Feb. 14, 1933. R. LONG ET AL 1,897,173

AIR NOZZLE FOR SPRAY APPLIANCES

Filed April 29, 1931 2 Sheets-Sheet 1

Fig. 1.

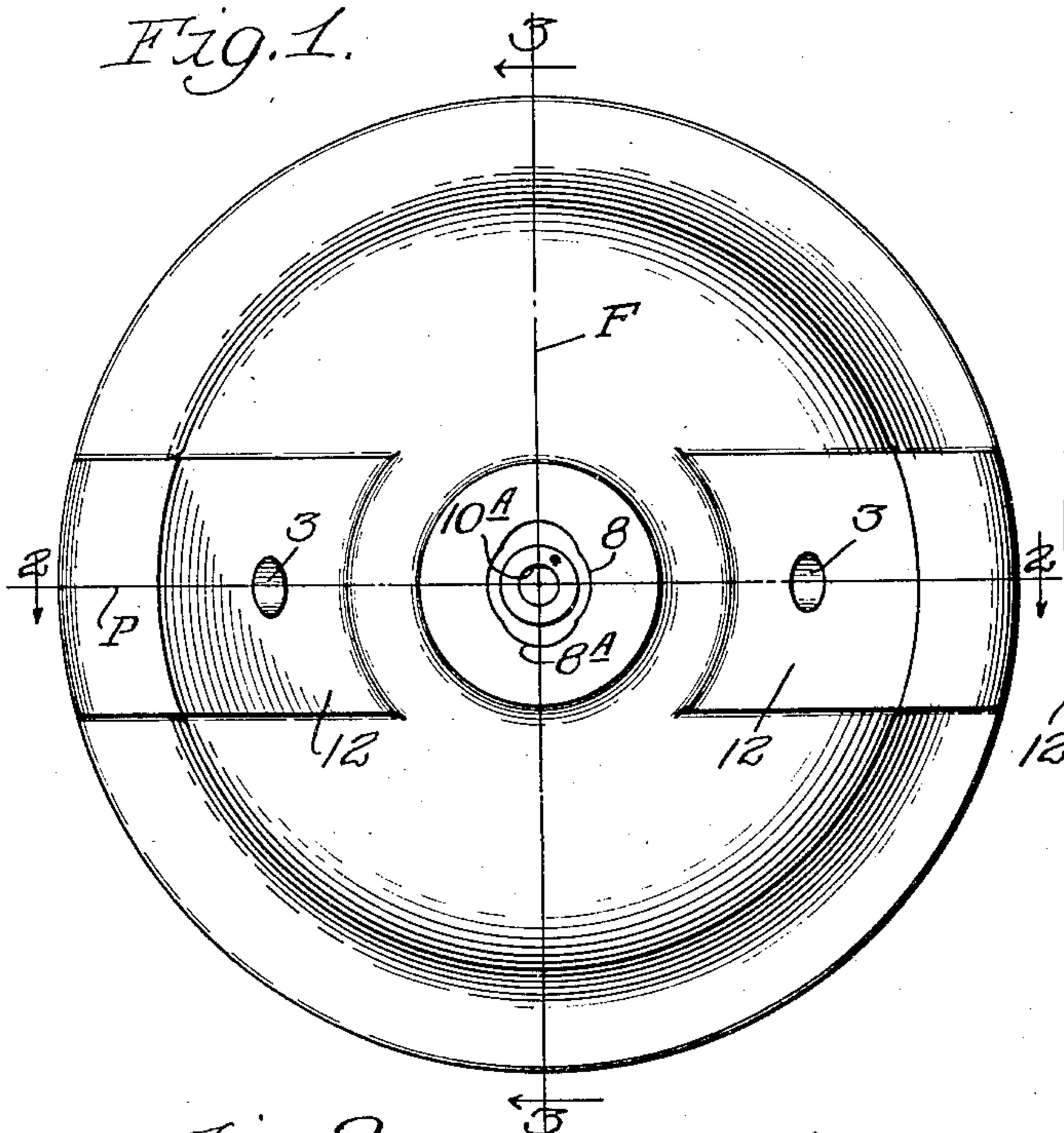

Fig. 3.

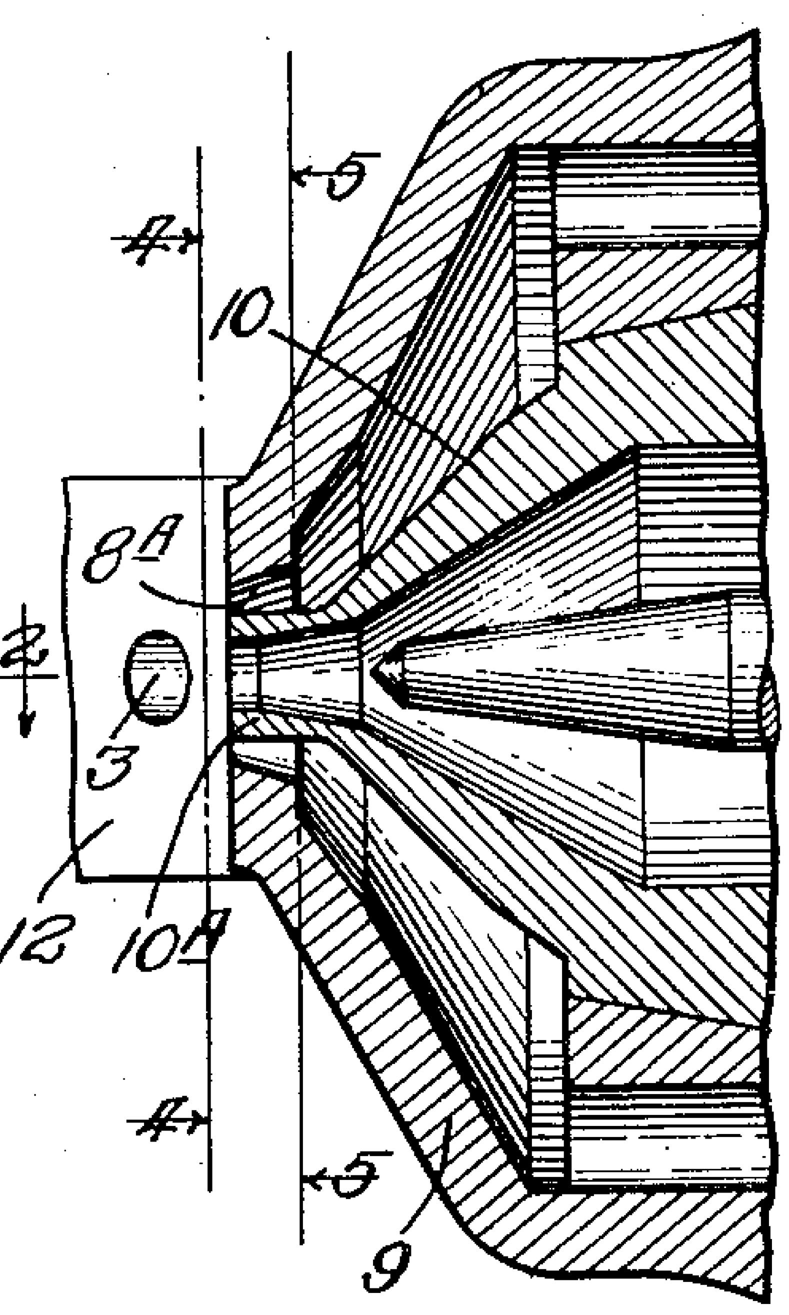

Fig. 2.

