Aug. 15, 1967 | J. R. JAMES | 3,335,956

SPRAY PROCESS

Original Filed July 22, 1963 | 2 Sheets-Sheet 1

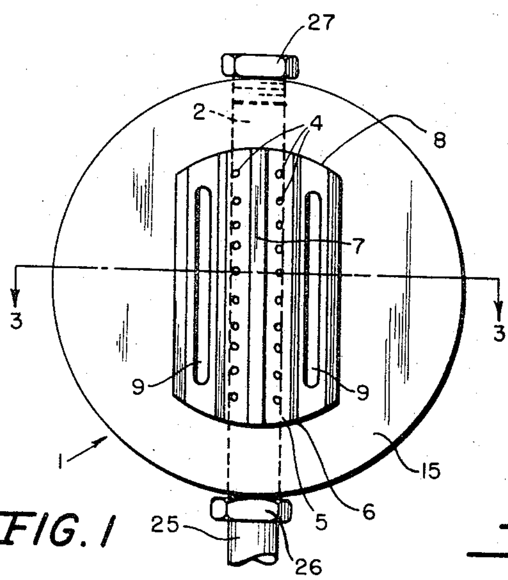

FIG. 1

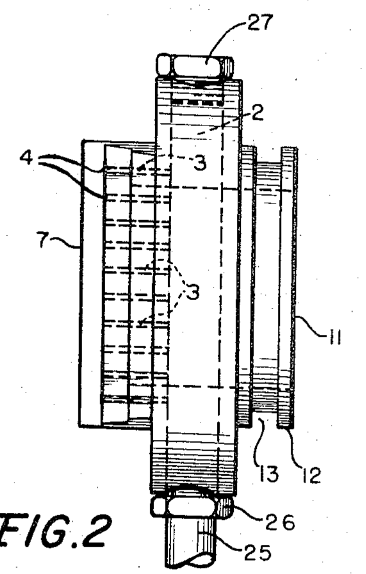

FIG. 2

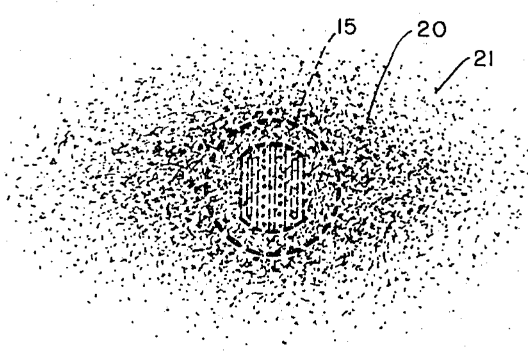

FIG. 4

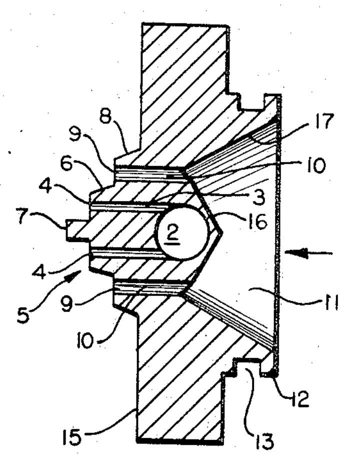

FIG. 3

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SPRAY PROCESS

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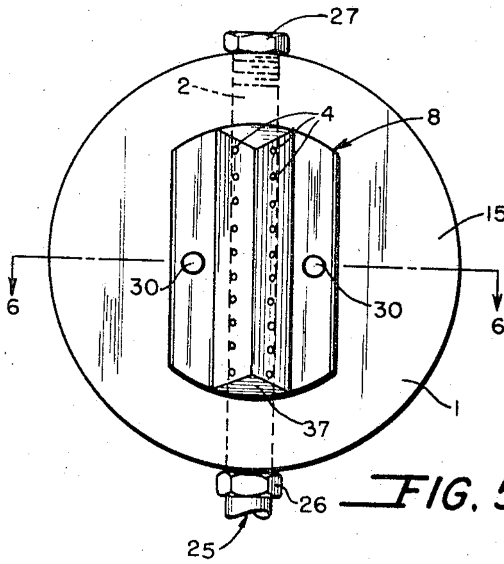

