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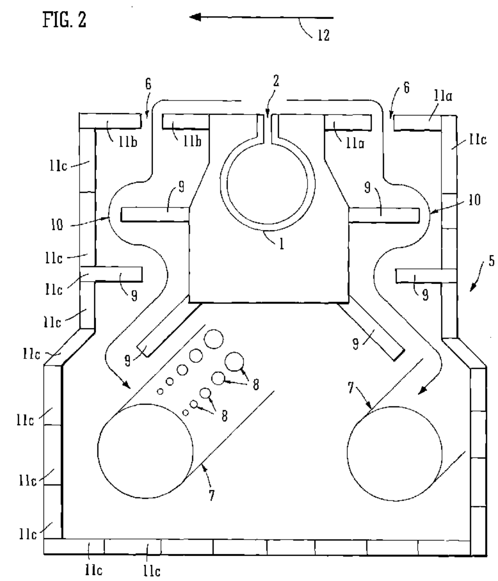
(54) Title: BURNER FOR FLAME COATING

FIG. 2



(57) Abstract: A burner apparatus suitable for CCVD (flame) coating is disclosed in which excess heat from the CCVD and other processes is removed from the apparatus by cooling with a heat exchange fluid. Hot gases may be removed and the fluid is also used to cool the regions of the apparatus contacted by the gases.

WO 2012/156684 A1

Burner for Flame Coating

The invention is concerned with apparatus and methods for the deposition of coatings on a substrate by Combustion Chemical Vapour Deposition (CCVD) also known as Flame Coating or Flame Pyrolysis.

CCVD is a well known process whereby chemical precursors of a coating material are brought to the region of a continuous flame, where they react to form the coating material. The coating material is deposited on a substrate located at or near the flame. WO 94/21841 provides a general description of the CCVD technique.

The use of CCVD for the deposition of coatings on flat glass substrates in particular is also known. WO 2009/007745 describes the deposition of anti-reflective silica coatings on glass substrates using a flame pyrolysis process.

During the float glass manufacturing process, a continuous supply of molten glass is fed to a bath of molten tin. The molten glass naturally distributes over the surface of the tin and, as it solidifies, a continuous flat ribbon of glass is drawn off. One of the major advantages of the float glass manufacturing technique is that it provides high quality flat glass with a smooth surface, without the need for further grinding or polishing.

CCVD deposition of coatings may be performed on float glass either ‘on-line’ or ‘off line’. In on-line CCVD deposition, a burner or burners are arranged to perform the deposition continuously on the glass ribbon as it passes over or under the flame. In off-line CCVD deposition, the coating is done on the glass after it has been cut from the ribbon to form separate sheets and removed from the float glass manufacturing apparatus.

During the CCVD process, a substantial amount of heat, generated by the flame, may be imparted to the glass (a typical linear burner used for CCVD coating on a float glass production facility might have a power rating of 200 – 250kW). In particular, heating may occur as the metal parts of the burner apparatus absorb heat from the flame and re-radiate this toward the glass. Heat may also be transferred to the glass from the hot exhaust gases produced by the CCVD reaction.

The burner may be associated with means for extracting the exhaust gases from the region adjacent the surface of the substrate where CCVD takes place. Typically the extraction means comprises a conduit and an extraction fan and additional unwanted heat may be transferred to the glass as components associated with gas extraction means absorb heat from the gas and re-radiate it.

Unwanted heat has the potential to cause breakage due to thermal shock, expansion and bending of the glass. Moreover heating causes the glass to bend or warp which in turn causes the distance between the glass and the burner to change. This distance is a crucial reaction parameter in the CCVD process. Finally, stresses may be induced in the glass, which give rise to problems during subsequent processing.

The use of low-emissivity (Low-E) coatings on glass in order to reduce heat transfer is known. For example Pilkington® K-Glass® includes a fluorine-doped tin oxide coating which serves to reduce the emission of heat from the interior of an installation site (e.g. a building). There are numerous occasions where CCVD coating is done on one side of a glass substrate which already bears a Low-E coating on the other side. On such occasions, the detrimental effects of heat transfer to the glass are exacerbated because the Low-E coating inhibits onward transmission of the heat from the glass.

US 2009/0155493 describes a proposed solution to the problem of glass heating during deposition of coatings. By this approach, infrared burners are used to distribute the heat over a greater area of glass than would typically be seen using conventional equipment.