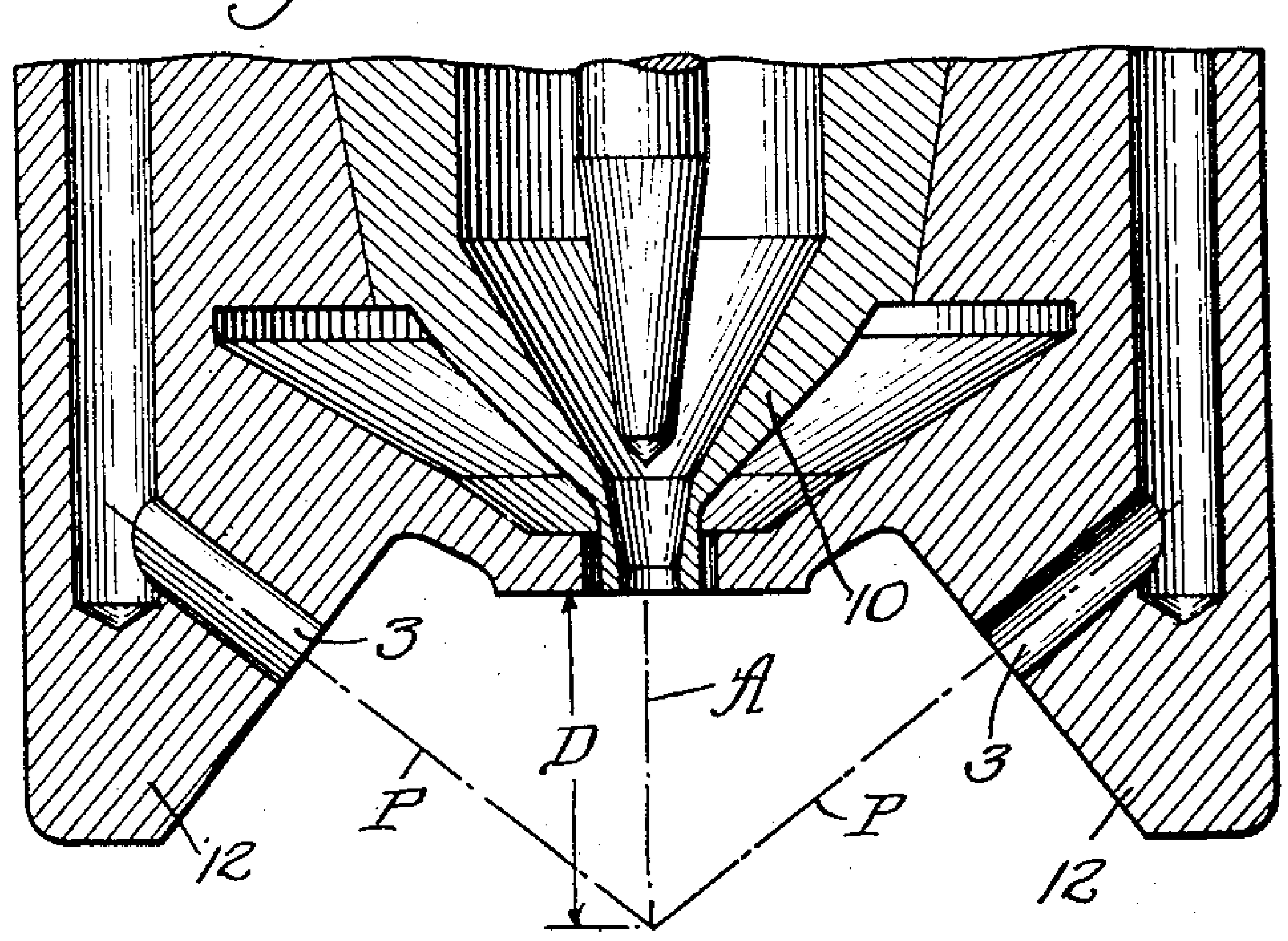

Fig. 4.

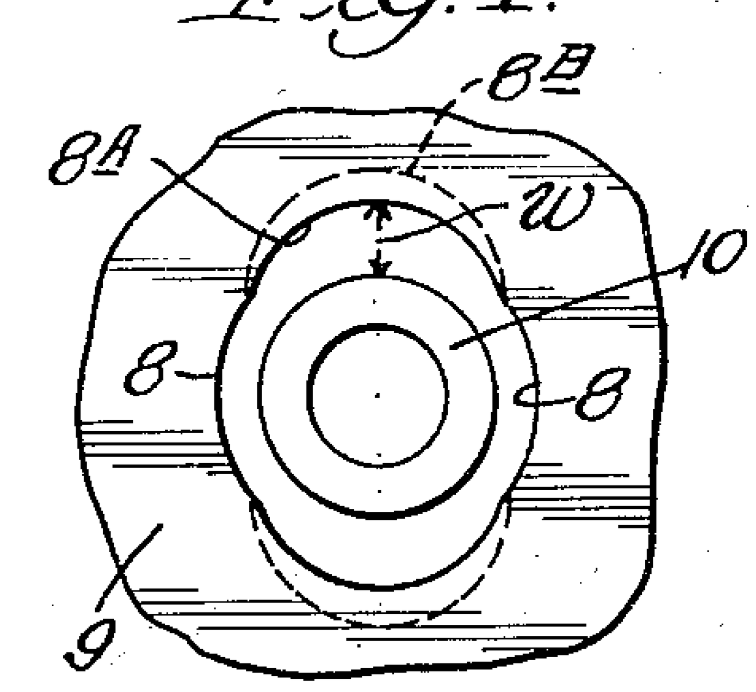

Fig. 5.

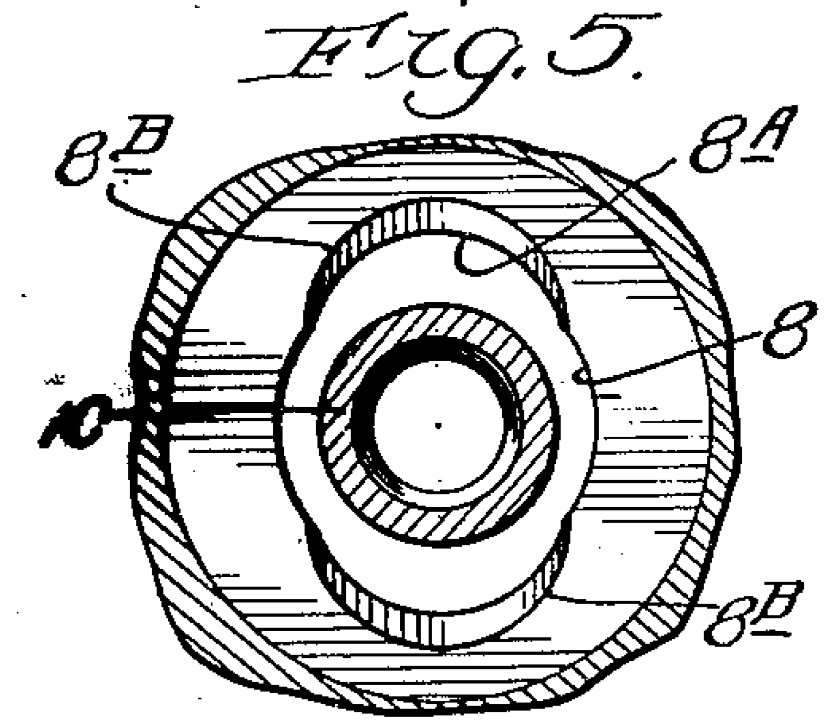

Fig. 6.

