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(54) Title: COATING APPARATUS AND METHOD

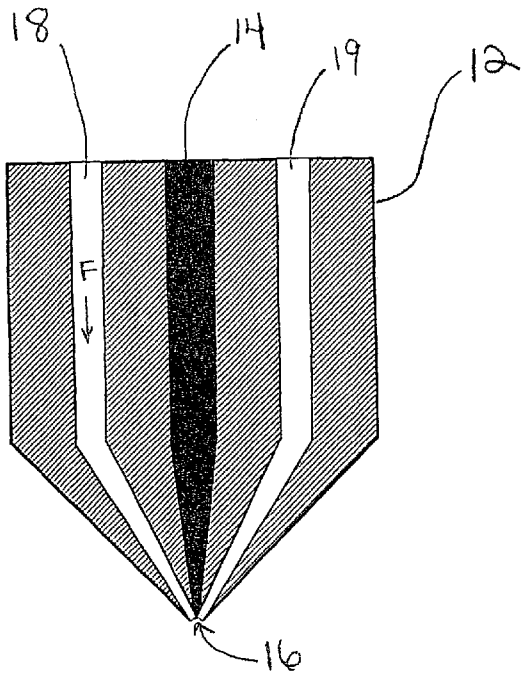

FIGURE 4

(57) Abstract: The invention is an alternative to a conventional atomizing coating apparatus. The apparatus and associated coating methodology of the invention provides a uniform atomized fluid stream, and, in turn, a uniform coating to an object on an industrial scale. The apparatus and methodology addresses many of the critical parameters associated with the conventional curtain and atomizing coating techniques, including but no limited to, uniform distribution, acoustical transparency, reduction or elimination of clogged nozzles, and elimination of the need for reciprocating nozzles.

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TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *with international search report (Art. 21(3))*

COATING APPARATUS AND METHOD

FIELD OF THE INVENTION

[0001] The invention relates to a coating apparatus, and, more specifically, to an improved coating apparatus which provides a longitudinally extending, uniform, atomized coating stream.

BACKGROUND OF THE INVENTION

[0002] A critical issue for manufacturers of coating equipment is the need to meet customer demands for increased efficiencies in the coating application process. Regardless of the coating type or application methodology, uniformity of application and transfer efficiency are critical parameters that continue to be addressed by research and development efforts. Selection of the appropriate application methodology depends not only on the type of coating but also on the requirements of the substrate to which it is applied.

[0003] For example, where the acoustical capabilities of an object are sought to be maintained, it is widely known in the coatings art that it is critical for the coating to have little or no impact on acoustical performance of the material, i.e. the coating is acoustically transparent. It is also widely known that the acoustical performance of a material is impacted by both the uniformity of application as well as the thickness of the coating. Thus, obtaining the optimal performance of a material, such as an acoustical fibrous mat, requires a minimum deviation of acoustic capability across the entire surface of the material.

[0004] One well known large-scale, i.e. industrial-scale, atomization technique which provides acoustical transparency and wide-area coverage is illustrated in prior art Figure 1. This conventional large-scale coating technique utilizes a series of single-point atomizing

spray guns, or nozzles. This system is commonly known in the industry as an overlap, or multi-tip header. As shown in Figure 1, each nozzle 1A-1E, commonly referred to in the art as a single-point nozzle, produces an atomized fluid stream, 3A-3E respectively, which spreads out, or diverges, into a conical spray pattern. To ensure complete coverage across a large width, the outer portions of the atomized fluid streams 3A-3A must overlap. Though undetectable to the naked eye, these overlapping streams do not uniformly apply the coating.

[0005] To approach uniformity of application using overlap header technology, several features can be manipulated, including: the spacing of the nozzles; the spacing between the overlap header and the object to be coated; the tip geometry of the nozzles; and the flow rate of the fluid passing through the nozzles. However, it is widely known and understood by those of ordinary skill in the art that overlap header technology assumes a density gradient for each nozzle, and, thus, the effort to approach uniformity of application is an iterative process that is fundamentally variable.