US 2009/0304941 describes a burner for depositing a coating on a substrate by combustion deposition. The burner includes a discrete precursor delivery manifold having walls that are cooled by a heat transfer liquid (notably oil) that is supplied thereto. This cooling is done to reduce the occurrence of precursor pre-reactions upstream of the intended precursor reaction zone.

The present invention offers an alternative solution to the problem of excess heating of the glass substrate.

According to the invention, apparatus for coating a substrate by CCVD comprises the features set out in claim 1 attached hereto.

In a preferred embodiment, the apparatus comprises means for extracting gaseous products, arising from the CCVD process, from the vicinity of the substrate.

The chamber is preferably located in a body having at least one exhaust aperture, and the apparatus further comprising means for applying a negative pressure to the exhaust aperture.

The apparatus may further comprise at least one exhaust conduit located in the body, the means for applying negative pressure being arranged to apply said pressure to the interior of the conduit. A number of baffles may define a tortuous flow path between the exhaust aperture and the exterior of the conduit and the conduit may have a plurality of holes providing fluid communication between said exterior and its interior.

At least two exhaust apertures are preferred, arranged on either side of the outlet aperture with a plurality of baffles defining a tortuous flow path between each exhaust aperture and an exhaust conduit. More preferably, the apparatus comprises at least two conduits.

In another preferred embodiment, the body comprises at least one hollow box section and the apparatus includes means for directing said heat exchange fluid through said box section.

The heat exchange fluid may comprise, for example, air or oil. Preferably, the fluid comprises water.

The CCVD reaction precursor may be delivered to the region of the linear flame by dissolving the precursor in the flammable fluid or the precursor may be delivered separately, via a precursor manifold.

Preferably, at least one cooled region is located in the means for extracting the gaseous waste products.

Preferably, the apparatus includes means for monitoring and regulating the temperature and, or flow rate of the heat exchange fluid.

According to a second aspect of the invention, a method of depositing a coating on a substrate by Combustion Chemical Vapour Deposition comprises the steps set out in claim 16 attached hereto.

In a preferred embodiment the method is further characterised by extracting gaseous products, arising from combustion of the flammable solution of reactants, from the vicinity of the substrate. More preferably, cooling is done on one or more region of the apparatus contacted by the waste gases as they are extracted.

The inventors have shown that heat transfer to the glass can be reduced by cooling the metal parts of the burner apparatus which may absorb heat directly from the flame or from the exhaust gases and would otherwise re-radiate this heat on to the glass. The invention may be especially helpful in cooling apparatus which includes means for directing the exhaust gases, produced by the CCVD process, away from the glass ribbon.

Mathematical modelling indicates a dramatic reduction in the heat induced deflection of the glass ribbon when the invention is employed and this is borne out by observation.

The invention will now be described with reference to the attached figures in which:

Figure 1 illustrates a typical burner used in the prior art to produce a coating on a substrate by CCVD;

figure 2 illustrates a burner for CCVD coating according to the invention;

figure 3 shows an alternative design for CCVD burner apparatus according to the invention and

figure 4 shows a flow circuit for heat exchange fluid used in a particular embodiment of the invention.

It should be noted that, while the invention is described with reference to CCVD coating on glass, this should not be regarded as limiting. The invention is applicable in any situation where CCVD is employed and regulation of substrate heating would be desirable.

Referring to figure 1a and 1b, a typical linear burner used for CCVD according to the prior art comprises a substantially linear (e.g. tubular) chamber 1, to which flammable fluid is supplied. The chamber includes a linear outlet aperture 2 through which the flammable fluid exits and is combusted to provide a linear flame 3. The chamber 1 and outlet aperture 2 include design features to provide for equal flow of flammable fluid at all points along outlet aperture 2 (for example flammable fluid may be supplied to both ends of conduit 1 at equal pressure). Such features are well known to persons skilled in the art and do not require further description here.

During CCVD coating of a glass substrate, chemical precursors are brought to the region of the flame where they react to form the coating material. Substrate 4 is passed over the burner at a controlled speed and reaction product is deposited thereon. As previously noted, the distance between the glass and the burner is an important reaction parameter. While the optimum value of this parameter may vary according to specific circumstances, the glass should typically be arranged to pass within 2mm of the flame inner cone 3a.