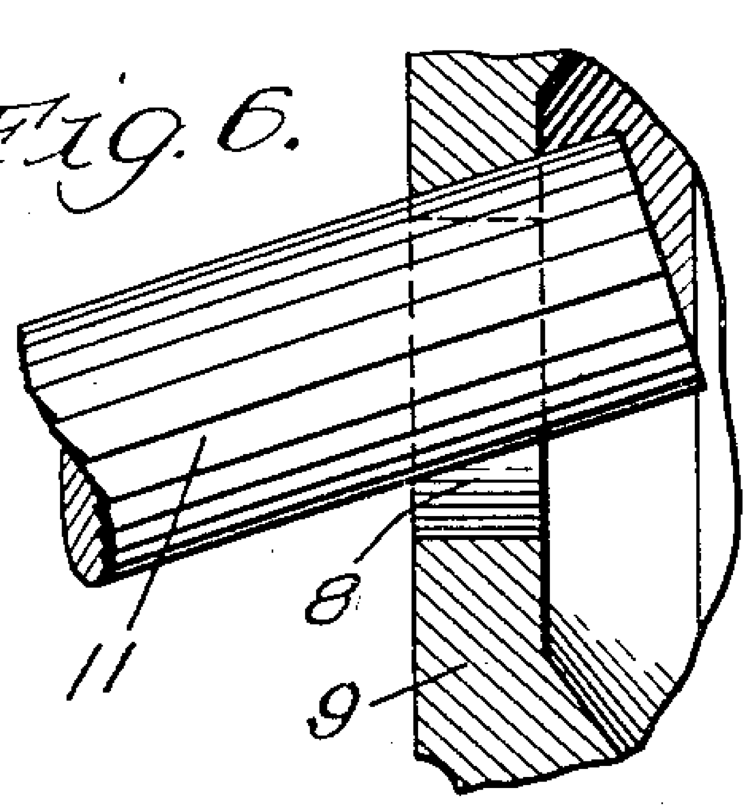

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Fig. 8.

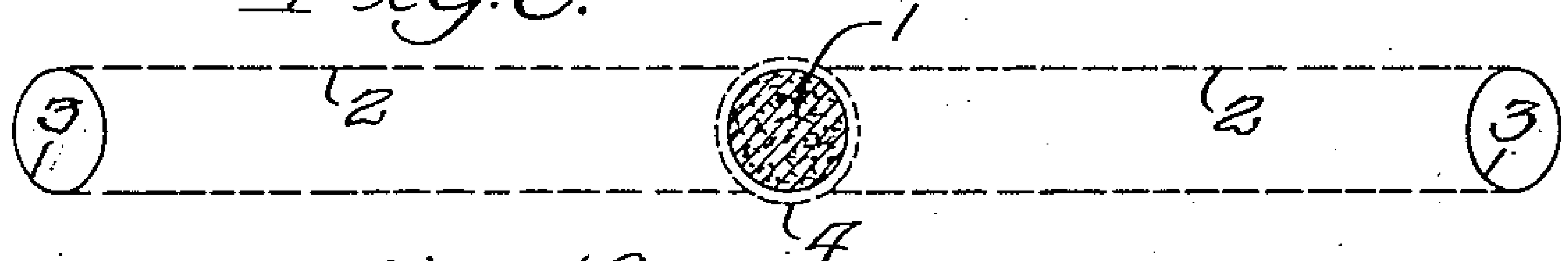


Fig. 10.

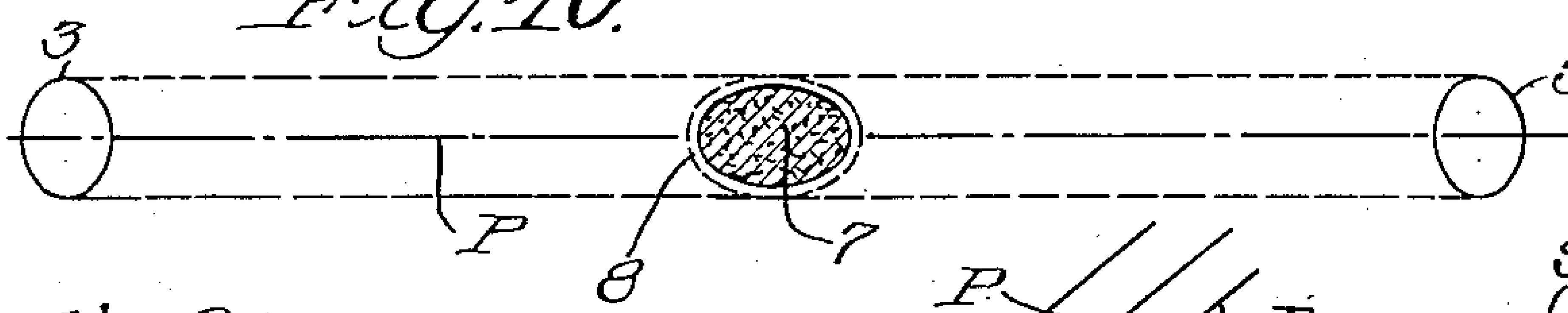


Fig. 9.

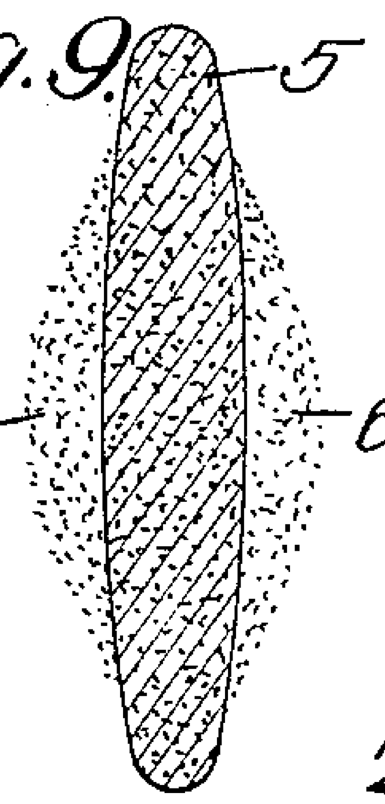


Fig. 7.

