



- (51) **International Patent Classification:**
B05B 7/14 (2006.01) *B05B 7/16* (2006.01)
- (21) **International Application Number:**
PCT/EP2015/072266
- (22) **International Filing Date:**
28 September 2015 (28.09.2015)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
1417502.0 3 October 2014 (03.10.2014) GB
- (71) **Applicant:** ZEPHYROS INC. [US/US]; 160 Mclean Drive, Romeo, Michigan 48065 (US).
- (72) **Inventor; and**
- (71) **Applicant (for BB only):** DEVANNES, Thomas [FR/FR]; 1 Rue Lindberg, ZA Activeum, Altorf, F-67129 Molsheim Cedex (FR).
- (72) **Inventors:** BELANGER, Christian; 1 Rue Lindberg, ZA Activeum, Altorf, F-67129 Molsheim Cedex (FR). CROUZET, Francois; 1 Rue Lindberg, ZA Activeum, Altorf, F-67129 Molsheim Cedex (FR). MORRAL, Xabier; 1 Rue Lindberg, ZA Activeum, Altorf, F-67129 Molsheim Cedex (FR).
- (74) **Agents:** WOLFF, Felix et al.; Theodor-Heuss-Ring 23, 50668 Köln (DE).
- (81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).
- Published:**
— with international search report (Art. 21(3))

(54) **Title:** DE LAVAL NOZZLE TO APPLY AN ADHESIVE TO THE SURFACE OF A WORK PIECE

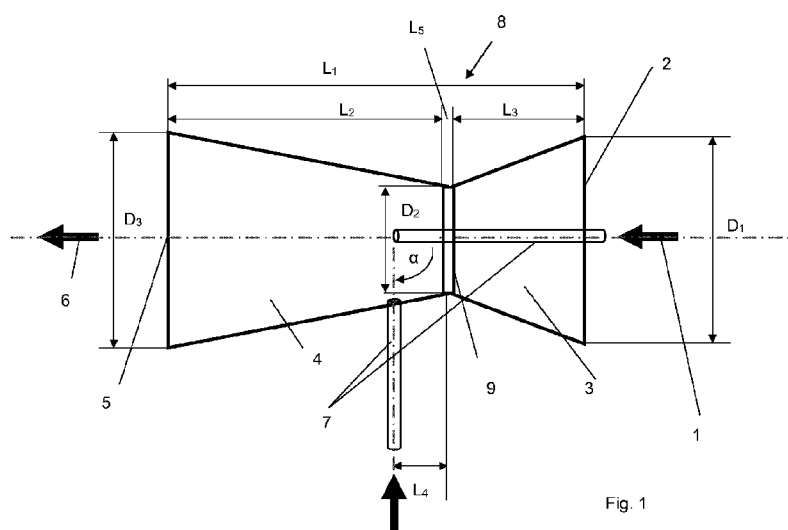


Fig. 1

(57) **Abstract:** The present invention relates to a nozzle for the deposition of an adhesive material onto a surface of a work piece.

De Laval nozzle to apply an adhesive to the surface of a work piece

The present invention relates to a nozzle for the deposition of an adhesive material onto a surface of a work piece.

Adhesives, particularly heat activated adhesive materials are, for example, used in the automotive industry to bond parts together. It is proposed in United States Patent Application Publication 2014/0027039 that adhesives may be deposited on surfaces such as metal surfaces by spraying a powder of the adhesive material on the surface of a work piece with a spray-nozzle. However, spray nozzles have disadvantages like, for example, overspray.

It is objective of the present invention to provide an alternative apparatus to apply an adhesive powder coating to a work piece.

The problem is attained with an apparatus for applying an adhesive powder coating to a surface of a work piece, wherein the apparatus comprises a De Laval-nozzle.

The present invention suggests a De laval-nozzle for the provision of an adhesive layer on the surface of a work piece, for example a metal substrate. A gas flow is supplied to the inlet of the De Laval-nozzle, flows through the De Laval-nozzle and leaves it at its exit. A powdered adhesive is also supplied to the De Laval-nozzle, which mixes with the gas stream and exits the De Laval-nozzle together with the gas flow. The gas/particle mixture is directed to the surface of a work piece, where the powdered adhesive adheres to the surface of the work piece

The De Laval-nozzle comprises an entry region for a gas flow, an adhesive powder entry and an exit region for the gas/powder mixture. Furthermore, the De Laval-nozzle comprises a converging part and a diverging part and a nozzle throat in between. A detailed description of the De Laval-nozzle can be, for example found in wikipedia.org/wiki/De_Laval_nozzle. This publication is herewith incorporated by reference and hence part of the disclosure of the present patent application.

