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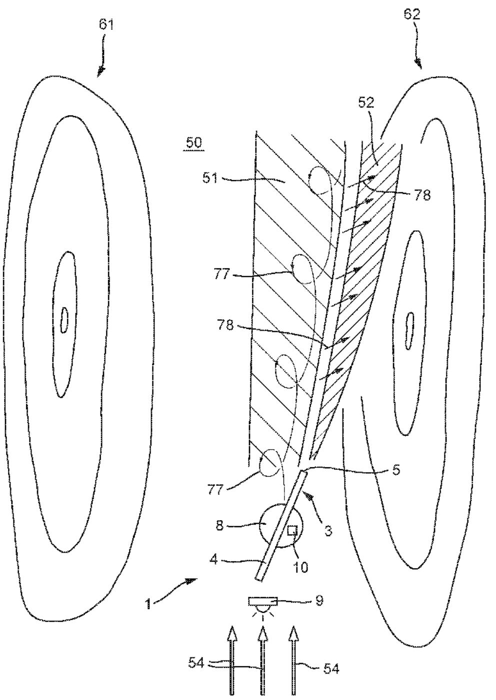
(54) Title: METHOD OF AND SYSTEM FOR CONTROLLING A HEIGHT DISTRIBUTION OF A BOTTOM OF A WATER

Fig. 3



(57) Abstract: A support structure (2) is installed in or near a water (50). The support structure is holding a deltalike-wing (3) under an angle of incidence relative to an incoming flow (54), caused by at least a prevailing current in the water, thus generating a vortex (77). The action of the vortex is effective for the purpose(s) of maintaining the suspension of already suspended sediment within said current and/or of suspending sediment from a targeted first area (51) of the bottom of the water and/or of depositing suspended sediment within said current onto a targeted second area (52) of the bottom of the water. Thereby, the height distribution of the bottom of the water is controlled.

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Title: Method of and system for controlling a height distribution of a bottom of a water

The invention relates to a method of and a system for controlling a height distribution of a bottom of a water.

It is noted that the term “water”, as used herein in expressions like “a water”, “waters”, or “the water(s)”, is meant to refer to a stretch or area of water, such as a lake, sea, ocean, river, seaport, shipping lane, other waterway, or the like.

As considered herein, there is, on the one hand, the problem of undesirable raising of bottom parts of waters. This may for example lead to loss of operational depth of seaports, shipping lanes, etc.

On the other hand, there is the problem of undesirable deepening/excavation of bottom parts of waters. This may for example lead to damage to dams, sandbanks, intertidal flats, foundations on the seabed (e.g. wind turbine foundations, storm surge barriers), etc.

These problems are caused by currents in the waters, such as tidal currents. Also, erosion by wave action plays a role, which may be natural wave action or, e.g., wave action from shipping traffic.

In many cases, both problems occur simultaneously in that undesirable deepening/excavation of some bottom parts of a water goes hand in hand with undesirable raising of other bottom parts of the water. In these cases, the currents in the water are responsible for suspending sediment at a first bottom location, transporting that sediment to a second bottom location, and depositing that sediment at said second bottom location.

Currently, the main ways of dealing with said problems, individually or in combination, are sand dredging and sand deposition (sand suppletion). However, these activities, together with the sand transportation involved, are very costly, both in energetic terms and in financial terms. In addition, these activities are highly disturbing for the local flora and fauna, both at the dredging areas and at the sand suppletion areas. The adverse effects of these disturbances take upto a few years to recover. On top of that, said activities have to be periodically repeated every so-many (5 to 10) years.

It is an object of the invention to provide a solution according to which a height distribution of a bottom of a water is controlled in a manner being less costly in energetic, financial and environmental terms.