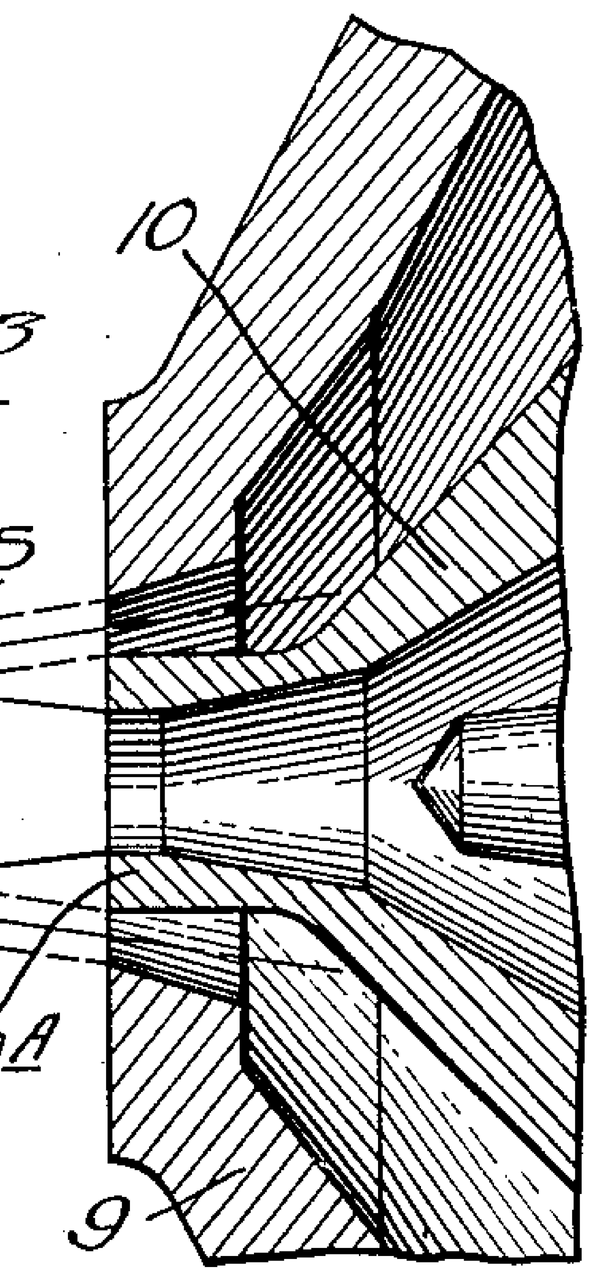


Fig. 11.

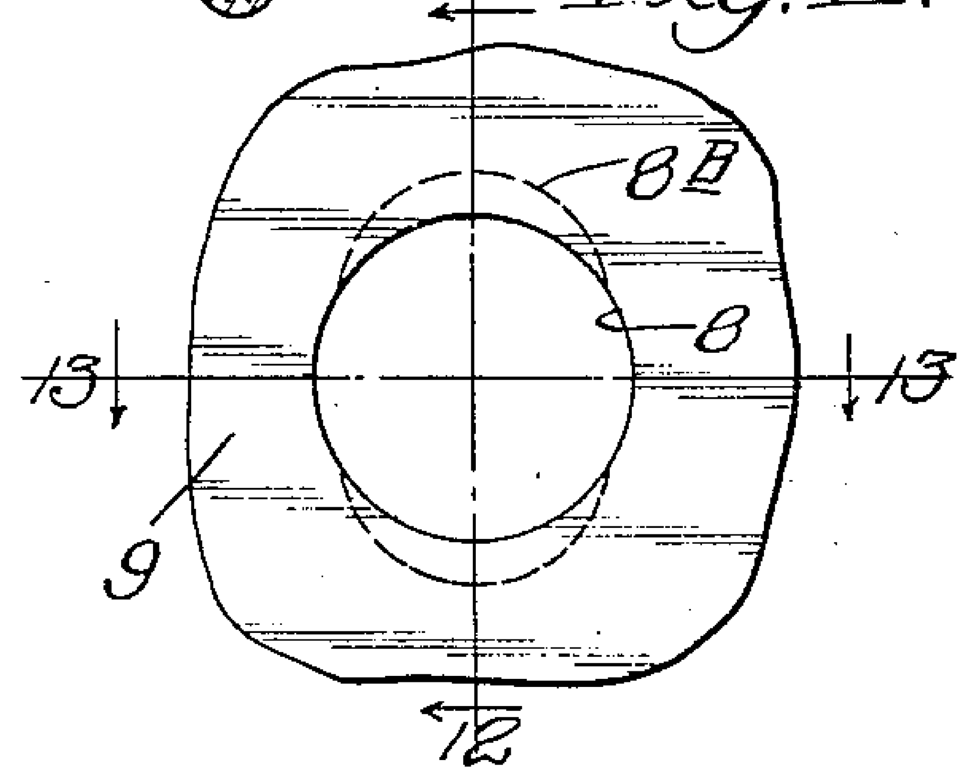


Fig. 12.

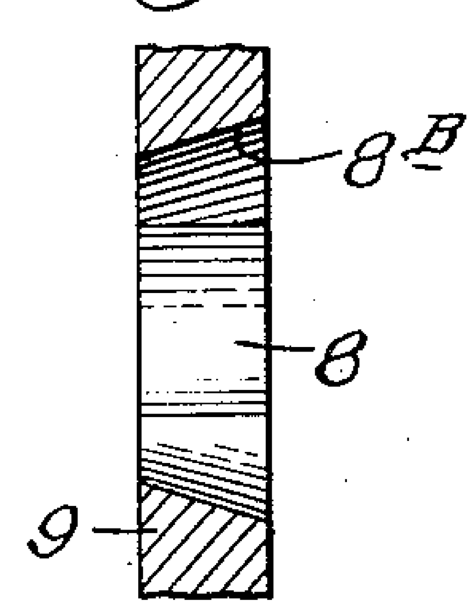


Fig. 13.

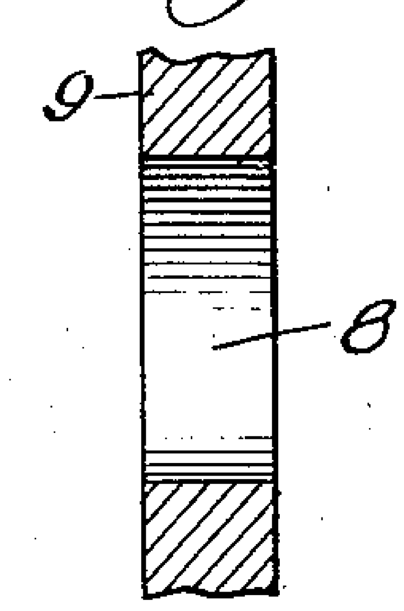


Fig. 14.