[0006] One skilled in the art further understands that it is impossible to completely eliminate defects such as streaks and shade variation using an overlap header. A conventional attempt to randomize these defects is to use cyclically traversing, i.e. reciprocating, multi-tip headers instead of multi-tip fixed headers. Conventional wisdom is that randomizing these defects will in effect disguise the defects and make them undetectable to the naked eye.

[0007] Unfortunately, both fixed and reciprocation headers add cost to the final product. For example, as the tip of each gun gradually wears or even becomes clogged, the spray pattern of the gun will change and ultimately lead to a more non-uniform application. Also, frequent interruptions due to cleaning or replacement of the tips adds considerable expense in terms of

the downtime required and the cost of the replacement part. Thus, an alternative large-scale technique which addresses the issues with existing techniques is needed.

SUMMARY

[0008] The present invention is an industrial-scale coating apparatus for applying a liquid coating to the surface of a sound absorbing material. The apparatus includes a longitudinally extending discharge nozzle having a specified length. The nozzle discharges a linear stream of atomized droplets at a uniform velocity along the entire specified length of the nozzle.

[0009] The present invention further includes an improved methodology of spray coating a moving object on an industrial scale. The method includes the steps of: (a) providing an industrial-scale coating apparatus having a longitudinally extending discharge nozzle having a specified length; (b) positioning the coating apparatus above a conveyor, the conveyor having a direction of travel such that the longitudinally extending discharge nozzle extends in a direction transverse the direction of travel of a conveyor; and (c) discharging a linear stream of atomized droplets onto the surface of an object moving on the conveyor, the linear stream of atomized droplets being discharged from the nozzle at a uniform velocity along the entire specified length of the nozzle.

[0010] The improved coating apparatus and spray coating methodology are particularly useful in applying a liquid coating to the surface of a material that requires a minimum deviation in acoustic capability across the entire surface of the material for optimum performance. The apparatus and methodology are also useful when a minimal deviation of one or more of light reflectance, color, and gloss capability of the material is desired. Additional advantages include, but are not limited to: the elimination of visual defects

created by multiple atomizing streams; the elimination of the use of a multiple atomizing streams utilizing the technique of reciprocation to randomize visual defects; and the elimination of the cost of and the maintenance of multiple, single-point atomizing spray nozzles.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Figure 1 is an elevation view of a prior art coating apparatus utilizing multiple single-point atomizing spray nozzles.

[0012] Figure 2 is a perspective view of a portion of a coating system utilizing the coating apparatus of the invention.

[0013] Figure 3 is a perspective view in partial cross-section of an example embodiment of the coating apparatus of the invention.

[0014] Figure 4 is a cross sectional view of the example embodiment illustrated in Figure 3.

[0015] Figure 5 is a perspective view in partial cross-section of a second example embodiment of the coating apparatus of the invention.

[0016] Figure 6 is a cross sectional view of the example embodiment illustrated in Figure 5.

DETAILED DESCRIPTION OF THE DRAWINGS

[0017] Reference is now made to the drawings wherein similar components bear the same reference numerals throughout the several views.

The improved atomizing apparatus can be utilized in conventional industrial-scale coating systems, including systems having a longitudinally extending conveyor which transports the object or material to be coated through a coating station such as illustrated in Figure 1. As

shown, the atomizing apparatus 10 is positioned above a conveyor 11, or backing roller, in spaced relation, thereby forming a "coating zone". The conveyor 11 has a direction of travel indicated by Arrow C. The apparatus 10 is positioned in a direction transverse to the direction of travel of the conveyor 11. As shown, an uninterrupted stream of atomized coating material 20 is discharged onto the surface of an object 22, such as an acoustical ceiling tile, at an application rate that is uniform across the entire length of the discharge nozzle 16, and, in turn, the entire length of the object 22.

