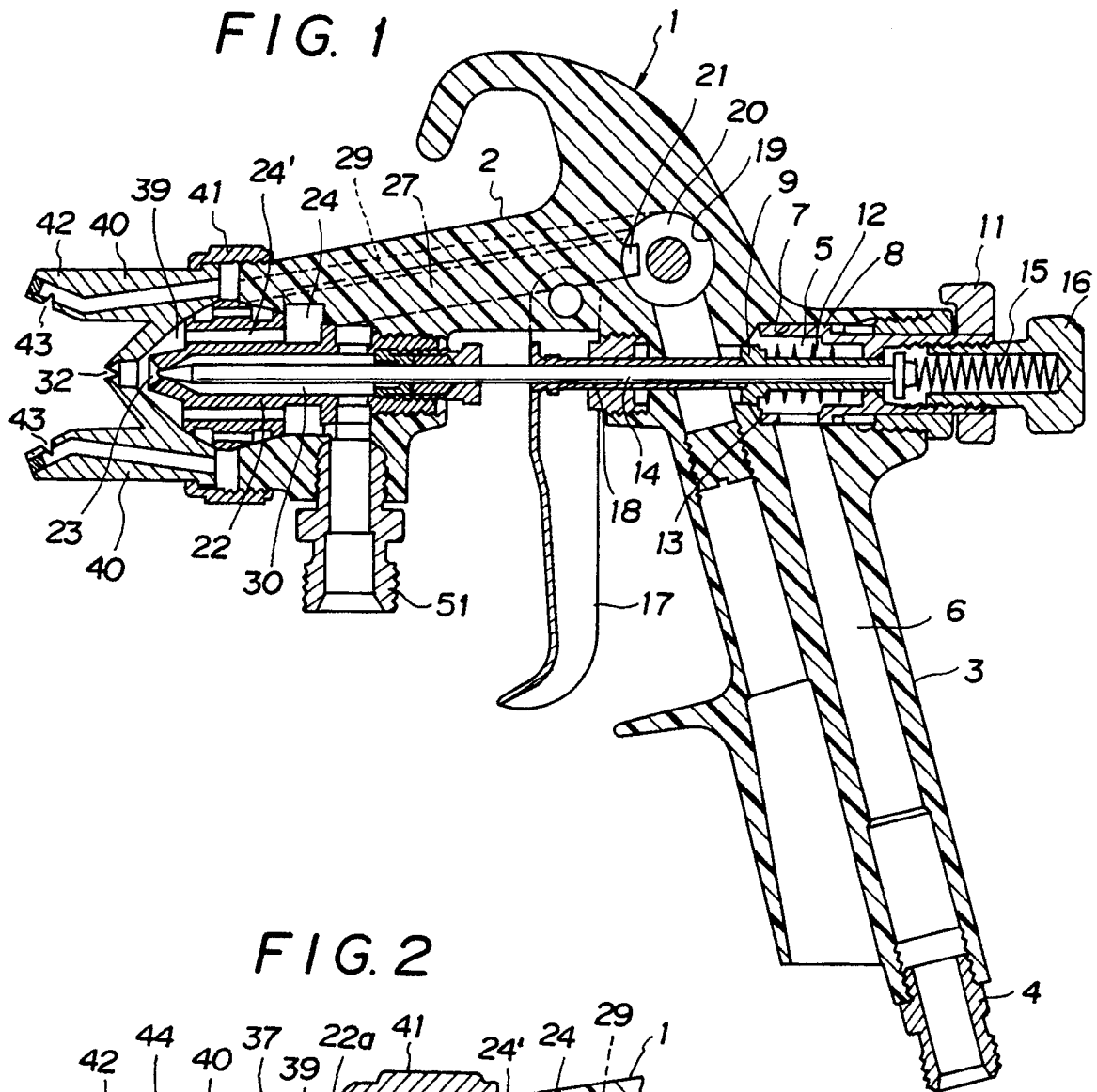


FIG. 2

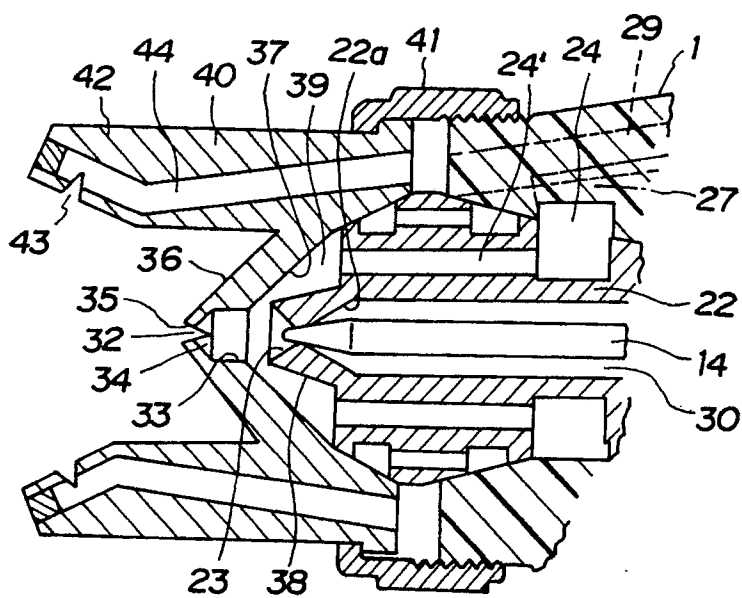


FIG. 3

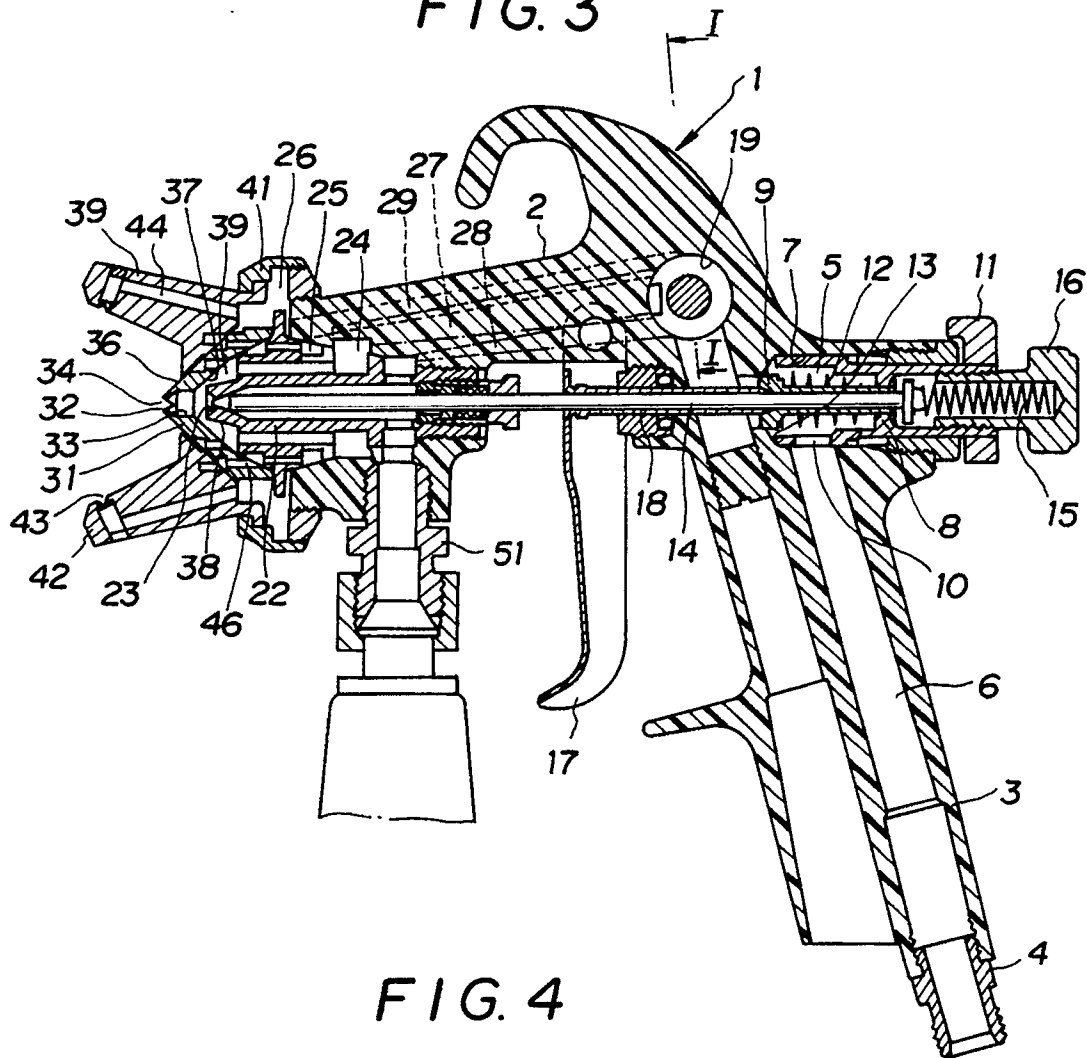