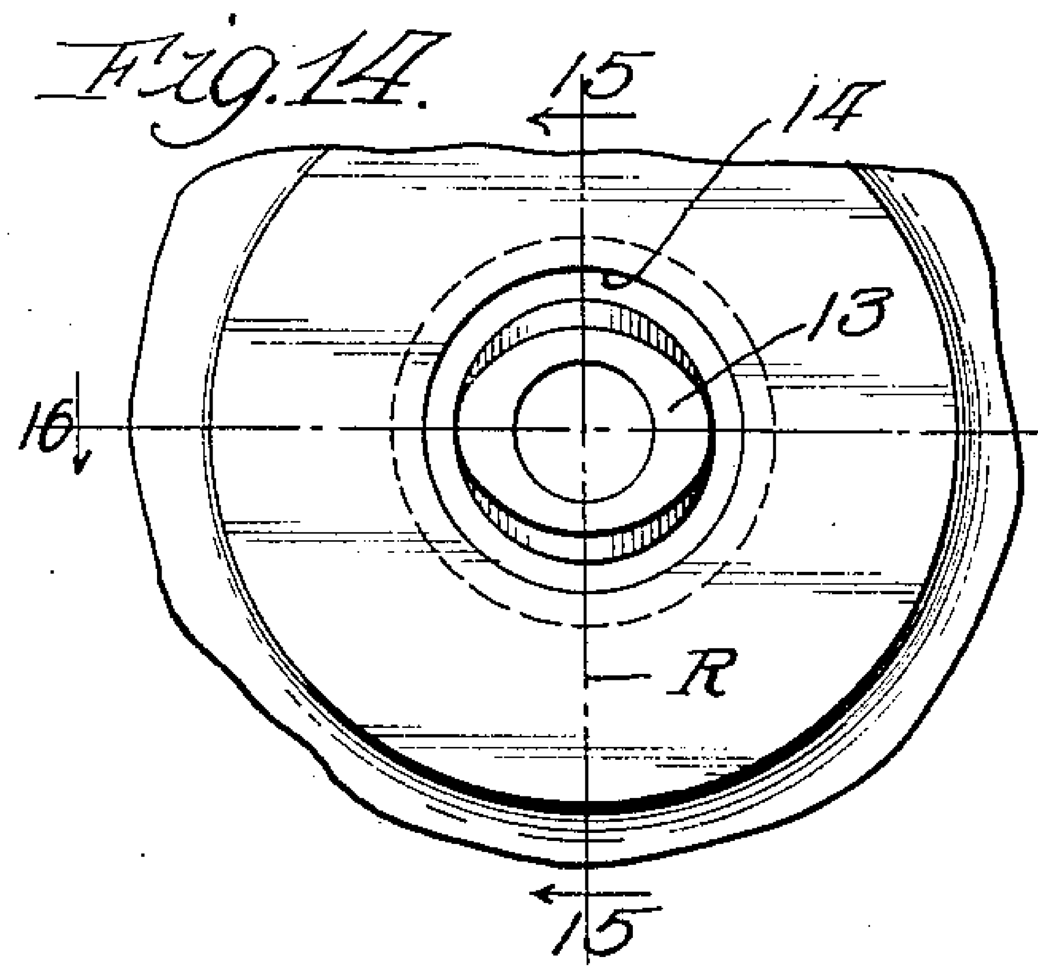


Fig. 15.

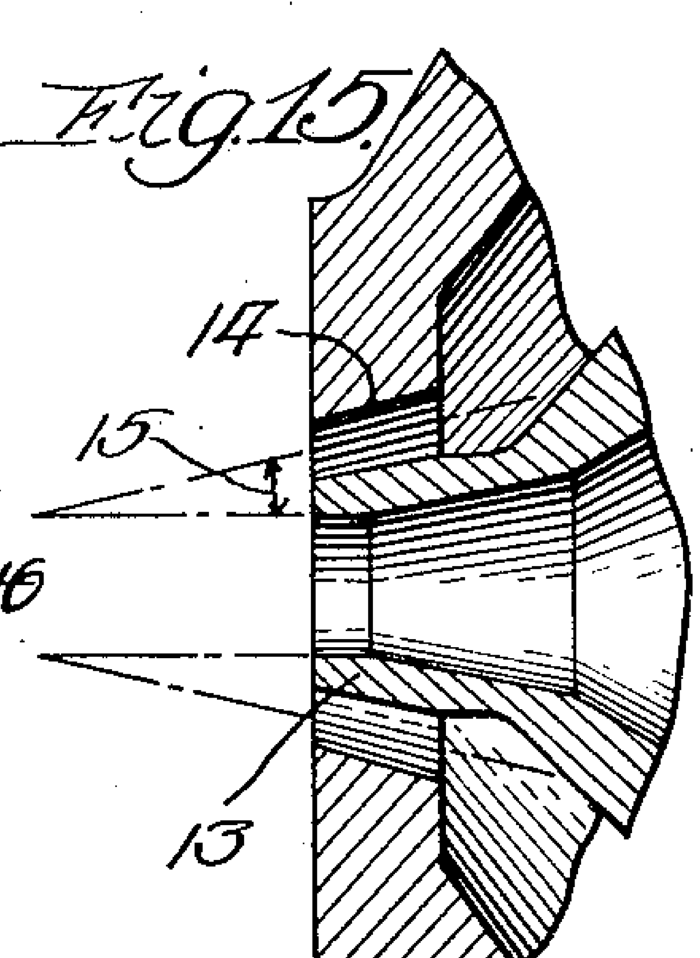
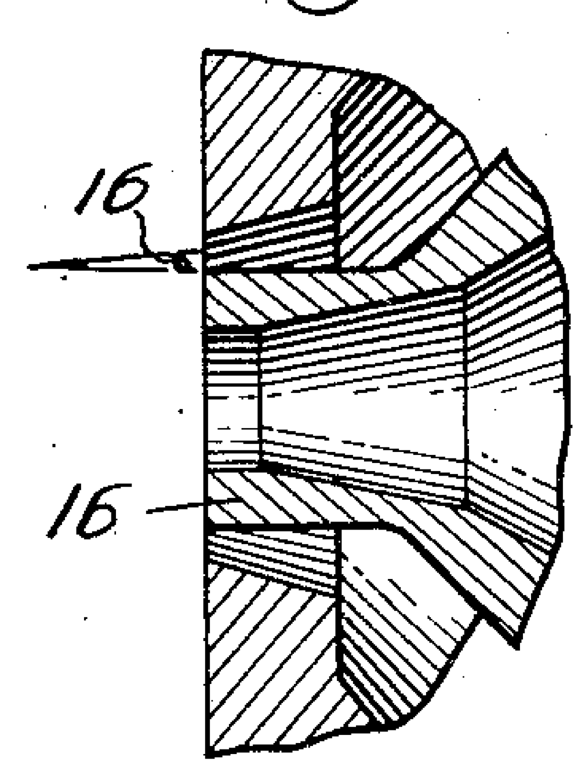


Fig. 16.



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Patented Feb. 14, 1933

1,897,173

UNITED STATES PATENT OFFICE

ROBERT LONG AND ERIC GUSTAFSSON, OF CHICAGO, ILLINOIS, ASSIGNORS TO BINKS MANUFACTURING COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE

AIR NOZZLE FOR SPRAY APPLIANCES

Application filed April 29, 1931. Serial No. 533,664.

Our invention relates to socalled "flat spray" appliances, namely appliances for projecting liquid in the form of a spray, and more particularly to the types of such appliances by which the liquid (or generally liquid) material is initially projected in a solid stream and in which this projected stream is thereafter atomized and deformed in its cross-section with the aid of air jets directed against opposite sides of the said stream.

In applying paints, varnishes, lacquers and other liquid coating materials of uniform consistency, it has heretofore been customary to employ spray appliances of this type, usually in the form of "spray guns" having head portions formed for projecting a tubular sheath of air around a cylindrical stream of liquid and also for projecting supplemental air jets against opposite sides of the air-sheathed liquid stream at a relatively short distance from the discharge outlet of the liquid.