[0018] Figures 3 and 4 illustrate a first example embodiment of the improved industrial size coating apparatus 10 in greater detail. The coating apparatus 10 includes a generally linear, longitudinally extending housing structure 12. The housing structure 12 includes a hopper 14, which houses liquid coating material. The liquid coating material typically used to coat materials on an industrial-sized scale, such as liquid coating material for acoustical ceiling tiles, includes about 40% to about 70% solids by weight, and preferably from about 50% to about 60% solids by weight.

[0019] In the embodiments shown throughout the drawings, the hopper 14 extends longitudinally and substantially the entire length of the housing structure 12. As best seen in Figure 4, at the base of the hopper 14 is a linear discharge nozzle 16 which, although not required, may also extend substantially the entire length of the housing structure 12. Typically, the liquid coating material is permitted to flow from the hopper 14 and through the linear discharge nozzle 16 by gravity.

[0020] The housing structure 12 further includes a first air stream 18 and a second air stream 19. Both air streams 18, 19 extend in the longitudinal direction and are positioned in parallel relation with the linear discharge nozzle 16. The outlets of the air streams 18, 19 are

positioned proximate the linear discharge nozzle 16. High velocity air flows through the air streams as illustrated by arrow F, and ultimately impinges on the liquid coating material as the fluid exits the linear discharge nozzle 16. Preferably, the air stream outlets are positioned behind, e.g. above, the outlet of the discharge nozzle so that the high velocity air causes the liquid coating to rush toward the object to be coated as an uninterrupted, uniform, longitudinally extending stream of atomized fluid droplets 20 having a longitudinally extending fan radius. By way of comparison, when a stream of air impinges on the coating stream in a conventional atomization spray apparatus, such as atomization spray apparatus illustrated in Figure 1, the atomized droplets form a circular fan radius.

[0021] Figures 5 and 6 illustrate a second example embodiment of the coating apparatus of the invention. The second example embodiment includes all of the features described above with respect to the first example embodiment. In addition, at the base of this coating apparatus 10' is a cap 25 which provides an area for internal mixing of the air and liquid coating prior to exiting the apparatus 10. For purposes of this description, internal air mixing is defined as a fluid stream being mixed within the confines of the coating apparatus. The cap 25 includes first and second side walls, 27 and 28 respectively. At least a portion of each sidewall 27, 28 is disposed at an angle so as to form a linear opening 32 therebetween. The linear cap opening 32 is preferably in alignment with the linear discharge nozzle 16. Furthermore, the length of the linear cap opening 32 is preferably substantially the same length as the longitudinally extending linear nozzle 16 and air streams 18, 19.

[0022] The above description of the invention is provided as an enabling teaching of the invention in its best, currently known embodiment. It will be understood by those of skill in the art that variations on the embodiments set forth herein are possible and within the scope

of the present invention. The embodiments set forth above and many other additions, deletions, and modifications may be made by those of skill in the art without departing from the spirit and scope of the invention.

[0023] For example, the apparatus 10, 10' may also utilize external air assistance. For purposes of this description, "external air assistance" means that the air is added by means of an air stream outside the components of the coating apparatus such as air generated via linear air knives or jets which are known in the art. External air assistance will further atomize the stream of atomized fluid droplets and maintain uniformity. Depending on the angle on impingement, the external air assistance may increase the speed of the droplets 20 towards the spray target.

We claim:

1. An industrial-scale atomizing apparatus for applying a liquid coating onto materials which require porosity, acoustical transparency, or very light coating weight, the apparatus comprising a discharge nozzle of a specified length, the discharge nozzle which extends longitudinally is capable of discharging a uniform stream of atomized liquid droplets at a uniform velocity at least along the entire specified length of the discharge nozzle.

2. The industrial-scale atomizing apparatus of claim 1, comprising first and second opposed air streams positioned proximate the discharge nozzle, each of the first and second opposing air streams extending longitudinally and in parallel relation to the discharge nozzle.

3. The industrial-scale atomizing apparatus of claim 1, wherein the liquid coating comprises from about 40% to about 70% solids by weight.