FIG. 5

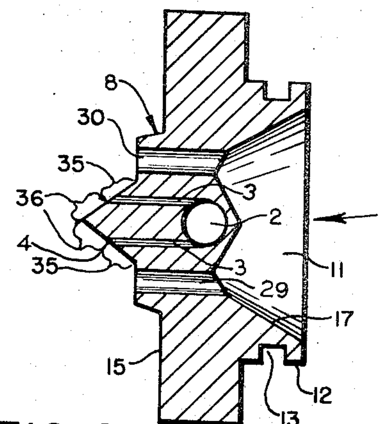

FIG. 6

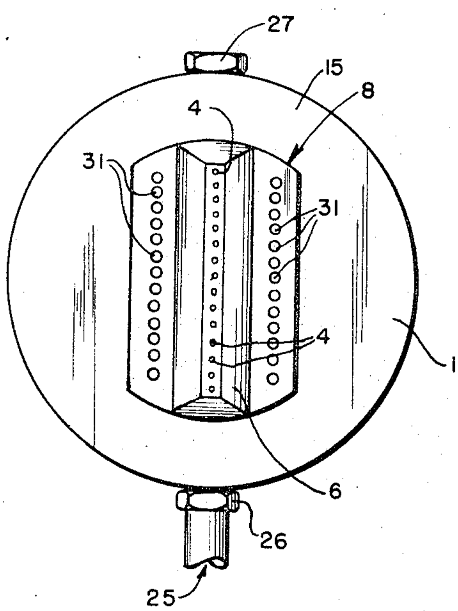

FIG. 7

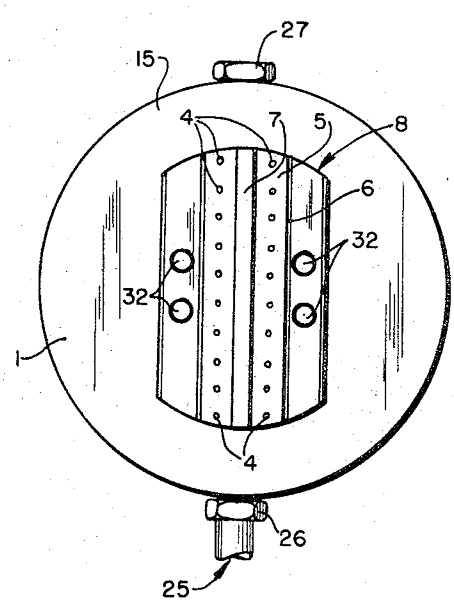

FIG. 8

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3,335,956
SPRAY PROCESS

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Original application July 22, 1963, Ser. No. 296,724, now Patent No. 3,199,789, dated Aug. 19, 1965. Divided and this application July 23, 1965, Ser. No. 474,396
4 Claims. (Cl. 239—8)

ABSTRACT OF THE DISCLOSURE

Discloses a spray nozzle and process for spraying viscous material to produce a uniform spray pattern. The nozzle contains a series of high velocity jet openings which form a narrow rectangular gas pattern and two or more low velocity liquid openings located on both sides and behind said jet openings. It also contains a distribution surface sloping from the liquid openings toward said jet openings so that liquid is drawn across said distribution surface in the form of a film and is aspirated into said narrow rectangular gas pattern.

This application is a division of my copending application for Spray Nozzle Having a Rectangular High Velocity Gas Outlet and Low Velocity Liquid Outlets, Ser. No. 296,724, filed July 22, 1963, now U.S. Patent 3,199,789.

This invention relates to a novel spray nozzle for use in spraying a liquid stream which is conveyed by a pressurized gas. More specifically, this invention relates to a spray nozzle which is adapted to spray a liquid stream comprising mixed liquid components in which one or more of said components may contain suspended solids. More specifically, this invention relates to a spray nozzle which is adapted to produce an elliptical spray pattern on a substrate.

The spray nozzle of this invention is specifically adapted for use in spraying various foam blends, as for example, polyurethane. However, it may be advantageously used in spraying other liquid components wherein the problem of overspray and the production of a uniform pattern of uniform thickness is encountered. Overspray, which is sometimes termed "off spray," relates to materials which fall outside of the general spray pattern. Additionally, overspray relates to particles of materials which do not reach the surface of the substrate. Thus, if the atomization of the material is too great, there is a possibility of a large portion of the liquid material being so fine in particle size that it is not conveyed to the substrate and either falls short or is blown away by cross draft or the exhaust system in the spray booth. Overspray refers also to volatile components in the stream which turn into a gas prior to reaching the substrate and thus are effectively lost.