The gas flow is used to propel the powdered adhesive from the exit region onto the surface of the work piece. Preferably, the gas used is inert to the powder material. For many applications air and/or nitrogen is suitable. Typical gas pressures are in the range of 0,3 to 3,0 MPa at the inlet of the De Laval-nozzle. Preferably, the De Laval-nozzle forms a supersonic gas/powder flow in the diverging part of the nozzle.

Preferably, the De Laval-nozzle has an overall length of 100-200 mm and the diverging part is preferably 70-90 % of the overall length.

According to a preferred embodiment of the present invention, the diameter of the entry region is preferably 8-10 mm and the diameter of the exit region is preferably 40-70 % of the diameter of the entry region.

Preferably, the diameter of the nozzle throat is 2-3 mm. The nozzle throat is the passage between the converging- and the diverging part of the De Laval-nozzle.

Preferably, the distance between the throat and the adhesive powder entry is 1-10 mm. The adhesive powder entry can be upstream and/or downstream from the throat relative to the flow-direction of the gas.

Preferably, the length of the throat is between 0 and 10 mm, preferably 0 – 3 mm.

According to a preferred embodiment, the adhesive powder entry is provided at an angle of 1- 90°, preferably 90°, relative to the center-axis of the nozzle or in line with the axis of the nozzle. A preferred range for the angle is 10 -80°, even more preferred 20 – 70°.

The De Laval nozzle can be made from any suitable material. However, it is preferably made from steel, preferably hardened steel. and/or tungsten carbide alloy and/or ceramic material..

Preferably, the De Laval nozzle and/or the work piece is/are connected to a movement device, so that the De Laval-nozzle and the substrate may move relative to each other. Preferably, the movement can be programmed to deliver the adhesive coating precisely in any desired pattern on the surface of the substrate.

The exit of the De Laval-nozzle is preferably located close to the surface of the work piece, more preferably at a distance of from 20 to 60 mm from the surface of the substrate.

The apparatus shall be set up so that the particles of the adhesive powder are at the temperature at which they will adhere to the surface of the substrate when they reach and/or when they have reached the surface of the work piece. Deformation of the particle due to impact of the particles on the surface of the work piece will increase their temperature. Preferably, the temperature of the particles is 25 – 80 °C at the entry and/or the exit of the De

Laval-nozzle. A more preferred upper limit is 60 °C and an even more preferred upper limit is 40 °C. A more preferred lower limit is 30 °C and an even more preferred lower limit is 35 °C.

Preferably, the De Laval-nozzle comprises multiple adhesive powder entries. Through each entry, a component or a mixture of at least two components of the powdered adhesive can be supplied. Through the entries powder can be supplied simultaneously and/or in sequence.

Preferably, the apparatus comprises a mixing device for at least two components of the adhesive powder. The mixing device is preferably upstream from the De Laval-nozzle.

According to a preferred embodiment of the present invention, the apparatus comprises a heating/cooling-device for the gas flow. A preferred gas temperature of the gas flow is in the range of 200°C to 600°C prior to the entry of the De Laval-nozzle. Preferred temperature ranges are 200 – 500 °C or 200 – 400 °C or 200 – 300 °C or 300 – 600 °C or 400 – 600 °C or 500 – 600 °C.

Preferably, the apparatus comprises a metering device for the adhesive powder. Preferably, the metering is adjusted relative to the gas flow. According to a preferred embodiment, the gas flow through the De Laval-nozzle is measured and the addition of the adhesive powder to the gas flow is adjusted accordingly.

Preferably, the apparatus comprises a control device for the gas flow and/or the gas pressure.

Preferably, the apparatus comprises a sensor for the quality of the coating. Preferably the parameters of the nozzle are controlled according to the signal of the sensor. The sensor can be, for example, a camera, a radiation type sensor, for example a X-ray sensor or an infrared-sensor. Potential quality parameters are the density of the coating, the dimensions of the coating, the position of the coating on the work piece, the stickiness of the adhesive layer.

Preferably, the apparatus comprises means to temper the work piece. According to a preferred embodiment, the work piece is heated, preferably uniformly heated. A preferred temperature range for the work piece is 40 – 80 °C.