For that purpose, the invention provides a method of controlling a height distribution of a bottom of a water, wherein a support structure is installed in or near the water, said support structure holding a deltalike-wing under an angle of incidence relative to an incoming flow, caused by at least a prevailing current of the water, said deltalike-wing comprising a sweepback leading edge, a trailing edge and a root edge, which three edges are mutually arranged in delta-winglike fashion, in such manner that at the sweepback leading edge of the deltalike-wing a delta-wing type vortex is generated out of said incoming flow, wherein the action of said delta-wing type vortex is effective for the purpose(s):

- of maintaining the suspension of already suspended sediment within said prevailing current; and/or

- of suspending sediment from a targeted first area of said bottom of said water; and/or

- of depositing suspended sediment within said prevailing current onto a targeted second area of said bottom of said water.

Hence, the invention substantially only requires that the said support structure is installed in or near the water, while holding the said deltalike-wing in the said manner. The invention in a smart manner makes beneficial use of the specific feature that such a deltalike-wing has, i.e. the feature that such a deltalike-wing, if the said angle of incidence is sufficiently high, is able to generate the delta-wing type vortex already at low speeds of an incoming flow. At the same time, the invention in a smart manner makes beneficial use of the specific capabilities that such a generated vortex has, i.e. to maintain suspension of already suspended sediment within a prevailing current in a water, to suspend sediment from a first targeted bottom area of a water, and to deposit suspended sediment onto a second targeted bottom area of a water. The invention makes use of kinetic energy which already exists in (currents of) the water, and the invention does so in a highly passive and very gradual way. For these reasons, as compared to the commonly used sand dredging and sand suppletion operations, the benefits that the invention offers in energetic, financial and environmental terms are of undreamed-of extent.

It is noted that the said “delta-wing type vortex” is an elongated, substantially helical vortex of relatively high strength, which helical vortex is extending from the sweepback leading edge until far downstream of the deltalike-wing. The longitudinal direction of this helical vortex is extending substantially parallel to the direction of the incoming flow onto the deltalike-wing. When the incoming flow is known, the strength and location of this vortex, and therefore its aimed effects, are highly predictable.

In principle, said prevailing current may be any current in the water. In a preferable embodiment of the invention, said prevailing current is a tidal current. An advantage of using tidal currents is that they are strong, periodical and highly predictable.

The invention may also be embodied in a system for controlling a height distribution of a bottom of a water, the system comprising:

- a support structure being installed in or near the water; and
- at least one deltalike-wing being held in the water by said support structure, said deltalike-wing comprising a sweepback leading edge, a trailing edge and a root edge, which three edges are mutually arranged in delta-winglike fashion;

wherein the system is configured, arranged and effective to generate, out of an incoming flow under an angle of incidence relative to the deltalike-wing, which incoming flow is caused by at least a prevailing current of the water, at the sweepback leading edge of the deltalike-wing a delta-wing type vortex, wherein the action of said delta-wing type vortex is effective for the purpose(s):

- of maintaining the suspension of already suspended sediment within said prevailing current; and/or

- of suspending sediment from a targeted first area of said bottom of said water; and/or

- of depositing suspended sediment within said prevailing current onto a targeted second area of said bottom of said water.

In a preferable embodiment of the invention, the deltalike-wing is supported by said support structure from below. This enables, for example, to design the system so as to leave the space above the deltalike-wing to be unobstructed by components of the system.

In another preferable embodiment of the invention, which may be used in combination with any one of the abovementioned embodiments of the invention, the deltalike-wing is suspended from said support structure. This enables, for example, to design the system so as to leave the space below the deltalike-wing to be unobstructed by components of the system.

In another preferable embodiment of the invention, which may be used in combination with any one of the abovementioned embodiments of the invention, the system further comprises:

- an actuatable adjustor, which is configured, arranged and effective to adjust the orientation and/or the position of the deltalike-wing relative to the earth, for influencing the characteristics of the generated delta-wing type vortex and/or for interchanging between an operative condition and a stowed condition of the deltalike-wing.

Such an actuatable adjustor provides ease in adjusting the system, for example in dependence of changes in desired effects of the system and/or in dependence of changes in characteristics of prevailing currents in the water.