An object of my invention, therefore, is the provision of a spray nozzle which minimizes the amount of off-spray.

Another problem which is encountered in the spraying of foam blends onto a substrate is in obtaining a uniform desired thickness. In spraying of foam blends, thicknesses of from a fraction of an inch up to several inches are desired, and this normally creates a difficulty in producing an even planar surface. In some instances, thicknesses up to ten inches or more are required. In some cases, the exterior surface appears rough and pebbly. More importantly, however, with prior art apparatus, there has been a lack of uniformity in thickness of the sprayed material. This produces waste material on the thicker portions if one thickness is desired to accomplish the purpose of coating and/or insulation. Thus, for example, if a

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thickness of one inch of insulation is required, it was sometimes necessary with prior art apparatus to spray an average of one and one-quarter to one and one-half inches to insure that in certain areas there would be a minimum of one inch.

Another important object of my invention is the provision of a spray nozzle which will provide a uniform pattern whereby a uniform thickness of material may be sprayed onto a substrate.

The nozzle of my invention may be utilized on some types of mixing heads now in production. One such type of mixing head is commercially produced by the Martin Sweets Company, Inc. of Louisville, Ky. This type of mixing head is described by John F. Reeves in an article entitled "Rigid Foams—Application and Use in Transportation," contained in the publication, "Cellular Plastics—Today's Technology," which was presented at the 7th Annual Technical Conference Proceedings, Cellular Plastics Division, Society of the Plastics Industry, and published by the Society of the Plastics Industry, Inc., New York, N.Y., Section 2N, pages 2 through 6, April 1963. This mixing head utilizes a rotatable rod-type valve such as that disclosed by G. F. Spragens in U.S. Patent 3,098,506 for Valve Packing Assembly. By use of this valve, communication is established in one position to the mixing chamber of the mixing head and in another position to return lines for recirculation of the liquid components by liquid pumps. Thus, the liquid components, as for example, a prepolymer mixture and a catalyst, are mixed internally in the mixing chamber so that the provision of my improved nozzle with an accessory source of gas will provide a spraying apparatus for use on various substrates, which may be disposed either vertically or horizontally.

Basically, my invention provides a gas pattern forming means whereby a gas pattern of high velocity and low pressure is formed directly adjacent to the face of the nozzle. Combined with the high velocity gas pattern is a low velocity liquid flow which is pushed by atmospheric pressure or, more precisely, by the difference in atmospheric pressure and the low pressure zone created by the high velocity gas into the gas pattern to be conveyed onto the substrate. Additionally, I have found it advantageous to utilize a liquid distribution face directly adjacent to the gas pattern forming means and the liquid outlets so that the liquid will be pushed up onto the liquid distribution face in the form of a uniform layer to be aspirated into the gas stream. The low pressure, high velocity gas pattern is provided by a series of small diameter gas outlets arranged in such a manner as to produce a gas pattern which is rectangular in shape and of small cross section directly adjacent to the face of the nozzle. In one modification, I have used a single row of small diameter gas outlets. The pattern formed thereby is considered to be rectangular in shape and of small cross section. The low velocity liquid flow is accomplished by use of relatively large liquid outlets disposed on each side of the gas pattern forming means. The liquid distribution face is disposed on either side of the gas pattern forming means between the gas outlets and the liquid outlets, so that the liquid is first distributed over the distribution face prior to atomization by the gas stream. I have found that it is advantageous to make both the gas pattern forming means and the liquid distribution face longer than the liquid outlets to insure that all of the liquid is drawn onto the sides of the face. Furthermore, in a preferred embodiment, I utilize slit-like liquid outlets to assist in distributing the liquid over a relatively long area. I have found that if the liquid projects in the form of a stream away from the nozzle to meet the gas stream, that considerable turbulence results, thus producing an excessive amount of overspray. Thus, one of the features of my invention is the mixing of the liquid and the gas in an area adjacent to the face of the nozzle and not in spaced relation therefrom.

My invention will be better understood by reference to the accompanying drawings and to the following detailed description.

FIG. 1 is a front elevation of the spray nozzle of this invention.

FIG. 2 is a side elevation of the nozzle.

FIG. 3 is a horizontal section of the nozzle of this invention taken along lines 3—3 of FIG. 1.