The powdered adhesive preferably has a particle size in the range of 50 to 300 microns preferably 100 to 200 microns. The volume median diameter $Dv(50)$ of the particles is

preferably in a range of 110 – 150 microns. The particle size is for example measured with a Malverne Mastersizer 3000 or 3000 E. The powders are preferably prepared by comminuting preferably by grinding pellets of the appropriate adhesive formulation preferably under a cold and/or inert atmosphere such as a stream of liquid nitrogen or gaseous nitrogen. Once prepared the powders are preferably stored and transported in a sealed container. In a preferred embodiment the powder are prepared at a temperature no higher than -20°C.

The adhesive applied by the De Laval-nozzle to the surface of the work piece is preferably a heat activatable adhesive and the temperature at which the adhesive is activated will depend upon the nature of the adhesive and the nature of the activation and when the activation is to take place. For example, it may be desirable that the adhesive adheres to the surface of the substrate but remains at a temperature at which it remains activatable by subsequent heating (such as by thermal cross linking and/or thermal expansion). Prior to its activation, the adhesive powder preferably only comprises a stickiness that is sufficient to maintain the adhesive power on the work piece.

In order to form a desirable adhesive that exists first in powder form, can then fuse to form a film layer, and later be activated to cure, the adhesive (e.g., the precursor layer) may include an epoxy based material. The epoxy may be any dimeric, oligomeric or polymeric epoxy materials containing at least one epoxy functional group. Moreover, the term epoxy can be used to denote one epoxy or a combination of multiple epoxies. The polymer-based materials may be epoxy-containing materials having one or more oxirane rings polymerizable by a ring opening reaction. A precursor layer may include up to 80% or more of an epoxy. The precursor layer may include between 2% and 70% by weight epoxy, between 4% and 30% by weight epoxy, or even between 7% and 18% by weight epoxy. The adhesive may be substantially free of an epoxy material (other than any epoxy supplied in the form of an epoxy/elastomer adduct). The epoxy may be aliphatic, cycloaliphatic, aromatic or the like. The epoxy may be supplied as a solid (e.g., as pellets, chunks, pieces or the like) or a liquid. The epoxy may include an ethylene copolymer or terpolymer that may possess an alpha-olefin. Preferably, an epoxy is added to the precursor layer to increase the adhesion, flow properties or both of the precursor layer. The epoxy may include a phenolic resin, which may be a novolac type (e.g., an epoxy phenol novolac, an epoxy cresol novolac, combinations thereof, or the like) or other type resin. Other preferred epoxy containing material includes a bisphenol-A epichlorohydrin ether polymer, or a bisphenol-A epoxy resin which may be modified with butadiene or another polymeric additive. Moreover, various mixtures of several different epoxies may be employed as well. Examples of suitable epoxies are sold under the

trade name DER® (e.g., DER 331, DER 661, DER 662), commercially available from the Dow Chemical Company, Midland, Michigan.

The epoxy may be combined with a thermoplastic component, which may include styrenics, acrylonitriles, acrylates, acetates, polyamides, polyethylenes, phenoxy resins or the like. The thermoplastic component may be present in an amount of at least 5% by weight of the precursor layer. The thermoplastic component may be present in an amount of at least 20% by weight of the precursor layer. The thermoplastic component may be present in an amount of at least 60% by weight of the precursor layer. The thermoplastic component may be present in an amount of less than 80% by weight of the precursor layer. The thermoplastic component may be present in an amount of less than 30% by weight of the precursor layer.

While it is contemplated that various polymer/elastomer adducts may be employed according to the present invention, one preferred adduct is an epoxy/elastomer adduct. The precursor layer may thus include an elastomer-containing adduct. The epoxy/elastomer hybrid or adduct may be included in an amount of up to 80% by weight of the precursor layer. The elastomer-containing adduct may be approximately at least 5%, more typically at least 7% and even more typically at least 10% by weight of the precursor layer. The adduct may be up to 60% or more, but more preferably is 10% to 30% by weight of the precursor layer. Of course, the elastomer-containing adduct may be a combination of two or more particular adducts and the adducts may be solid adducts or liquid adducts at a temperature of 23°C or may also be combinations thereof. The adduct may be composed of substantially entirely (i.e., at least 70%, 80%, 90% or more) of one or more adducts that are solid at a temperature of 23°C.