In practice, the relative diameter of each of the supplemental air jets in proportion to that of the discharge outlet for the liquid may be varied somewhat according to the extent to which the resulting spray is to be flattened in section (namely, from a circular section to an elliptical section) and also according to the viscosity of the liquid. However, with liquid of a given viscosity, the diameter of each supplemental air jet must not be so much smaller than the diameter of the liquid stream as to cause these air jets to cut the stream into two parts, or even to deform the cross-section of the stream to a dumb-bell shape; nor should the supplemental air jets be so much larger in diameter than the liquid stream as to waste air.

With the homogeneous liquids, such as those above mentioned, the proper proportions of the various air outlets with respect to the discharge outlet for the liquid are easily determined, so that such liquids can readily be projected with the aid of compressed air to form sprays having a fairly sharply defined elliptical cross-section. However, when the projected coating material is not homogeneous, the results have not been equally satisfactory; for the reason that some of the heavier constituents of the liquid stream would be blown out of the stream during the atomizing and flattening of this stream, thereby producing an "off spray" beyond the generally elliptical contour of the stream.

This projection of "off spray" particles outside of the general path of the spray has been particularly serious in connection with the socalled vitreous enamels, which can be applied to surfaces by intermingling them with a relatively light liquid which does not cling tenaciously to the solid particles. With the usual liquid material generally employed for spray-coating an object with such vitreous enamels—consisting for example of finely ground solid vitreous materials suspended in water—the commonly employed spray guns project some of these solid particles outside of the general path of the spray so that a sharply defined edge of the resulting coating cannot be obtained, thereby requiring considerable manual labor for removing the "off spray" particles and even barring the efficient use of spray appliances for many purposes.

In general, our present invention aims to eliminate the formation of this objectionable "off spray" by means of a simple and entirely automatic procedure, and also aims to provide simple and easily made changes in the spray projecting heads of appliances of the above recited class whereby the elimination of this "off spray" can readily be accomplished.

In one of its major objects, our invention aims to provide a method of transforming a liquid stream into a flattened spray of sharply defined contour, which method includes the modifying of the cross-section of the projected stream of material prior to the impact of the supplemental air jets on this stream to such an extent as to prevent these air jets from forcing particles of the stream outside the general stream.

In another major object, our invention aims to provide a novel air nozzle in substitution for the usual spray-flattening air nozzle of spray guns of the type commonly used for spray-painting, which new air nozzle will accomplish the desired elimination of the "off spray" without materially increasing the cost of the appliance and without requiring any change in the manipulation of the appliance.

Still further and also more detailed objects of our invention will appear from the following specification and from the accompanying drawings, in which drawings

Fig. 1 is a front elevation of an air nozzle and liquid nozzle assembly embodying our invention.

Fig. 2 is a fragmentary section taken diametric of the same head portions along the line 2—2 of Fig. 1, namely in the common plane of the axes of the supplemental air ports from which the spray-flattening supplemental air jets issue.

Fig. 3 is a fragmentary diametric section taken along the line 3—3 of Fig. 1, namely at right angles to a common plane through the axes of the said ports.

Fig. 4 is an enlargement of the central portion of Fig. 1.

Fig. 5 is a fragmentary section, taken along the line 5—5 of Fig. 3 and looking forwardly with respect to the nozzle assembly.

Fig. 6 is a diametric section through the central forward portion of the air nozzle of Figs. 1 to 5, showing a step in its manufacture.

Fig. 7 is an enlargement of a portion of Fig. 3, with dotted lines indicating the outline of the material stream, the cross-section of the air sheath in one plane, and the general direction in which certain portions of air for this sheath issue from the air nozzle.

Fig. 8 is a diagrammatic view showing a cross-section through an air-sheathed liquid stream at the point of impact of the supplemental air jets, and showing the outlines of the supplemental air jets with the heretofore customary flat-spray appliances.

Fig. 9 is a diagram of the "target" and "off spray" produced by the arrangement of Fig. 8 with non-homogeneous materials, such as vitreous enamels.

Fig. 10 is a diagram similar to Fig. 8, but showing the modified cross-section of the material stream at the point of impact of the supplemental air jets as produced by the here disclosed method and air nozzle modifications.

Fig. 11 is a fragmentary front elevation of the central forward portion of another air nozzle suitable for use according to our invention.

Figs. 12 and 13 are sections taken respectively along the correspondingly numbered lines in Fig. 11.

Fig. 14 is a fragmentary front elevation of another air nozzle and liquid nozzle assembly suitable for use according to our invention.

Figs. 15 and 16 are sections taken respectively along the correspondingly numbered lines in Fig. 14.

In the heretofore employed paint spray guns which include air nozzles designed for flattening the projected spray of liquid, the air nozzle has a central port presenting a cylindrical wall coaxial with and housing the exteriorly cylindrical tip of the liquid nozzle, and the supplemental air ports of the nozzle have their axes in a common plane with the said central port and intersecting the axis of the central port at a common point forward of the air nozzle. Such an arrangement is shown for example in the Binks Patent #1,655,255.

Owing to this coaxial arrangement of the central air port and the tip of the liquid nozzle, the air sheath which surrounds the liquid (so as to deter a rapid expanding of the liquid stream and also to furnish part of the air for the atomizing) is initially a cylindrical tube of uniform radial thickness. The projected liquid stream expands into this tube before the stream reaches the supplemental air jets, and this diametric expansion of the liquid stream 1 may make the stream approximately equal in diameter to each of the supplemental air jets 2 issuing from the supplemental air ports 3 of the air nozzle, as shown in Fig. 8. When the liquid stream is surrounded by such a tubular air sheath 4, this approximately equal diameter of the liquid stream and the supplemental (or flattening) air jets is not objectionable when the liquid is homogeneous, and particularly not when the liquid also has the considerable viscosity found in a paint, varnish or lacquer.

With such a homogeneous liquid stream housed by an air sheath, the portions of the supplemental air jets which are approximately tangential of the liquid stream 1 will simply merge with parts of the air sheath 4 and will cooperate with this sheath to prevent the liquid from being promiscuously scattered during the flattening and atomizing of the spray into a fan-shaped spray of elliptical cross-section. Consequently, the projection or so-called "target" of the spray on a distant surface will have a fairly sharply defined elliptical contour, such as that shown at 5 in Fig. 9.

However, if the stream 1 in Fig. 8 consists of a finely ground solid material loosely suspended in a non-viscous material, such as water, the impact of the said approximately tangential portions of the supplemental air jets on this stream will flick some of the solid particles out of the water, since the water will not cling to these particles with any considerable tenacity. Consequently, the resulting projection of the spray, although still of the same general elliptical outline 5, will also include scattered particles 6 outside the adequately coated part of the object against which the spray is directed.

To overcome the detaching of such "off-spray" producing particles from a stream of material when this stream is of a non-homogeneous constituency, we deform the cross-section of the projected stream before the supplemental air jets impact on this stream, so as to reduce the diameter of this stream in a plane at right angles to the common plane P (Fig. 1) of the axes of these air jets. With this deformation carried to a suitable extent, the cross-section of the generally liquid stream 7 when reached by the converging supplemental air jets 2 has an eliptical contour with the longer axis of the ellipse in the said common plane P of the axes of these air jets, as shown in Fig. 10; as the result, the same edge portions of the air jets which would flick heavy particles out of light liquid if the stream were of circular section (as in Fig. 8) will pass freely alongside the stream and will merge with the (now also elliptical) air sheath 8 so as to prevent the ejecting of particles from the stream. Consequently, by pre-flattening the projected stream along a diameter at right angles to the said common plane of the air jets (or in the plane F of Fig. 1 along which the spray is to be flattened), we avoid the objectionable off-spray which heretofore has prevented an efficient use of spray guns in connection with such materials as vitreous enamels.