4. The industrial-scale atomizing apparatus of claim 3, wherein the liquid coating comprises from about 50% to about 60% solids by weight.

5. The industrial-scale atomizing apparatus of claim 1, whereby a minimum deviation is achieved in the acoustic capability of the acoustical material to which the liquid coating is applied.

6. The industrial-scale atomizing apparatus of claim 1, whereby the apparatus provides a coating which has minimal impact on the light reflectance, color, and gloss of the material to which the coating is applied.

7. A method of spray coating a moving object comprising the steps of:

(a) providing an industrial-scale coating apparatus having a longitudinally extending discharge nozzle having a specified length;

(b) positioning the industrial-scale coating apparatus above a conveyor, the conveyor having a direction of travel such that the longitudinally extending discharge nozzle extends in a direction transverse the direction of travel of a conveyor; and

(c) discharging a linear stream of atomized droplets onto the surface of an object moving on the conveyor, the linear stream of atomized droplets being discharged from the nozzle at a uniform velocity along the entire specified length of the nozzle.

8. The method of claim 7, wherein in step (c) the linear stream of atomized droplets extends uniformly over a cross-machine width of the moving object.

9. The method of claim 8, wherein in step (c) first and second opposing air streams are positioned proximate the discharge nozzle, the air streams discharging air which atomizes the liquid coating.

10. The method of claim 9, wherein the first and second air streams extend in the longitudinal direction of the discharge nozzle.

11. The method of claim 10, wherein the first air stream is located upstream of the discharge nozzle.

12. The method of claim 11, wherein the second air stream is located downstream of the discharge nozzle.

13. The method of claim 7, wherein the moving object is a fibrous mat.

14. The method of claim 13, wherein the fibrous mat has a top surface having perforations therein.

15. The method of claim 13, wherein the fibrous mat is an acoustical ceiling panel.

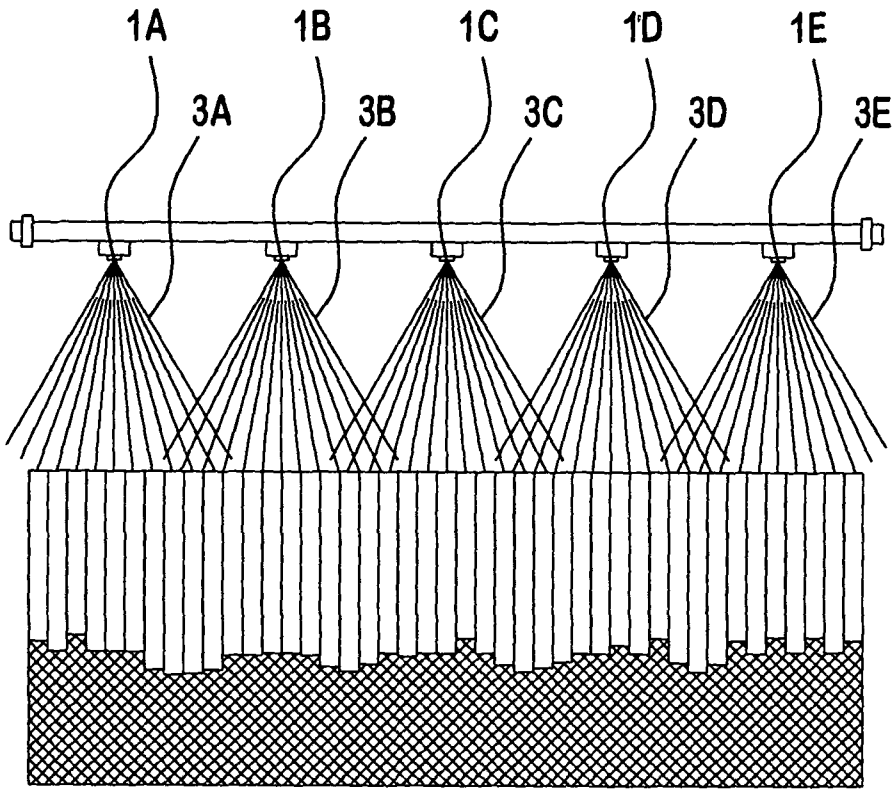

FIGURE 1
(PRIOR ART)