The adduct itself generally includes 1:8 to 3:1 parts of epoxy or other polymer to elastomer, and more preferably 1:5 to 1:6 parts of epoxy to elastomer. More typically, the adduct includes at least 5%, more typically at least 12% and even more typically at least 18% elastomer and also typically includes not greater than 50%, even more typically no greater than 40% and still more typically no greater than 35% elastomer, although higher or lower percentages are possible. The elastomer compound may be a thermosetting elastomer. Exemplary elastomers include, without limitation, natural rubber, styrene-butadiene rubber, polyisoprene, polyisobutylene, polybutadiene, isoprene-butadiene copolymer, neoprene, nitrile rubber (e.g., a butyl nitrile, such as carboxy-terminated butyl nitrile), butyl rubber, polysulfide elastomer, acrylic elastomer, acrylonitrile elastomers, silicone rubber, polysiloxanes, polyester rubber, diisocyanate-linked condensation elastomer, EPDM (ethylene-propylene diene rubbers), chlorosulphonated polyethylene, fluorinated

hydrocarbons and the like. An example of a preferred epoxy/elastomer adduct is sold under the trade name HYPOX commercially available from CVC Chemical.

The inventive apparatus may be used to provide structural adhesives. The apparatus is preferably used in the automotive industry, aerospace industry, building industry and/or furniture industry.

The present invention can be used to deposit powder of an adhesive on larger surface areas of the work piece than has hitherto been possible by extrusion deposition and by pumpable liquid adhesives or by other spray-technologies. It has been found useful in the provision of substantially uniform films of thickness ranging from 50 to 2000 μm , preferably, 300 – 600 μm on three dimensional structures including those of complex shape. The thickness and location of the adhesive film on the work piece can be varied by the use of masks and/or by a certain movement of the De Laval-nozzle. The adhesive may be applied without contact between the De Laval-nozzle and the surface of the work piece.

During and/or after impact on the work piece, each particle deforms and forms a layer on the work piece. Preferably, the particle melts at least partially on the surface of the work piece.

The invention is illustrated by the accompanying Figures.

Fig. 1 shows the De Laval-nozzle.

Fig. 2 shows the use of the De Laval-nozzle.

Figure 1 shows the inventive De Laval-nozzle 8 for the application of an adhesive powder to the surface of a work piece. The De Laval-nozzle 8 has a gas entry region 2 through which a gas flow is forced into the De Laval-nozzle 8. The gas passes the De Laval-nozzle 8 and is mixed with the adhesive powder, which is provided through at least one adhesive powder entry inlet 7. This inlet can be either collinear with the center axis of the De Laval-nozzle 8 and/or provided at an angle α , here 90° . The gas/powder mixture 6 leaves the De Laval-nozzle 8 at an exit region 5 and hits a work piece (not depicted) where the powder forms an adhesive film. The De Laval-nozzle 8 comprises a converging part 3 and a diverging part 4. In between is the nozzle throat 9. The De Laval-nozzle 8 has an overall length of L_1 which is preferably 100-200 mm and the length L_2 of the diverging part is preferably 70-90 % of the overall length L_1 . The diameter D_1 of the entry region 2 is preferably 8-10 mm and the diameter D_3 of the exit region 5 is preferably 40-70 % of the diameter of the entry region 2. The diameter D_2 of the nozzle throat is preferably 2-3 mm. The distance L_4 between the

throat and the adhesive powder entry 7 is preferably 1-10 mm. The length of the throat L_5 is preferably between 0 and 10 mm, more preferably, between 0 and 3 mm.

Figure 2 shows the utilization of the De Laval-nozzle 8 to apply an adhesive coating (11) to a work piece 12. A gas flow 1 is provided at the entry of the De Laval-nozzle 8. The temperature of the gas may be adjusted by a heating/cooling-device 10. The gas flow and/or its pressure can preferably also be adjusted. In the De Laval-nozzle, the gas flow 1 is mixed with a adhesive powder material 7. This adhesive powder material can be a mixture of two or more components 13, 14. The components 13, 14 can be fed into the De Laval-nozzle directly through individual inlets and/or, as depicted, can be premixed in a mixer. Preferably, a metering-device is provided, which doses the adhesive powder material into the gas flow. The metering device may be controlled depending on the magnitude of the gas flow and/or based on the desired local thickness of the adhesive layer on the work piece and/or based on the magnitude of the relative movement between the De Laval-nozzle and the work-piece and/or based on the signal of a sensor, which determines at least one property of the adhesive layer on the work piece. The gas/powder-mixture, leaving the De Laval-nozzle can be additionally tempered. This can be done with a torch or the like which is preferably also controllable. The gas/powder stream hits the work piece and the particles are deposited on the surface of the work piece where they form a layer. The work piece can be heated or cooled as needed to assure that the particles stick to the surface of the work piece. The distance between the outlet of the De Laval-nozzle and the surface work piece is preferably 20 – 60 mm. This relatively small distance and the relatively small diameter of the exit of the De Laval-nozzle allows a very exact deposition of the adhesive powder material on the surface of the work piece. Certain pattern of the adhesive layer can be established and the local thickness and/or the local composition of the adhesive layer can influenced. Preferably, there is a relative movement between the De Laval-nozzle and the work piece.