FIG. 4

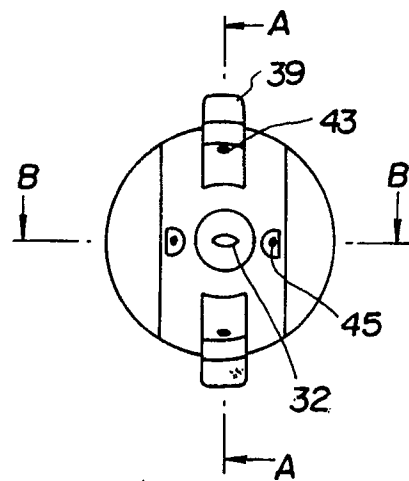


FIG. 5

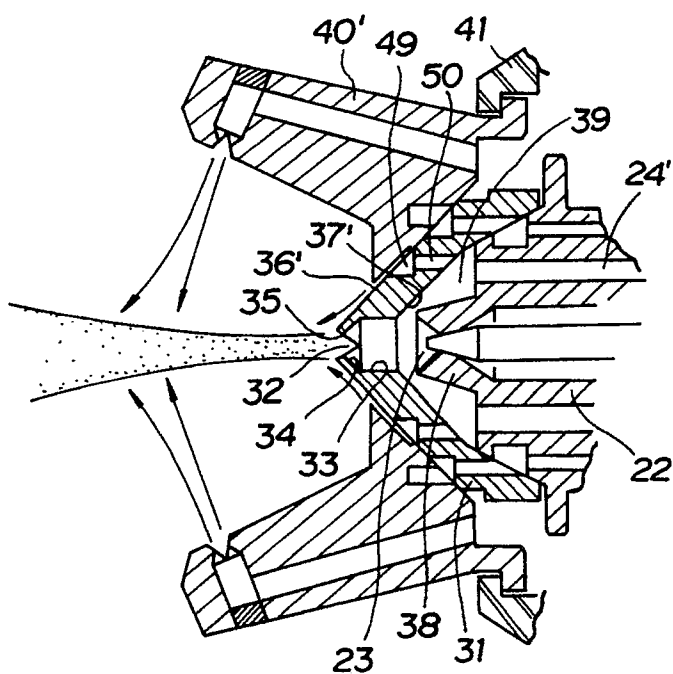


FIG. 7

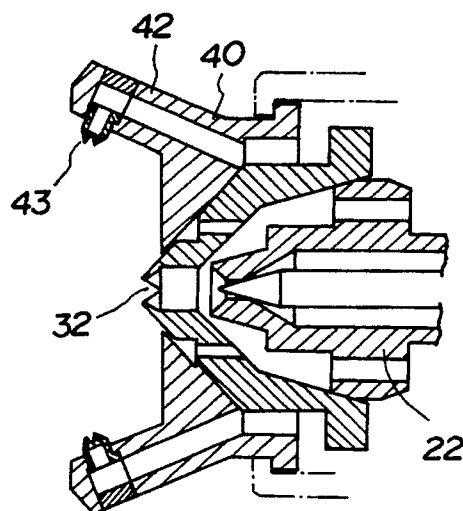