In the illustrated embodiments, the CCVD reaction precursors are direct to the region of the linear flame 3 by dissolving them in the flammable fluid and causing the resultant solution to exit the linear outlet aperture. However this should not be seen as limiting and the invention is equally applicable to arrangements where the reaction precursors are delivered to the region of the flame separately from the flammable fluid, entering the region via a precursor delivery manifold. US 2009/0304941 shows such an arrangement.

As noted previously, excess heat from the flame has a detrimental effect on the glass substrate 4.

Referring to figure 2, a linear CCVD burner according to the invention includes means for directing a heat exchange fluid to contact various components of the burner so that cooling is effected thereby.

In the example illustrated, the burner comprises a body 5 in which the conduit 1 and outlet aperture 2 are located. The body includes exhaust apertures 6 and exhaust conduits 7 (for clarity, only exhaust conduits 7 are shown in perspective). Conduits 7 comprise tubes (for example cylindrical tubes) having a plurality of holes 8 in their walls (only some shown for clarity).

Baffles 9 define a tortuous flow path, indicated by arrows 10, for exhaust gases from apertures 6 to conduit 7. Moreover, baffles 9 are arranged to prevent any glass fragments arising from breakage from falling into the interior of the body 5.

Upon application of a negative pressure to one end of a conduit 7 (for example by means of an extractor fan, not shown) exhaust gases are drawn from the CCVD region through exhaust apertures 6; along the path indicated by arrows 10 and through holes 8 to be extracted along conduits 7.

Preferably, the negative pressure is applied to one end of conduit 7 (the other end being closed) and the diameters of holes 8 increase along the length of conduit 7 towards the closed end. This arrangement facilitates a uniform flow of exhaust gases along the length of the burner.

As previously noted, the location of the glass substrate 4 in relation to the flame inner cone 3a is a critical parameter for optimum CCVD conditions. This parameter may be affected by the application of negative pressure to extract exhaust gases and it is important to maintain a constant flow of exhaust gases during the extraction operation.

The extraction rate is determined *inter alia* by the magnitude of the negative pressure applied (in the embodiment shown, by regulating the speed of the extractor fan) but control is made easier by including some resistance in the exhaust gas flow path and inducing turbulence in the exhaust gas. These effects are provided by the tortuous flow path defined by baffles 9.

In addition, an orifice plate (not shown) may be located on the end of conduit 7 further to assist in controlling the exhaust gas flow.

While the extraction of exhaust gases serves to divert heat away from the region where the CCVD process is occurring, there remains the possibility that heat absorbed by metal parts of the burner assembly (including the gas extraction means) may be re-radiated towards the glass. This problem is addressed by fluid cooling of the metal parts.

In the embodiment illustrated by figure 2, the burner body 5 and baffles 9 are constructed using hollow metal box sections 11a – 11c (for clarity, not all are labelled in figure 2) and, during operation of the burner, heat exchange fluid is arranged to flow through these box sections to provide cooling. Water conveniently serves as the heat exchange fluid although oil or air can serve.

The regions of the body defined by box sections 11a and 11b are subject to direct heating from the flame, whereas those defined by box sections 11c are more likely to absorb heat from the exhaust gases as the latter are drawn off. Clearly the effect of cooling is to reduce the amount of this heat which is re-radiated on to the substrate but it is noted that for some regions, the effect goes beyond prevention of re-radiation and actual cooling of the glass is achieved.

In the embodiment shown in figure 2 (as used during on-line CCVD coating of a float glass substrate) the direction of the substrate, as it passes the flame, is indicated by arrow 12. In this arrangement cooling the region defined by box sections 11a has the effect of removing from the substrate some of the residual heat from the float glass process. Thus the protection of the substrate from overheating offered by the current invention is due, in part, to a lowering of the substrate temperature before it passes the flame. This effect depends on, and may be regulated by, the extent to which the cooled region defined by box sections 11a is exposed to the substrate i.e. the size of the exposed area.

Water may be arranged to flow through the box sections in series or in parallel. In order to achieve uniform cooling, it may be desirable to arrange for the water in adjacent sections to flow in opposite directions.

In one embodiment, the cooling water may be arranged to flow in a closed loop which includes means for transferring heat (i.e. a radiator) from the cooling water to the external environment.