Example 1:

An adhesive formulation comprising the following ingredients was comminuted to an average particle size of about 100 μm (as measure used a Beckman Coulter LS 13320 laser scattering particle size analyzer):

Lotader [®] AX-8900 ¹	Polymer backbone	15.50 wt.-%
Evatane [®] 2805 ² /Escorene [®] UL 7760 ³		16.16 wt.-%
Elvax [®] 420 ⁴		10.00 wt.-%
Norsolene [®] S105 ⁵		12.20 wt.-%

	Wax and oil	6.7 wt.-%
	Peroxide curing agent	1.4 wt.-%
	Curing agent	2.50 wt.-%
	Blowing agent	1.60 wt.-%
	Pigment	0.01 wt.-%
	Thixotropic agent	1.00 wt.-%
	Calcium carbonate filler	32.93 wt.-%

¹ Lotader® AX-8900 is a random terpolymer of ethylene, acrylic ester and glycidyl methacrylate;

² Evatane® 2805 is a random copolymer of Ethylene and Vinyl Acetate

³ Escorene® UL 7760 is a high viscosity, 26.7% VA copolymer

⁴ Elvax® 420 0 is an ethylene-vinyl acetate copolymer

⁵ Norsolene® S105 is a light colored, low odor aromatic resin

The powder was sprayed onto a steel panel employing an apparatus as illustrated in Figure 2. Nitrogen was used as the propelling gas and the pressure in the gas chamber was 0,344 MPa and the temperature of the gas prior to the venturi was 580 °C. The tube (4) for delivery of the powder was at a temperature in the range 80-90 °C. The speed of ejection of the mixture of the powdered heat activatable adhesive and the gas from the nozzle was 300 mm/sec and the distance from the nozzle to the surface of the substrate was 30 mm. The substrate was a steel sheet held at room temperature and the nozzle was moved relative to the substrate to provide a coating of the powdered heat activatable adhesive over the desired bonding area.

A uniform coating 0.25 mm thick was provided on the desired bonding area and it could be subsequently activated to produce an automotive adhesive.

Example 2:

A series of powdered heat activatable adhesives was prepared only differing in the relative content of two different types of epoxy based material contained therein. The overall content of epoxy based material was kept constant (26 wt.-%), like all other ingredients, their content and the other overall properties of the powder material:

	Sample 1	Sample 2	Sample 3
Solid epoxy resin:			

- type I (EEW 450-530 g/eq)	-	-	-
- type II (EEW 590-630 g/eq)	18.00	-	-
- type III (EEW 730-820 g/eq)	-	18.00	-
- type IV (EEW 860-930 g/eq)	-	-	18.00
Liquid epoxy resin (EEW 200 g/eq)	8.00	8.00	8.00
MBS based core shell impact modifier	13.40	13.40	13.40
Polyvinylbutyral	4.85	4.85	4.85
Phenoxy resin derived from Bisphenol A	16.95	16.95	16.95
Epoxy terminated CTBN adduct	20.00	20.00	20.00
Micronized Polyamide 6/12 (particle size 20 μm)	8.00	8.00	8.00
Talc	1.01	1.01	1.01
Calcium oxide	5.00	5.00	5.00
Thixotropic agent (Organo clay)	0.76	0.76	0.76
Pigment	0.05	0.05	0.05
Disubstituted urea	0.35	0.35	0.35
Dicyandiamide	3.00	3.00	3.00
Chemical blowing agent ADCA	0.63	0.63	0.63
TOTAL	100.00	100.00	100.00