In proceeding according to this method with common types of spray guns—such as that of the above mentioned Binks patent—we merely need to modify the spray head so that diametrically opposed portions of the stream-housing air sheath will exert the needed flattening action in the desired direction on the projected stream before the forwardly converging air jets impact on this stream.

For this purpose, we desirably make the central air port 8 in the cap-like air nozzle 9 (Figs. 1 to 5) substantially elliptical in cross-section, with the longer axis of the elliptical formation in the plane F along which the spray is to be flattened; so that with the exteriorly cylindrical tip 10 A of a liquid nozzle 10 freely housed by this central air port, a greater volume of air will issue through the radially enlarged bore portions 8 A than through the bore portions adjacent to the shorter axis of the ellipse. Since the compressed air issuing from this annular air port will begin to expand as soon as it leaves the port, the increased amount of air issuing through the enlarged bore portions (and which in each case is greatest adjacent to the longer axis of the ellipse) will exert a greater pressure against the stream than the air issuing from air outlet portions intermediate of these radially enlarged bore portions, thereby compressing the stream of liquid along the said axle F.

However, the average distance D (Fig. 2) which this stream traverses before the forwardly converging air jets impact on it is so short that the flattening effect ordinarily would not be sufficient for our purpose; hence we desirably also form the enlarged port portions so that they taper forwardly, so that the air sheath portions S (Fig. 7) which issue through these bore portions will converge toward the axis L of the liquid stream. By doing this, we can readily modify this initially expanding liquid stream so that its diametric longitudinal section (taken in the said plane F) will be as indicated by the stream edge lines 20 in Fig. 7, before the air jets J impinge on this stream.

Such an enlarging of two diametrically opposed portions of the central air port, together with the said forward tapering of these port portions, can easily be accomplished by initially forming the air cap 9 with a circular central bore 8 corresponding in diameter to that needed when the same air nozzle is to be used in spraying a homogeneous liquid, and thereafter taking two cuts with a milling cutter disposed at a suitable angle with respect to the axis of the air nozzle. Thus, Fig. 6 shows the position of the milling cutter at the end of the first of two such operations; and the arcs 8 A and 8 B (in Figs. 4 and 5) show the contours of such an enlarged port respectively at the front and rear ends of the port.

By thus merely forming two arcuate bore enlargements we can sufficiently approximate a true elliptical contour for practical purposes, and the gradual decrease in the width W (Fig. 4) of the annular air port from the middle of each such arc to the end of the arc causes a gradual reduction in the volume of air issuing through circumferentially different portions of each such port enlargement. This progressive difference obviously will hold true also with changes in the proportionate diameter of the milling cutter (and of the corresponding change in the radius of the arcuate-sectioned enlargement) in proportion to the diameter of the unenlarged bore portions; and the spread of the arcuate enlargements (circumferentially of the bore) can also be varied considerably. However, we preferably form these enlargements so that each thereof extends through an arc of not less than 90 degrees and so that the extreme spread of each enlargement (radially of the port) is not more than half the radial minimum width of the resulting annular air discharge outlet.

The extent of these diametrically opposite port enlargements may be varied according to the specific gravity of the liquid material, and also according to the differences in the pressures at which the liquid and the compressed air are supplied to the appliance. Thus, under some conditions the enlarging of two opposed port bore portions need not be carried to the extent shown in Figs. 1 to 6, in which the enlargements extend to the forward end of the port. Instead, we have found it sufficient for some purposes to use the milling cutter only to such an extent that the forward end of the central air port 8 remains a circle, as in Fig. 11; thereby still obtaining a substantially elliptical rear end for the port, the cross-sections along the two axes of the ellipse being as shown in Figs. 12 and 13 respectively.

In each of the heretofore described embodiments, the increase in the emission of air through two diametrically opposite portions of the annular air port is obtained by corresponding arcuate recess formations in the outer wall of this port, so that the needed special machining is all on the air nozzle. This is desirable, since the recess formations can then be accurately located in relation to the supplemental air ports 3 which commonly are formed in diametrical opposite integral projections 12 on the air nozzle; and since this construction permits the plane of the flattened spray to be shifted by rotating the air nozzle on the body of the appliance without affecting the beneficial results of our invention and without requiring other adjustments.

However, our invention can also be employed by deforming the exterior of the tip of the liquid nozzle to a substantially elliptical cross-section while providing the air nozzle with a forwardly tapering central air port 14 of circular section, but in this case the liquid and air nozzles must be accurately assembled so that the supplemental air ports 3 in the air nozzle will be in a plane R (Fig. 15) along the common axis of both nozzles and along the shortest diameter of the elliptical exterior cross-section of the liquid nozzle 13. With this assembly, it will be evident from Figs. 15 and 16 that the amount of air issuing at the ends of the shorter axis of the elliptical exterior section of the liquid nozzle will be greater than that issuing at the ends of the longer axis; also that the general direction of the larger volume of air will be at a larger angle 15 (Fig. 15) than the corresponding angle 16 for the smaller volume of air in Fig. 16, so that the operation of the nozzle assembly is similar to that of the previously described two embodiments.

Moreover, in each of the illustrated embodiments, the width of the annular air outlet (between the central air port in the air nozzle and the exterior of the tip of the liquid nozzle) decreases quite gradually in both directions circumferentially of the said tip from the shorter axis of the elliptically formed outlet wall, and the general angle at which the air issues from this outlet also decreases gradually in both of the said directions. Consequently, we avoid any tendency toward producing a jagged spray.

However, while we have heretofore described our invention in embodiments including desirable details of construction and arrangement, we do not wish to be limited in these respects, since many changes might be made without departing either from the spirit of our invention or from the appended claims. Nor do we wish to be limited to the type of appliance in connection with which our invention is employed, although we have found commercial types of spray guns particularly suited for this purpose.

So also, we do not wish to be limited to the use of our invention in connection with non-homogeneous liquid materials, as we have found that it also is advantageous in reducing the time required for coating objects with some of the more common homogeneous coating materials; hence we are using the terms "liquid material" and "generally liquid material" in the claims in the broad sense in which these terms include both homogeneous liquids, non-homogeneous liquids, and liquids having solid particles intermingled with them.

We claim as our invention:

1. The method of producing a flattened spray of liquid material of sharply defined cross-sectional contour, which consists in forming the liquid into a stream of elliptical cross-section and subjecting said elliptically sectioned stream to the compressing action of two opposed jets of air having their axes in a common plane with the longer axis of the said elliptical cross-section of the stream.

2. The method of producing a fan-shaped spray of liquid material which consists in projecting the liquid in the form of a cylindrical stream, then flattening the said stream along one diameter of the stream to an elliptical cross-section, and thereafter simultaneously atomizing the stream by the action of opposed air jets so as to flatten the stream along a diameter at right angles to the aforesaid diameter of the stream.