The inventors have used mathematical modelling techniques to predict the performance of apparatus substantially similar to that illustrated in figure 2 both with and without cooling water. For a standard glass ribbon of 3.2mm x 3650mm, having a low-E coating, the modelling predicts an edge deflection of 19mm when using the un-cooled apparatus and 6mm when using the cooled apparatus. Observations agreed very well with these predictions

For un-cooled apparatus, the glass temperature was raised by about 21°C on passing over the burner whereas on the cooled apparatus, the temperature was raised by about 2°C.

Referring to figure 3, the burner apparatus may be designed as discrete sections wherein the means 12 for extracting exhaust gases from the region of CCVD are arranged as separate components from the conduit 1. This design may readily lend itself to realisation of the invention by post-installation modification of existing burner equipment. Again, various components of the burner apparatus are formed in box sections 11 (not all drawn for clarity) through which cooling fluid is directed.

Referring to figure 4, heat exchange fluid may be supplied to the box sections by means of a cooling circuit comprising conduits (pipes) 12, a pump 13 and a reservoir 14. Reservoir 14 may be used in conjunction with an expansion tank or header tank (not shown).

During operation, the heat exchange fluid is supplied to the box sections (11a – 11c, figure 2) and absorbs heat generated by the CCVD process and, or the float glass process. The heat exchange fluid then returns from the box sections and is cooled as it passes through radiator 15.

The cooling effect can be augmented and controlled by fan 16, blowing air over radiator 15.

The temperature and flow rate of the heat exchange fluid are monitored by thermocouples 17 and flowmeter 18 respectively. Data from thermocouples 17 and flowmeter 18 are received by processor 19 which in turn controls pump 13 and fan 16. Thus thermocouples 17, processor 19, fan 16 and radiator 15 in combination provide means for monitoring and controlling the temperature of the heat exchange fluid: flow meter 18, processor 19 and pump 13 in combination provide means for monitoring and controlling the flow rate of the heat exchange fluid. Arrangement of processor 19 to adjust the fan speed or pump speed in response to data received, according to a chosen regime, is within the design capabilities of a person skilled in the art and requires no further explanation here.

It is noted that flow rate of the heat exchange fluid will also have an effect on the rate of heat exchange and hence temperature.

Radiator 15 and fan 16 represent only one example of how the heat exchange fluid may cooled. Other approaches, such as secondary cooling circuits combined with a heat exchange coil are within the knowledge and design capabilities of a person skilled in the art, and these fall within the scope of the invention.

In order to improve the efficiency of heat exchange between the metal of the burner assembly and the water, it is preferable to induce a turbulent flow. In practice the inventors have found that this is achieved with a linear water velocity of greater than $2ms^{-1}$.

Figure 4 represents an exemplary embodiment and should not be seen as limiting. The order and number of each component may vary.

As previously noted, figures 2, 3 and 4 represent non-limiting exemplary embodiments of the invention. In particular, box sections 11 only represent examples of regions of the apparatus to which heat exchange fluid might be directed. Other regions of the apparatus might be cooled and the invention is also applicable to burners not having means for exhaust gas extraction.

Claims

1. Apparatus for Combustion Chemical Vapour Deposition (CCVD) on a substrate, comprising:

a chamber;
a linear outlet aperture on the chamber, said outlet aperture being suitable for sustaining a linear flame as a flammable fluid, suitable for CCVD, exits the aperture;
means for supplying the flammable fluid to the chamber at a pressure sufficient to cause a flow of said fluid from the aperture and
means for supplying at least one CCVD reaction precursor to the region of the linear flame

the apparatus being characterized by at least one cooled region, arranged to reduce radiation of heat from the apparatus to the substrate and means for directing heat exchange fluid to the cooled region, thereby to effect cooling.

2. Apparatus according to claim 1, further comprising means for extracting gaseous waste products, arising from the CCVD process, from the vicinity of the substrate.

3. A burner according to claim 2, wherein the chamber is located in a body having at least one exhaust aperture, and further comprising means for applying a negative pressure to the exhaust aperture.

4. Apparatus according to claim 3, further comprising at least one exhaust conduit located in the body, wherein the means for applying negative pressure is arranged to apply said negative pressure to the interior of the conduit;
the apparatus further comprising a number of baffles arranged to define a tortuous flow path between the exhaust aperture and the exterior of the conduit, the conduit having a plurality of holes providing fluid communication between said exterior and its interior.

5. Apparatus according to claim 4, having at least two exhaust apertures arranged on either side of the outlet aperture, a plurality of baffles defining a tortuous flow path between each exhaust aperture and an exhaust conduit.