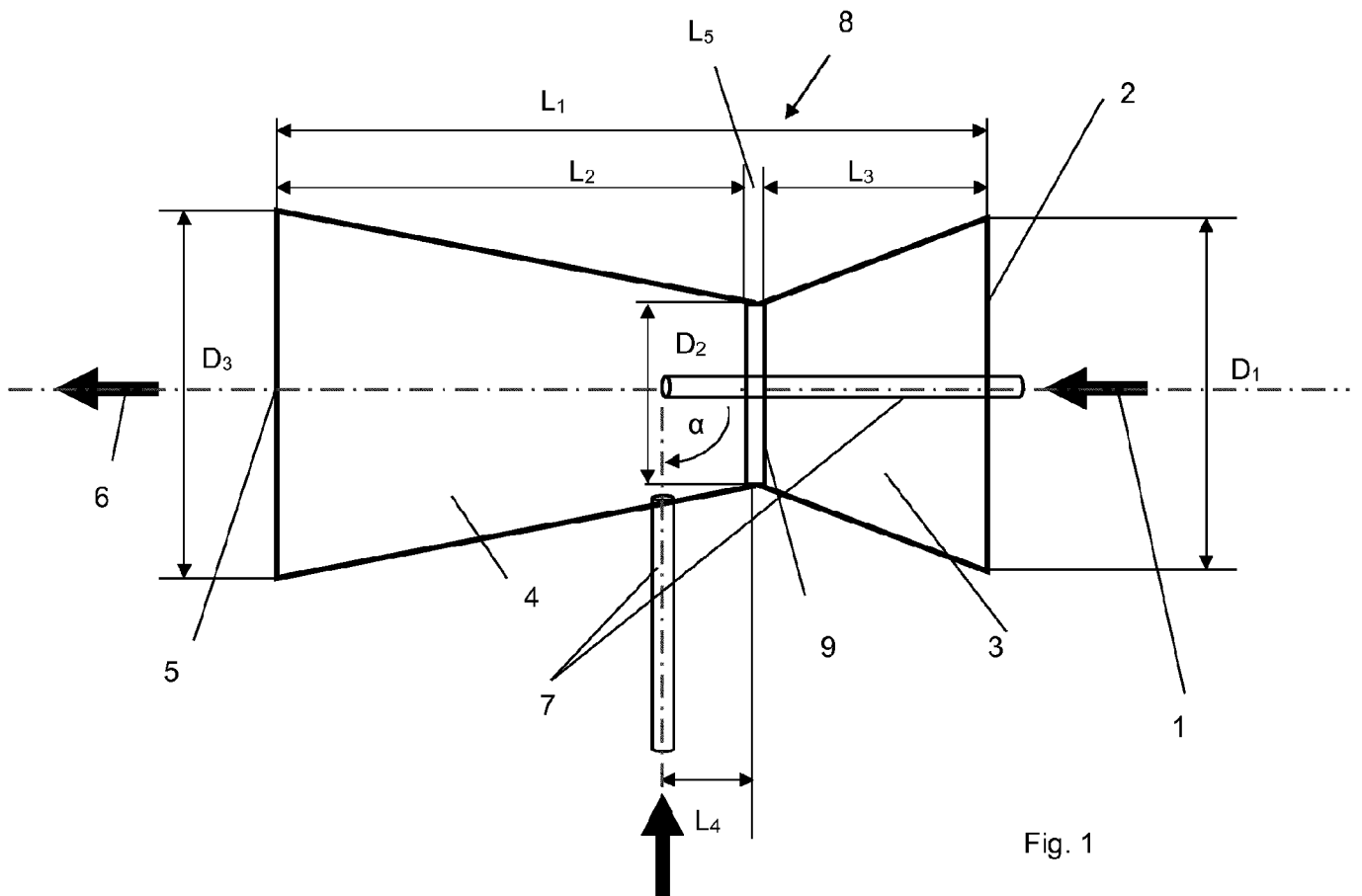
List of reference signs:

- 1 gas flow
- 2 nozzle entry region
- 3 converging part
- 4 diverging part
- 5 nozzle exit region
- 6 gas/powder mixture-flow
- 7 adhesive powder entry inlet
- 8 laval-nozzle
- 9 nozzle throat
- D₁ diameter of the entry region
- D₂ diameter of the nozzle throat
- D₃ diameter of the exit-region
- L₁ overall length of the nozzle
- L₂ length of the diverging part
- L₃ length of the converging part
- L₄ distance (L₄) between the throat and the adhesive powder entry (7)
- L₅ axial length of the throat
- α angel of the adhesive powder entry 7 relative to the axis of the nozzle