Preferably, the system further comprises:

- a sensor, configured, arranged and effective to sense at least one property of said incoming flow in the water; and

- a controller, which is communicatively connected to said sensor and to said actuatable adjustor, and which is configured, arranged and effective to control actuation of said actuatable adjustor based on said at least one property sensed by said sensor. Such a sensor allows, for example, to sense directions and magnitudes of currents in the water, while such a controller allows, for example, to automatically adjust an angle of incidence of the deltalike-wing relative to an incoming flow based on the sensed directions and magnitudes of currents in the water.

In another preferable embodiment of the invention, which may be used in combination with any one of the abovementioned embodiments of the invention, the at least one deltalike-wing is a plurality of such deltalike-wings, which respectively generate a corresponding plurality of such delta-wing type vortices, which respectively provide a corresponding plurality of such actions, the interaction of which is effective for the said purpose(s). The application of such a plurality of deltalike-wings provides various possibilities for obtaining, in juxtaposition and/or in synergy, the effects of the plurality of the said vortices for the stated purposes of: maintaining the suspension of already suspended sediment within said prevailing current; and/or of suspending sediment from a targeted first area of said bottom of said water; and/or of depositing suspended sediment within said prevailing current onto a targeted second area of said bottom of said water.

It is noted that any one of the abovementioned embodiments of a method according to the invention may be performed with the use of any one of the abovementioned embodiments of a system according to the invention.

The abovementioned aspects and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter by way of non-limiting examples only and with reference to the schematic figures in the enclosed drawing.

Fig. 1A shows an example of an embodiment of a deltalike-wing for use in a method and in a system according to the invention, the view being taken perpendicular to the straight wing plane of this deltalike-wing.

Fig. 1B shows the deltalike-wing of Fig. 1A in a transverse cross-section taken along the plane pointed at by arrows I-B in Fig. 1A, wherein said plane is viewed at in the direction of the arrows I-B.

Fig. 1C shows the deltalike-wing of Fig. 1A in a transverse cross-section taken along the plane pointed at by arrows I-C in Fig. 1A, wherein said plane is viewed at in the direction of the arrows I-C.

Fig. 2 shows, in a horizontal side view, an example of an embodiment of a system according to the invention, which system comprises the deltalike-wing of Fig. 1A, the view being taken in the direction of a horizontal current in the water in which the deltalike-wing is held.

Fig. 3 shows the situation of Fig. 2 in a view from above.

Figs. 4A-4K respectively show, in views similar to the view of Fig. 1A, examples of other embodiments of a deltalike-wing for use in a method and in a system according to the invention.

Reference is first made to Figs. 1A, 1B, 1C, 2 and 3. Figs. 2 and 3 show a water 50 in-between two sand banks 61 and 62. In Fig. 2, reference numeral 55 indicates the water level of the water 50, numeral 56 denotes sediment (e.g. sand), and no. 53 indicates the bottom of the water 50. In Fig. 3 the arrows indicated by reference numerals 54 refer to the direction of said horizontal current (e.g. a tidal current) in the water 50. The shown system 1 comprises support structure 2 (see Fig. 2) and deltalike-wing 3, being supported by the support-structure 2 from below. As seen in Fig. 2, the support structure 2 comprises a firm floor 12 and a number of piles 14, which have been driven into the underground (in this case into the sediment 56) and which are carrying the floor 12. It is noted, that in the shown example, the wing 3 is oriented such that its straight wing plane is a vertical plane. However, it is noted that for the invention it is not essential that its straight wing plane is a vertical plane, it may be a horizontal plane, or a plane having any other inclination relative to the horizontal (or vertical) as well.

The sweepback leading edge, the trailing edge and the root edge of the wing 3 have been indicated by reference numerals 4, 5 and 6, respectively. As seen in Figs. 1A, 1B and 1C, the sweepback leading edge 4 has been sharpened upto the shown sharpening width line 11. Under circumstances, the optional application of such a sharpened leading edge 4 may improve the generation of delta-wing type vortices at the leading edge.