6. Apparatus according to claim 5, comprising at least two conduits.

7. Apparatus according to any preceding claim, wherein the body comprises at least one hollow box section, and the apparatus includes means for directing said fluid through said box section.

8. Apparatus according to any preceding claim, where the heat exchange fluid comprises water.

9. Apparatus according to any preceding claim, where the heat exchange fluid comprises oil.

10. Apparatus according to any preceding claim, where the heat exchange fluid comprises air.

11. Apparatus to any preceding claim in which the at least one CCVD reaction precursor is delivered to the region of the linear flame by dissolving the precursor in the flammable fluid.

12. Apparatus according to any of claims 1 – 10, in which the at least one CCVD reaction precursor is delivered to the region of the linear flame via a precursor delivery manifold.

13. Apparatus according to any preceding claim, wherein at least one cooled region is located on the means for extracting gaseous waste products.

14. Apparatus according to any preceding claim, further comprising means for monitoring and regulating the temperature of the heat exchange fluid.

15. Apparatus according to any preceding claim, further comprising means for monitoring and regulating the flow rate of the heat exchange fluid.

16. A method of depositing a coating on a substrate by CCVD, comprising the steps of:

providing a burner apparatus, said apparatus comprising a chamber having a linear outlet aperture suitable for sustaining a linear flame as a flammable fluid exits the aperture,

supplying a flammable fluid, suitable for CCVD, to the chamber at a pressure sufficient to cause said fluid to exit the aperture in a continuous flow,

supplying at least one CCVD reaction precursor to the region of the linear flame,

combusting the flammable fluid as it exits the aperture, thereby sustaining the linear flame and

arranging the burner apparatus and the substrate to effect deposition on the substrate of reaction products,

characterized by cooling a region of the apparatus, thereby to reduce radiation of heat from the apparatus to the substrate, by directing a heat exchange fluid to said region.

17. A method according to claim 16, further characterised by extracting gaseous products, arising from combustion of the flammable solution of reactants, from the vicinity of the substrate.

18. A method according to claim 17, further comprising cooling one or more regions of the apparatus contacted by the waste gases as they are extracted.