FIG. 4 is a diagrammatical view illustrating the relation of the liquid outlets and the gas outlets of my spray nozzle to the pattern produced on the substrate.

FIG. 5 is a front elevation of another embodiment of my spray nozzle.

FIG. 6 is a horizontal section taken along lines **6—6** of FIG. 5.

FIGS. 7 and 8 are front elevations of other modifications of my spray nozzle.

Referring now to an illustration of the embodiments of my invention as shown in FIGS. 1–3, **1** designates the spray nozzle. The face of the nozzle **15** contains a raised enclosure **8** for the liquid and gas outlets **9** and **4**, respectively. Gas is introduced through gas hose **25**, which is connected to the nozzle by hose coupling **26**, and into gas conduit **2** which runs transversely across the diameter of the nozzle and terminates in plug **27**. Conduit **2** communicates with air channels **3**, the axes of which are substantially perpendicular to the conduit, and to the face **15** of the nozzle. The air channels **3** terminate in air outlets **4** which in FIG. 1 are in approximate linear arrangement along ridge **5** in two rows separated by septum **7**. The liquid component is introduced through liquid chamber **11**, which has sloping walls **17** which converge with liquid channels **10**. Liquid channels **10** terminate in slit-like liquid outlets **9** on each side of the walls **6** of ridge **5**. These slits are of such size that the liquid leaves the slits at a very low velocity, otherwise the liquid would shoot out some distance before being drawn into the gas stream, causing a tremendous amount of overspray. Further, it will be noted that the walls **6** of ridge **5** extend beyond the ends of the slits **9** to form a liquid distribution face, so that the liquid emerging therefrom at low pressure and low velocity is drawn up the walls **6** of the ridge in a uniform layer and is thence pushed into the low pressure gas stream. Liquid chamber **11** is separated in the middle by a V-shaped post **16** in which air conduit **2** is located (see FIG. 3). The entire assembly is equipped with flange **12** and groove **13** on the inner side for an O-ring seal so as to engage with the mixing head of the type previously referred to.

In the modifications shown in FIGS. 5 and 6, the liquid channels terminate in round liquid outlets **30**. Gas outlets **4** are contained in a triangular ridge **37** in which the area **35** constitutes a liquid distribution face and the area **36** serves as a dividing septum.

In the modification shown in FIG. 7, the liquid outlets comprise a series of round openings **31** and the gas outlets **4** form a single row along the face of the ridge. This modification is primarily useful with materials falling in the lower range of viscosities.

FIG. 8 illustrates another modification utilizing two round liquid outlets **32** on each side of the ridge **5**.

OPERATION

For purposes of illustration, the operation of the nozzle of this invention is as follows: If it were desired to produce a foam blend, the mixed chemical constituents in the form of one or more liquids in which one or more of the constituents might contain a suspended solid, enter liquid chamber **11**. The mixed components flow through liquid channels **10** and emerge from liquid outlets **9**. Compressed gas at a pressure generally in the range of from 25 to 100 p.s.i.g. is introduced via air hose **25** onto conduit **2** and is forced through air channels **3** to emerge from air outlets **4** as small gas jets of high velocity. These air channels in practice are about 1/32 of an inch in diameter although the diameter may vary somewhat depending on the particular requirements. Thus, there is produced a low pressure area projecting from the longitudinal axis of the nozzle, the shape of this area, in the zone adjacent to the face of the ridge is substantially rectangular, having a very narrow cross section. The liquid components emerging at a relatively low pressure and velocity from liquid outlets **9** are aspirated into the low pressure zone produced by the high velocity gas stream. More precisely, atmospheric pressure or the difference between asmospheric pressure and the low pressure zone caused by the gas jets, forces the liquid against the distribution wall **6** of ridge **5** to force the liquid components into the gas pattern. The pattern at this point is generally rectangular and thus differs from that which results on the substrate. It appears that the liquid entering the gas stream causes turbulence so directed that it confines itself for the most part to one of the two axes perpendicular to the direction of spray; thus spreading the original pattern composed only of gas to form an ellipse of approximately two to one dimensions (see FIG. 4). It will be noted that the longitudinal or major axis of the pattern **20** is essentially perpendicular to the longitudinal direction of the air outlets. The material **21** outside of the pattern area **20** is overspray previously referred to.