3. In the producing of a fan-shaped spray by the impact of opposed and converging jets of air against a stream of liquid, the steps of projecting the liquid in a stream of circular section; flattening the stream, before the impact of the air jets thereon after its said projection and in a direction at right angles to that in which the said jets exert a stream-flattening action.

4. The method of converting a projected cylindrical liquid stream into a flattened spray, which consists in first flattening the stream by air pressure in a plane diametric of the stream, and thereafter atomizing and reflattening and atomizing the stream by air pressure in a diametric plane at right angles to the aforesaid plane.

5. In the production of a flat spray by the simultaneous impinging against a projected stream of liquid of two opposed jets of air having their axes in a common plane diametric of the liquid stream, the step of flattening the said stream along the said plane

by air pressure prior to the impinging of the said air jets on the stream.

6. In the production of a flat spray by the simultaneous impinging against a projected stream of liquid of two opposed jets of air having their axes in a common plane diametric of the liquid stream, the step of housing the projected liquid stream prior to the said impinging of the air jets on the stream by a tubular sheath of air having a circular bore, which air sheath is of greatest radial thickness in a plane diametric of the said stream and at right angles to the aforesaid plane, and which air sheath decreases gradually in thickness toward the first named plane.

7. The method of converting a projected cylindrical liquid stream into a flattened spray which consists in surrounding the said projected stream with a tubular air sheath having two diametrically opposite sheath portions of greater thickness than the sheath portions intermediate thereof, and thereafter subjecting the air-sheathed liquid stream to the action of opposed air jets having their axes in the same longitudinal plane diametric of the sheath with the middle points of the said opposite sheath portions.

8. The method of producing a flattened spray of liquid, which consists in projecting the liquid in the form of a cylindrical stream; projecting around the said projected stream of liquid an air sheath having diametrically opposite portions thereof converging toward a common point on the axis of the liquid stream, so as to flatten the stream along one diameter thereof; and thereafter projecting against the flattened stream two opposed jets of air having their axes in a common plane of the longest diameter of the flattened stream.

9. The method of producing a flattened spray of liquid, which consists in initially projecting the liquid in the form of a cylindrical projected stream; projecting around the said stream of liquid an air sheath having diametrically opposite portions thereof converging toward a common point on the axis of the liquid stream, so as to flatten the projected stream along one diameter thereof; and thereafter projecting against the flattened stream two opposed jets of air having their axes in a common plane with the longest diameter of the flattened stream and converging toward a point on the axis of the stream adjacent to the aforesaid point.

10. In a liquid spraying appliance, means for producing a projected liquid stream of elliptical cross-section; and means for projecting against opposite sides of the said stream converging jets of air having their axes in a common plane with the longer axis of the elliptical cross-section of the stream.

11. In a liquid spraying appliance, means for producing a liquid stream of elliptical cross-section; and means for projecting against opposite sides of the said stream two jets of air having their axes in a common plane with the longer axis of the elliptical cross-section of the stream and with each jet of a diameter not less than the shorter diameter of the elliptical cross-section of the stream.

12. In a liquid spraying appliance, means for projecting a liquid stream of circular cross-section, means for directing air against opposite sides of the said stream, and means for thereafter projecting air against the two sides of the stream circumferentially intermediate between the aforesaid sides.

13. In a liquid spray appliance, an air-projecting member haxing a frontal wall provided with an air discharge port; the front and rear ends of the said port each being substantially elliptical, with the major ellipse axis of both ends in a common plane diametric of the port, and with the length of the said major axis longer at the rear end of the port than at the forward end, the minor ellipse axes being equal at both ends of the port.

14. In a liquid spraying appliance, a liquid-discharging nozzle having a tubular tip, and an air nozzle having an outlet port coaxial with the said tip and into which the said tip extends, the said tip being freely spaced from the bore wall of the said port, and the rear end of the said port being substantially elliptical.

15. In a liquid spraying appliance, a liquid nozzle having a tubular outlet tip, and an air nozzle coaxial with the liquid nozzle and having an axial central bore freely housing the said tip, the forward ends of the said tip and air nozzle bore being substantially in a common plane at right angles to their axes; the air nozzle also being provided with two supplemental air ports having their forwardly-converging axes disposed in a common plane diametric of the liquid nozzle; the said central bore being of a substantially elliptical cross-section with the minor axis of the ellipse in the said common plane.

16. In a liquid spraying appliance, a liquid nozzle having a tubular outlet tip, and an air nozzle coaxial with the liquid nozzle and having an axial central bore freely housing the said tip, the forward ends of the said bore and tip being in a common plane; the air nozzle also being provided with two supplemental air ports having their forwardly converging axes disposed in a common plane diametric of the liquid nozzle; the said central bore having its rear end of substantially elliptical cross-section with the minor axis of the ellipse in the said common plane, the diametrically opposite wall portions of the said bore being parallel at the ends of the minor axis of the bore and forwardly converging at the ends of the major axis of the bore.

17. In a liquid spraying appliance, a liquid

nozzle having a tubular outlet tip, and an air nozzle coaxial with the liquid nozzle and having an axial central bore freely housing the said tip; the air nozzle also being provided with two supplemental air ports having their forwardly converging axes disposed in a common plane diametric of the liquid nozzle; the said central bore having two diametrically opposite bore enlargements disposed with their middle points in a plane axial of the liquid nozzle and at right angles to the aforesaid plane, the said bore enlargements having their walls converging forwardly toward the axis of the liquid nozzle.

18. In a liquid spray appliance, a liquid-projecting nozzle having a hollow cylindrical tip, and an air-projecting member having a frontal wall provided with a forwardly tapering air discharge port housing the said tip and larger in all radial dimensions than the said tip; the front and rear ends of the said port each being substantially elliptical, with the major ellipse axis of both ends in a common plane diametric of the port.

19. In a liquid spraying appliance, a liquid-discharging nozzle having a tubular tip of circular periphery in cross-section and an air nozzle having a forwardly tapering outlet port coaxial with the said tip and freely housing the said tip, the said port being of substantially elliptical cross-section.

20. In a liquid spraying appliance, a liquid-discharging nozzle having a cylindrical tubular tip and an air nozzle having an outlet port coaxial with the said tip and freely housing the said tip, the said port being coaxial with the said tip and having two diametrically opposite and symmetrically formed bore enlargements, the remaining portions of the said port being parts of a common cylindrical surface.

21. In a liquid spraying appliance, a liquid-discharging nozzle having a cylindrical tubular tip, and an air nozzle having an outlet port coaxial with the said tip and freely housing the said tip, the said port being coaxial with the said tip and having two diametrically opposite and symmetrically formed bore enlargements; the port wall portions formed by the said enlargements respectively being portions of two cylindrical surfaces having their axes inclined at equal angles to the axis of the liquid nozzle, and the remaining port wall portions being portions of a cylindrical surface coaxial with the liquid nozzle.

22. In a liquid spraying appliance, a liquid nozzle having a cylindrical tubular tip, and an air nozzle having an outlet port into which the said tip extends, the forward ends of the said tip and port being in a common plane at right angles to the axis of the tip, the wall of said port and the exterior wall of the said tip being spaced apart to provide an annular air outlet, certain portions of the opposing walls of said outlet being convergently disposed and other portions being substantially parallel.

Signed at Chicago, Illinois, April 25th, 1931.

ROBERT LONG.
ERIC GUSTAFSSON.