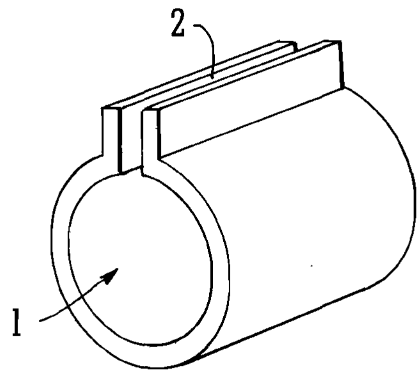


FIG. 1a
PRIOR ART

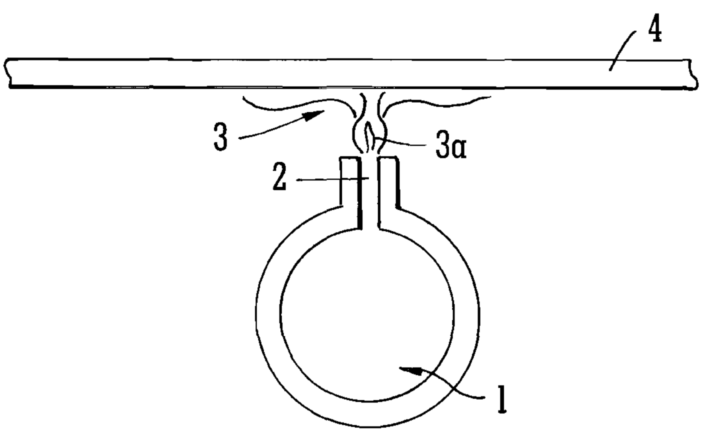


FIG. 1b
PRIOR ART

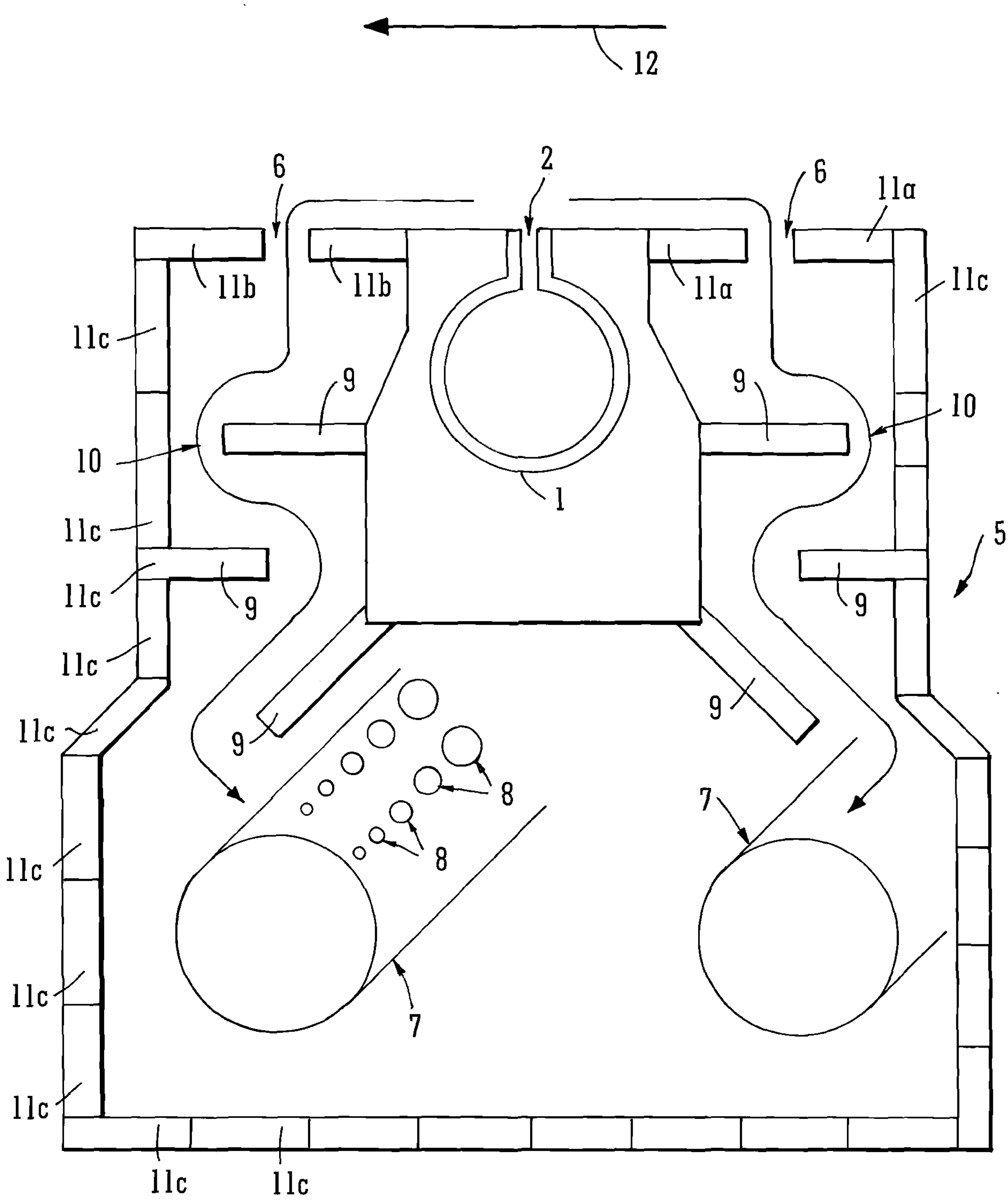