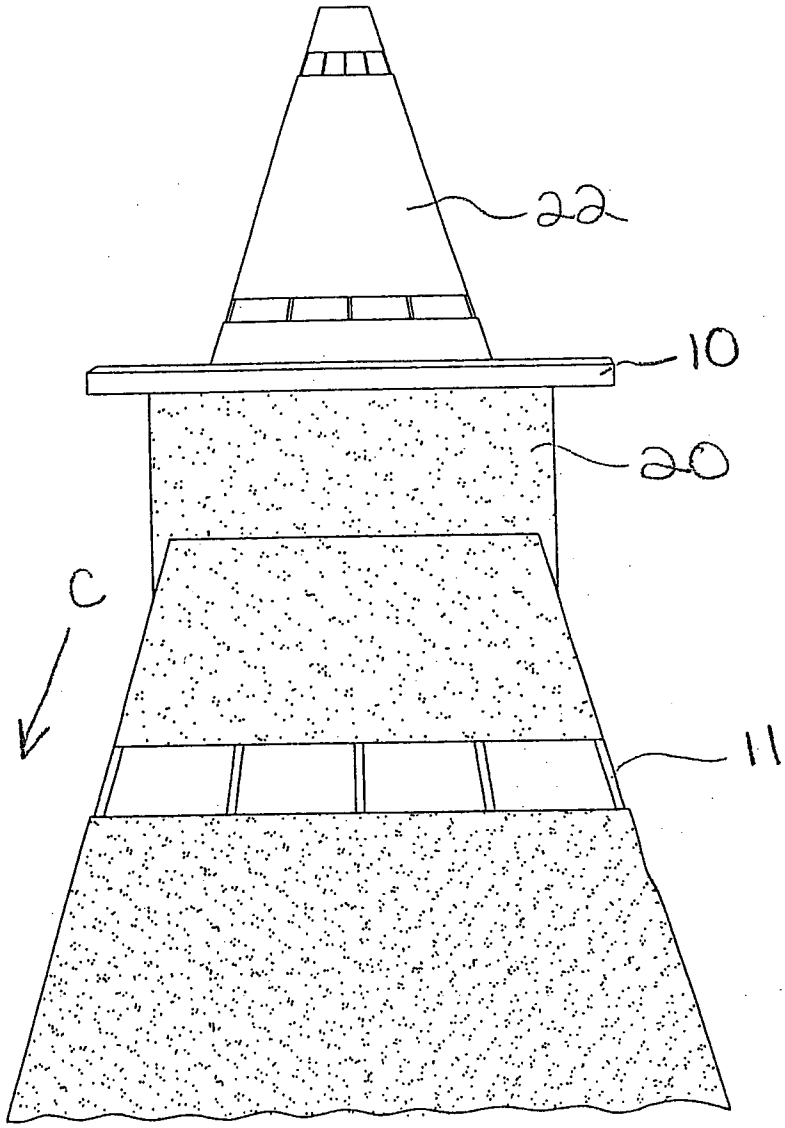

FIGURE 2

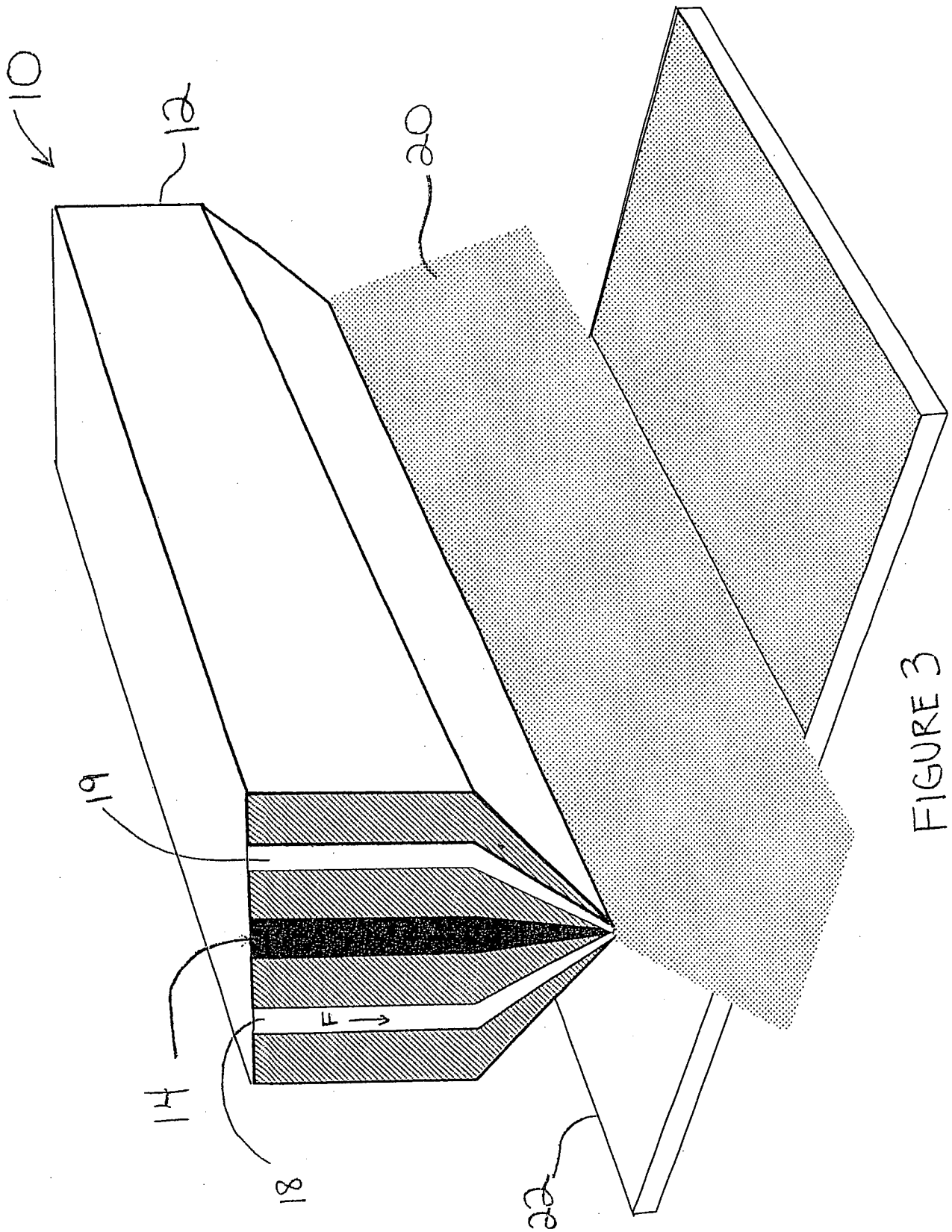

FIGURE 3

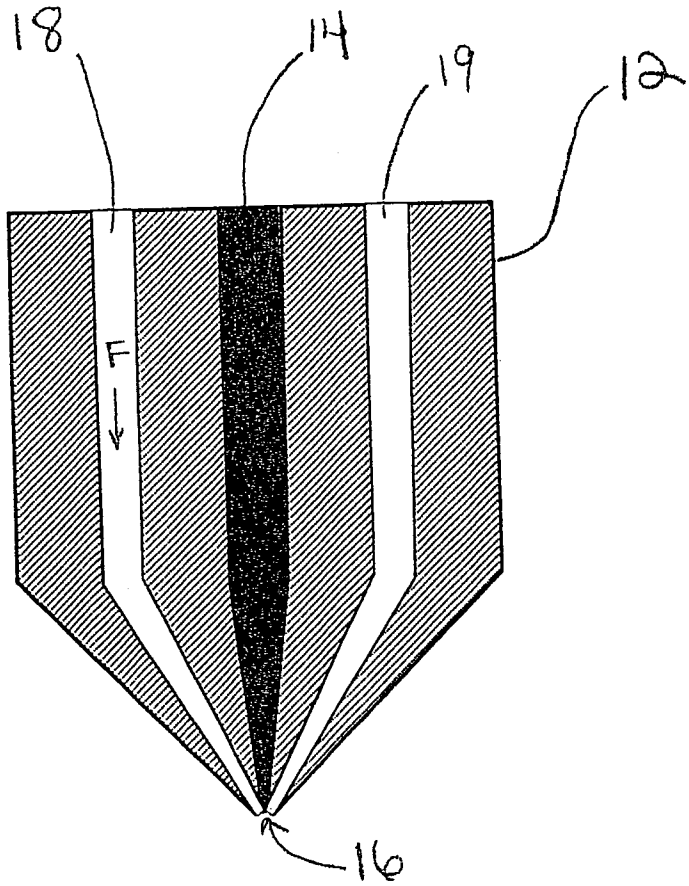

FIGURE 4

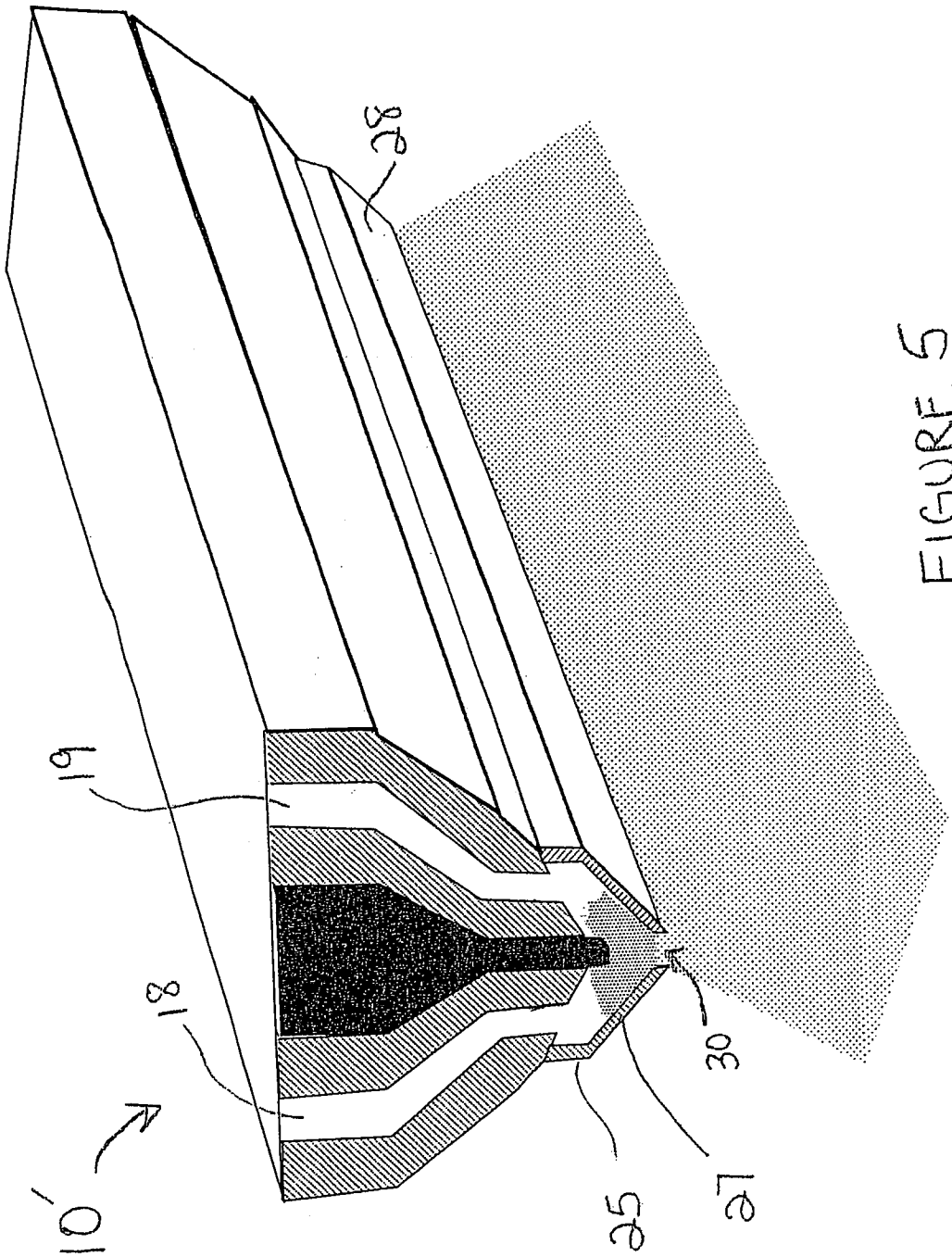

FIGURE 5

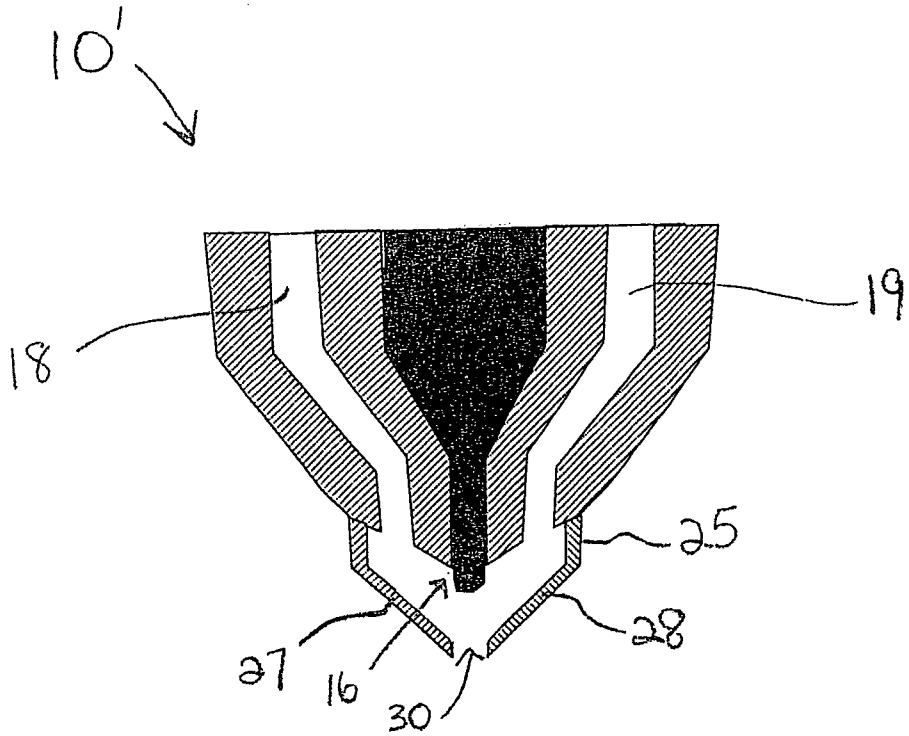

FIGURE 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 09/04097

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B05B 7/00 (2009.01)
USPC - 239/398
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 239/398

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 239/338,398,433

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
USPTO, PUBWEST (PGPB, USPT, USOC, EPAB, JPAB), Google
Search Terms Used: spray, atomize, uniform, constant, two, plural, second, multiple, speed, velocity, ceiling, wall, acoustic, fiber, fibrous

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005/0173561 A1 (Cotter et al.) 11 August 2005 (11.08.2005), para [0002], [0049]-[0087], Fig 1A-2B	1-15
Y	US 5,156,340 A (Lopes) 20 October 1992 (20.10.1992), col 2, ln 38-42	1-15

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 August 2009 (17.08.2009)	24 AUG 2009
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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