Claims:

1. Apparatus for applying an adhesive powder coating to a surface of a work piece, characterized in, that the apparatus comprises a De Laval-nozzle (8).
2. Apparatus according to claim 1, characterized in, that the De Laval-nozzle (8) comprises an entry region (5) for a gas flow (1), an adhesive powder entry (7) and an exit region (5) for the gas/powder mixture (6).
3. Apparatus according to claim 1 or 2, characterized in, that the De Laval-nozzle (8) comprises a converging part (3) and a diverging part (4) and a nozzle throat (9).
4. Apparatus according claim 3, characterized in that, the De Laval-nozzle (8) has an overall length (L_1) of 100-200 mm and that the diverging part is preferably 70-90 % of the overall length (L_1).
5. Apparatus according to one of claims 2 -4, characterized in, that the diameter (D_1) of the entry region (2) is preferably 8-10 mm and the diameter (D_3) of the exit region (5) is preferably 40-70 % of the diameter of the entry region (2).
6. Apparatus according to one of claims 3 – 5, characterized in, that the diameter (D_2) of the nozzle throat is 2-3 mm.
7. Apparatus according to one of claims 2 -6, characterized in, that the distance (L_4) between the throat and the adhesive powder entry (7) is 1-10 mm.
8. Apparatus according to one of claims 2 – 7, characterized in, that the adhesive powder entry (7) is provided at an angle (α) of 1 - 90° relative to the center-axis of the nozzle (8) or in line with the axis of the nozzle
9. Apparatus according to one of the preceding claims, characterized in, that the De Laval nozzle is made from full core hardened steel or tungsten carbide alloy or a ceramic material.
10. Apparatus according to one of the preceding claims, characterized in, that the nozzle and/or the work piece is connected to a movement device.

10. Apparatus according to one of the preceding claims, characterized in, that it comprises multiple adhesive powder entries (7).
11. Apparatus according to one of the preceding claims, characterized in, that it comprises a mixing device for at least two components of the adhesive powder.
12. Apparatus according to one of the preceding claims, characterized in, that it comprises a heating/cooling-device for the gas flow.
13. Apparatus according to one of the preceding claims, characterized in, that it comprises a metering device for the adhesive powder.
14. Apparatus according to one of the preceding claims, characterized in, that it comprises control devices for the gas flow and pressure.
15. Apparatus according to one of the preceding claims, characterized in, that it comprises a sensor for the quality of the coating.
16. Apparatus according to one of the preceding claims, characterized in, that it comprises means to temper the work piece.



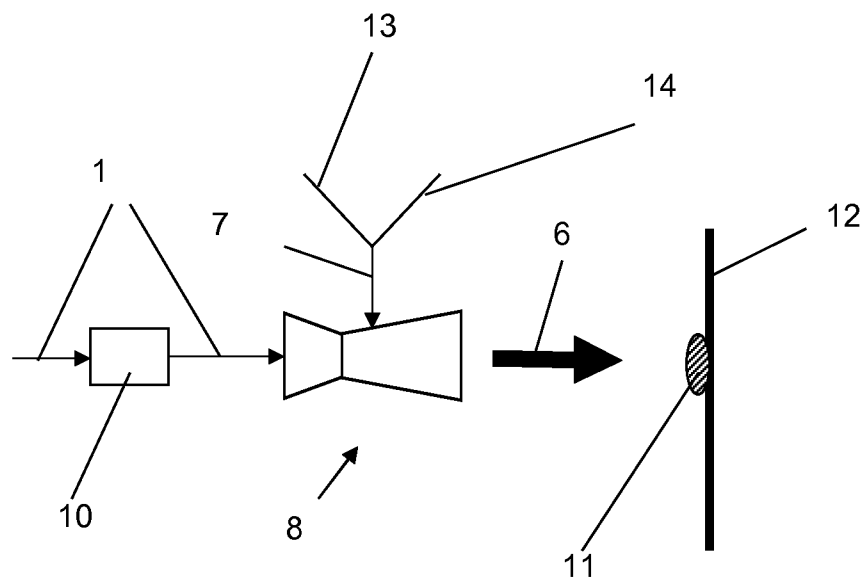


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/072266

A. CLASSIFICATION OF SUBJECT MATTER
INV. B05B7/14 B05B7/16
ADD.

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)
B05B B05D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 561 380 A (MULDER DOUGLAS C [US] ET AL) 31 December 1985 (1985-12-31) column 5, line 22 - column 10, line 45; figures	1-16
X	----- US 4 770 344 A (KAISER THOMAS A [US]) 13 September 1988 (1988-09-13) column 4, line 32 - page 7, line 32; figures	1-16
X	----- JP 2009 226329 A (IWATE IND RES CT; KANTO JIDOSHA KOGYO KK) 8 October 2009 (2009-10-08) abstract; figures	1-16
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