FIG. 6(A)

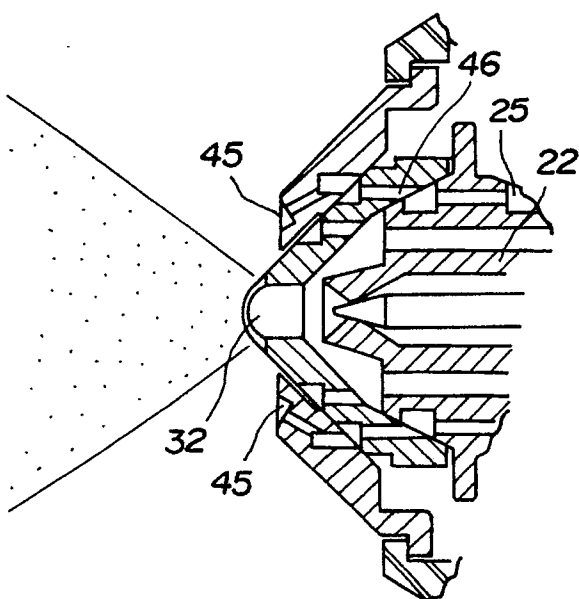


FIG. 6(B)

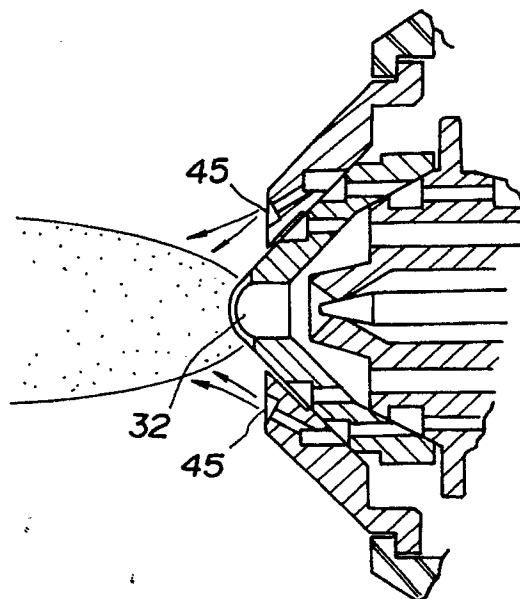


FIG. 8(A)