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FIG. 2

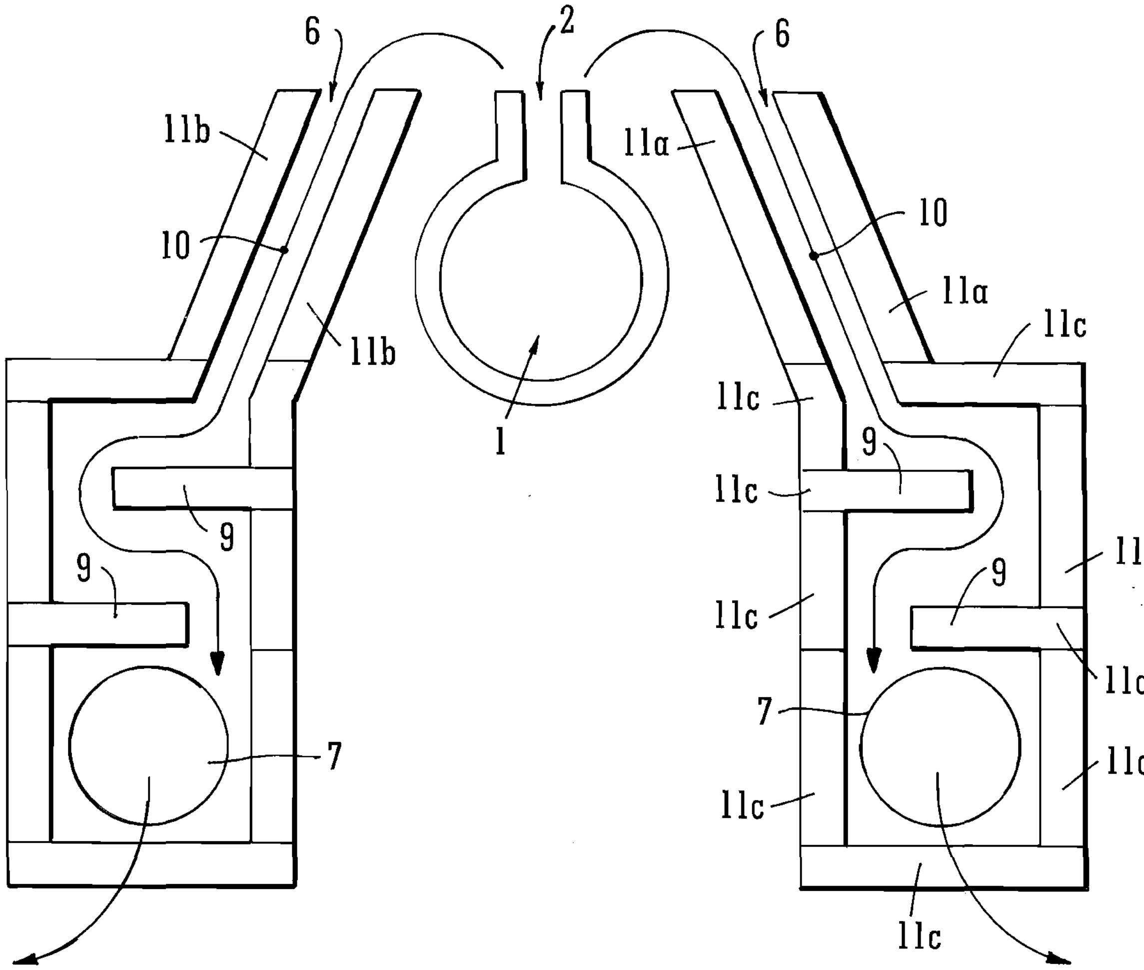
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FIG. 3