* 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

22 December 2015

Date of mailing of the international search report

14/01/2016

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Endrizzi, Silvio

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/072266

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 8 408 479 B2 (DI LORETO OSVALDO [BE]) 2 April 2013 (2013-04-02) column 3, line 44 - line 50 column 6, line 54 - column 11, line 67; figures -----	1-16
X	US 6 139 913 A (VAN STEENKISTE THOMAS H [US] ET AL) 31 October 2000 (2000-10-31) the whole document -----	1-16
X	US 2011/052824 A1 (VENKATACHALAPATHY VISWANATHAN [IN] ET AL) 3 March 2011 (2011-03-03) paragraphs [0001], [0005] - [0006], [0020] - [0030]; figures -----	1-16
X	EP 2 551 023 A2 (GEN ELECTRIC [US]) 30 January 2013 (2013-01-30) paragraph [0009] - paragraph [0024]; figures -----	1-16
X	EP 2 175 050 A1 (PLASMA GIKEN CO LTD [JP]) 14 April 2010 (2010-04-14) paragraph [0020] - paragraph [0034]; figures -----	1-16

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2015/072266

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4561380	A	31-12-1985	CA 1220677 A DE 3574885 D1 EP 0166496 A2 JP S618158 A JP H0659433 B2 US 4561380 A	21-04-1987 25-01-1990 02-01-1986 14-01-1986 10-08-1994 31-12-1985
US 4770344	A	13-09-1988	AU 593492 B2 AU 1081088 A BR 8707905 A CA 1277187 C EP 0330676 A1 JP H02501539 A US 4770344 A WO 8804202 A1	08-02-1990 30-06-1988 01-03-1990 04-12-1990 06-09-1989 31-05-1990 13-09-1988 16-06-1988
JP 2009226329	A	08-10-2009	JP 5344212 B2 JP 2009226329 A	20-11-2013 08-10-2009
US 8408479	B2	02-04-2013	AT 503855 T AU 2008270262 A1 BE 1017673 A3 CA 2692486 A1 CN 101755070 A CO 6251353 A2 DK 2171118 T3 EA 201070102 A1 EG 25537 A EP 2171118 A1 ES 2362385 T3 JP 5124641 B2 JP 2010532252 A KR 20100046175 A MA 31582 B1 NZ 583035 A PT 2171118 E RS 51850 B SI 2171118 T1 UA 98340 C2 US 2010193600 A1 WO 2009004053 A1	15-04-2011 08-01-2009 03-03-2009 08-01-2009 23-06-2010 21-02-2011 23-05-2011 30-08-2010 06-02-2012 07-04-2010 04-07-2011 23-01-2013 07-10-2010 06-05-2010 02-08-2010 28-09-2012 29-04-2011 29-02-2012 31-08-2011 10-05-2012 05-08-2010 08-01-2009
US 6139913	A	31-10-2000	AU 5885400 A DE 60009712 D1 DE 60009712 T2 EP 1200200 A2 US 6139913 A US 6283386 B1 WO 0100331 A2	31-01-2001 13-05-2004 12-08-2004 02-05-2002 31-10-2000 04-09-2001 04-01-2001
US 2011052824	A1	03-03-2011	EP 2289630 A1 JP 5736138 B2 JP 2011045877 A US 2011052824 A1	02-03-2011 17-06-2015 10-03-2011 03-03-2011
EP 2551023	A2	30-01-2013	CN 102896054 A EP 2551023 A2 US 2013026247 A1	30-01-2013 30-01-2013 31-01-2013

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2015/072266

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
EP 2175050	A1	14-04-2010	EP 2175050 A1	14-04-2010
			JP 5171125 B2	27-03-2013
			JP 2009001891 A	08-01-2009
			TW 200920878 A	16-05-2009
			US 2010251962 A1	07-10-2010
			WO 2009001831 A1	31-12-2008