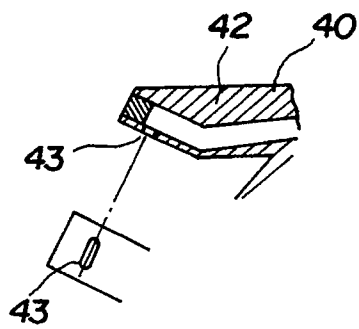


FIG. 8(B)

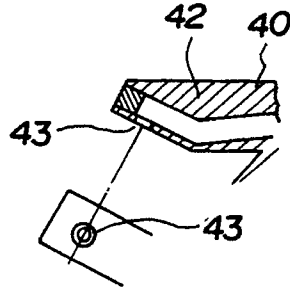


FIG. 9

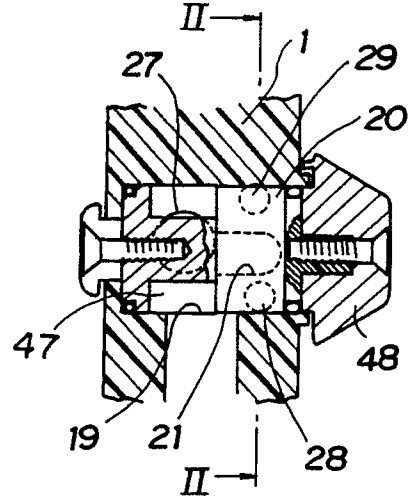


FIG. 11

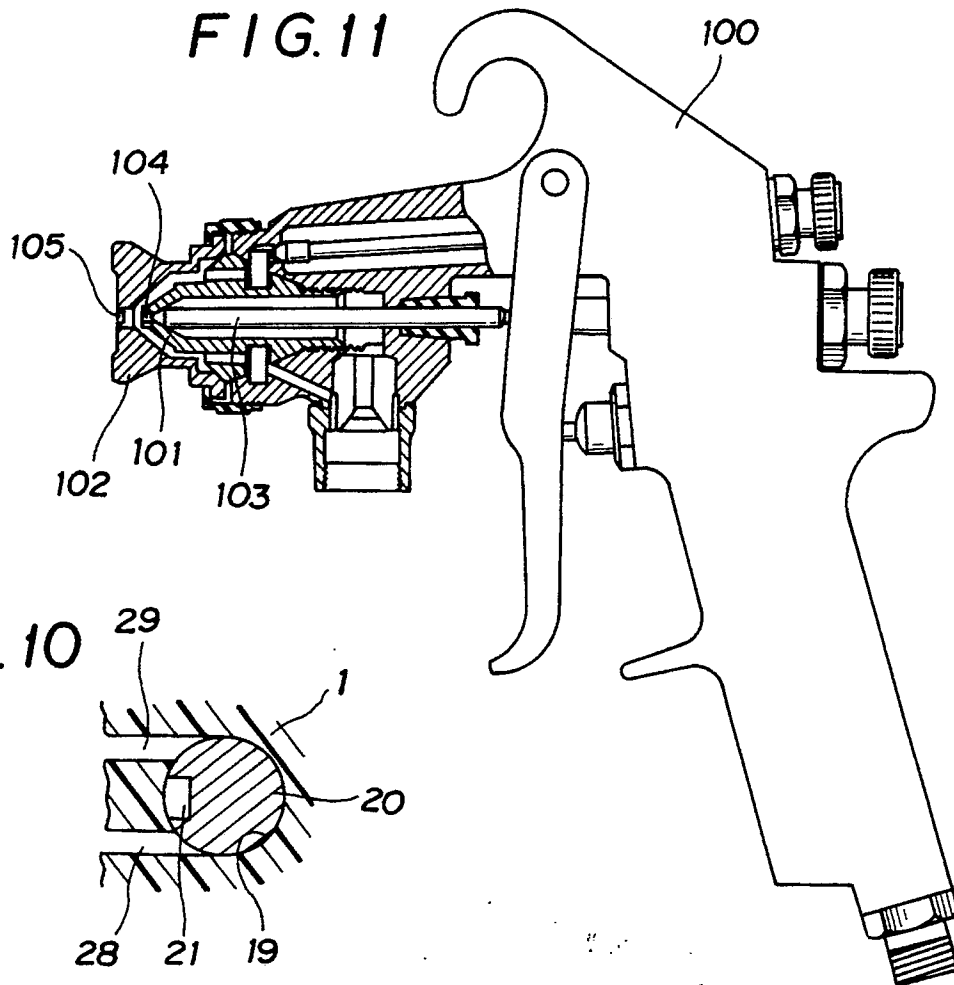


FIG. 10