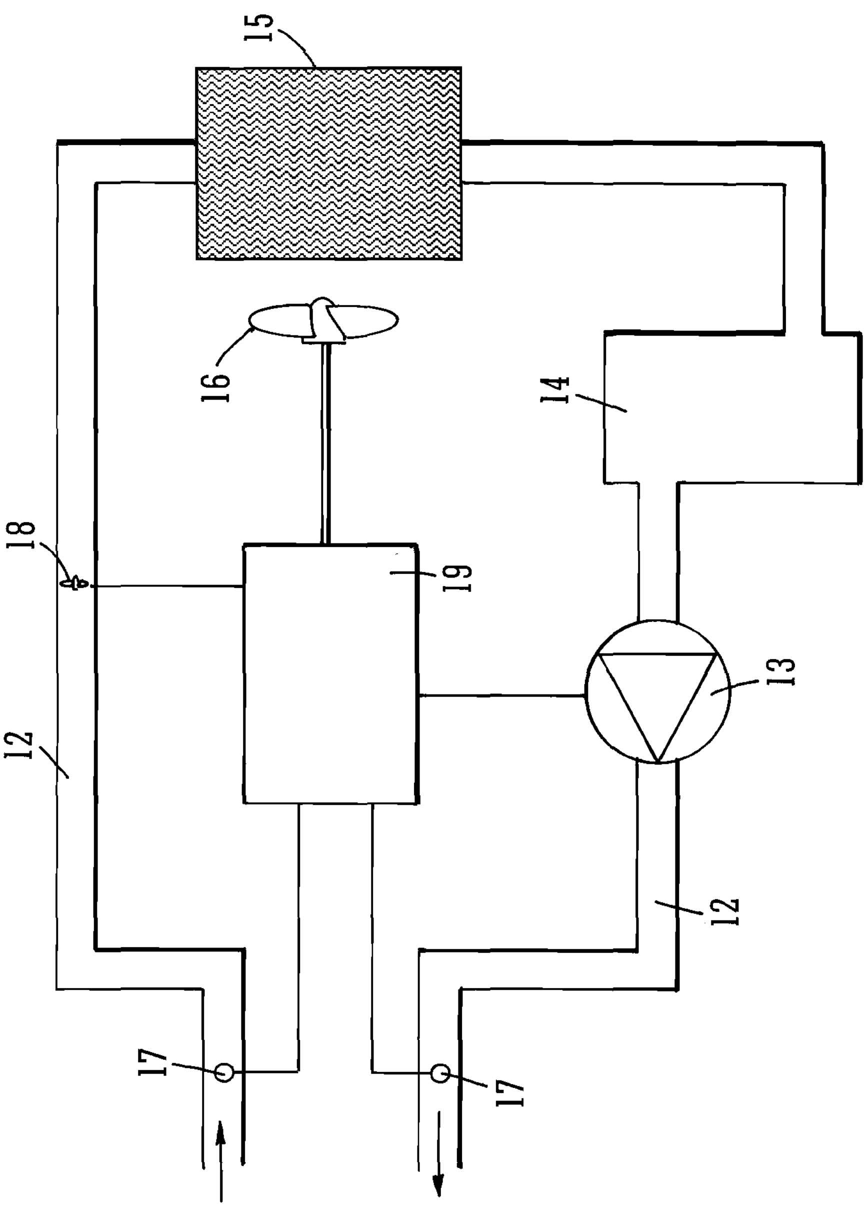

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2012/050979

A. CLASSIFICATION OF SUBJECT MATTER
INV. C23C16/453 C23C16/46 C03C17/245
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)
C23C C03C

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009/304941 A1 (MCLEAN DAVID D [US]) 10 December 2009 (2009-12-10) paragraphs [0026], [0030], [0031], [0036]; figure 2 -----	1,2, 7-12, 14-17
Y	"Large-area diamond deposition in an atmospheric pressure stagnation-flow reactor", APPLIED PHYSICS LETTERS, AIP, AMERICAN INSTITUTE OF PHYSICS, MELVILLE, NY, US, vol. 68, no. 15, 8 April 1996 (1996-04-08), pages 2158-2160, XP012015034, ISSN: 0003-6951, DOI: 10.1063/1.116014 page 2158, left-hand column; figure 1 -----	7,8
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[X] Further documents are listed in the continuation of Box C.

[X] 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

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"P" document published prior to the international filing date but later than the priority date claimed

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 August 2012	14/08/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Kudelka, Stephan

1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 02/061163 A2 (MICROCOATING TECHNOLOGIES INC [US]; OLJACA MIODRAG [US]; TOMOV TRIFON) 8 August 2002 (2002-08-08) page 2, line 22 - line 30 page 3, line 5 - line 6 page 3, line 7 - line 10 -----	1,9-12, 14-16
Y	WO 2009/007745 A1 (PILKINGTON GROUP LTD [GB]; HURST SIMON JAMES [GB]; BENITO GUTIERREZ GU) 15 January 2009 (2009-01-15) page 4, line 30 - page 5, line 10 -----	2,17
A	WO 2006/061785 A2 (KONINKL PHILIPS ELECTRONICS NV [NL]; PHILIPS CORP [US]; INNOVENT E V T) 15 June 2006 (2006-06-15) figure 1 -----	1,16

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2012/050979

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009304941 A1	10-12-2009	EP 2294242 A1	16-03-2011
		US 2009304941 A1	10-12-2009
		WO 2009151519 A1	17-12-2009
WO 02061163 A2	08-08-2002	AU 2002249829 A1	12-08-2002
		US 2006289675 A1	28-12-2006
		WO 02061163 A2	08-08-2002
WO 2009007745 A1	15-01-2009	CN 101688305 A	31-03-2010
		EP 2167702 A1	31-03-2010
		JP 2010532819 A	14-10-2010
		KR 20100035158 A	02-04-2010
		US 2011287178 A1	24-11-2011
		WO 2009007745 A1	15-01-2009
WO 2006061785 A2	15-06-2006	EP 1874978 A2	09-01-2008
		JP 2008523603 A	03-07-2008
		US 2010151130 A1	17-06-2010
		WO 2006061785 A2	15-06-2006