I have found that the relation of the minor axis of the ellipse to the major axis of the ellipse as it appears on the substrate is approximately one to two. Moreover, utilizing various liquid constituents having viscosities within the range of from less than 1 centipoise to about 5000 centipoises it has been found that the pattern produced is similar in all cases. While the shape of the pattern and its relation on the substrate relative to the face of the nozzle appears similar, the pattern does not appear to be the same size under various conditions and with different materials. My experiments show that the higher the throughput of the liquids the bigger the pattern becomes. However, the ratio of the major axis appears to remain about two to one. I have utilized materials ranging in viscosity from less than 1 centipoise to about 5,000 centipoises, i.e. from methylene chloride to a viscous foam blend of polyurethane. It appears, also, that the higher the viscosity of the liquid, the bigger the pattern on the substrate. Thus, it may be stated that the more turbulence which is created in the spray pattern, the larger the pattern on the substrate will be. It will be appreciated that the pattern under discussion is that obtained at the usual spray distance of two to four feet from gun to substrate. Under a different set of circumstances, moving the gun closer to the substrate causes the propelling gas to deform the spray already on the substrate. Moving farther away from the substrate causes the atomized foam, or a portion thereof, to fall short of the substrate. However, it may be stated that even though there are wide variations in the dimensions of the pattern depending upon the throughput of the liquid, the viscosity, and the distance from the substrate, that the resulting pattern has a ratio of the major axis of the pattern to the minor axis of the pattern of about two to one. It should also be pointed out that the major axis of the pattern on the substrate lies perpendicular to the longitudinal direction of the air outlets on the face of the nozzle.

While there has been shown and described the fundamental novel features of the invention as applied to preferred embodiments it will be understood that various omissions and substitutions, and changes in the form and details of the assembly illustrated and in its operation may be made by those skilled in the art, without departing from the spirit of the invention. It is the intention, therefore, to be limited only so as to be commensurate in scope with the appended claims.

I claim:

1. The process of spraying at least one liquid component onto a substrate in the form of an elongated pattern which comprises the steps of:

(a) forming a high velocity rectangular gas pattern having a long major axis and a short minor axis to create a rectangular zone of low pressure;

(b) forming a liquid stream of low velocity, relative to the velocity of said gas pattern, on each of the two long sides of said rectangular gas pattern;

(1) said liquid stream having a shorter major axis than the major axis of said gas pattern;

(c) aspirating said liquid stream into said gas pattern in an area close to the point of origin of said pattern.

2. The process of spraying at least one liquid component onto a substrate in the form of an elongated pattern which comprises the steps of:

(a) forming a high velocity gas pattern having a long major axis and a short minor axis to create a rectangular zone of low pressure;

(b) forming a liquid stream of low velocity relative to the velocity of said gas pattern on each of the two long sides of said gas pattern, at a point behind the point of origin of said rectangular gas pattern;

(1) said liquid stream having a shorter major axis than the major axis of said rectangular gas pattern;

(c) providing an inclined surface which extends tangentially from the point of origin of said liquid stream to an aera in proximity to the point of origin of said gas pattern;

(d) aspirating said liquid stream over said inclined surface in the form of a film and into said rectangular gas pattern in an area close to the point of origin of said gas pattern.

3. The process of spraying as defined in claim 2 in

which said inclined surface has a major axis longer than the major axis of said liquid stream.

4. The process of spraying at least one liquid component onto a substrate in the form of an elongated pattern, which comprises the steps of:

(a) forming a high velocity gas pattern having a long major axis and a short minor axis to create a rectangular zone of low pressure;

(b) forming a liquid stream of low velocity, relative to the velocity of said gas pattern, on each of the two long sides of said rectangular gas pattern, at a point behind the point of origin of said rectangular gas pattern;

(c) providing an inclined surface which extends tangentially from the point of origin of said liquid stream to an area in proximity to the point of origin of said gas pattern,

(1) said inclined surface having a major axis longer than the major axis of said liquid stream;

(d) aspirating said liquid stream over said inclined surface in the form of a film and into said rectangular gas pattern in an area close to the point of origin of said gas pattern.

References Cited

UNITED STATES PATENTS

723,010	3/1903	McLean et al.	239—549
1,524,990	2/1925	Macaulay	239—418
1,874,848	8/1932	Babb	239—424.5
2,396,765	3/1946	Walker	239—549
2,813,754	11/1957	Zielinski	239—424

FOREIGN PATENTS

588,788	6/1947	Great Britain.	

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