As seen in Fig. 3, there is an angle of incidence of the current 54 relative to the wing 3. In Figs. 2 and 3 the resulting delta-wing type vortex has been indicated by the reference numeral 77. Downstream of the wing 3, the abovementioned targeted first area of the bottom 53 of the water 50 has been indicated by reference numeral 51, while the abovementioned targeted second area 52 of the bottom 53 of the water 50 has been indicated by reference numeral 52. From Figs. 2 and 3 it will be readily appreciated that, as a result of the presence of the vortex 77, sediment from the targeted first area 51 will suspend into the water 50 and this newly suspended sediment will be transported through the water by the vortex 77. Subsequently, as a result of centrifugal/gravitational forces acting on the newly suspended sediment, being transported, this newly suspended sediment will be deposited substantially onto the targeted second area 52. In Figs. 2 and 3, the rough directions of this deposition process have been represented by arrows indicated by the reference numerals 78.

Hence, thanks to the generated vortex 77 the targeted first area 51 is automatically deepened/excavated, while at the same time sediment is deposited at the targeted second area 52. This way, the generated vortex 77 automatically prevents loss of operational depth in the targeted first area

51, while at the same time it automatically prevents damage to the sandbank 62. In other words, the invention automatically provides a sand dredging operation, a sand transportation operation and a sand suppletion operation. And this is all done by using kinetic energy from an available (e.g. tidal) current. Furthermore, it is done in a very gradual way, thus preventing adverse environmental effects.

It is remarked that, in the shown example, the wing 3 should preferably lie with its root edge 6 closely adjacent to the floor 12 (see Fig. 2), so as to stimulate the occurrence of favourable pressure distributions over the wing for the vortex generation.

In the shown example, the system 1 further comprises an actuatable adjustor 8, which is configured, arranged and effective to adjust the orientation and/or the position of the wing 3 relative to the earth, for influencing the characteristics of the generated delta-wing type vortex 77 and/or for interchanging between an operative condition and a stowed condition of the deltalike-wing. This actuatable adjustor 8 has been depicted in a very schematical way in Figs. 2 and 3. For example, the adjustor 8 may be configured, arranged and effective to rotate the wing 3 about a vertical rotation axis in order to adjust the angle of incidence relative to currents in the water. It is noted that the adjustor 8 may also be configured, arranged and effective to rotate the wing 3 about various other rotation axes, such as horizontal rotation axes, or any other rotation axis having any possible inclination relative to the horizontal/vertical, and/or to translate the wing 3 in various ways.

Furthermore, it is noted that said stowed condition may for example be a more or less horizontally folded position, or a position downwardly retracted into for example the support structure 2.

It has been mentioned above that a system according to the invention may further comprise a sensor, configured, arranged and effective to sense at least one property of said incoming flow in the water; and a controller, which is communicatively connected to said sensor and to said actuatable adjustor, and which is configured, arranged and effective to control actuation of said actuatable adjustor based on said at least one property sensed by said sensor. In the shown example, such a sensor and such a controller of the system 1 have been depicted in highly schematical ways, and have been indicated by the reference numerals 9 and 10, respectively (see Fig. 3).

From all of the above, it will be appreciated that the term “deltalike-wing”, as used in the context of the present invention, is meant to indicate a wing, which, as seen relative to a hypothetical uniform incoming water flow, comprises a sweepback leading edge, a trailing edge and a root edge, which three edges are mutually arranged in delta-winglike fashion, and wherein the wing, when placed under a sufficiently high angle of incidence relative to such an incoming water flow, is able to generate at the sweepback leading edge a delta-wing type vortex already at the (relatively low) speeds typical for currents in waters.

The term “sweepback”, as used in the expression “sweepback leading edge” refers to the fact that the leading edge is not a straight (reference) edge being fully perpendicular to the direction of said hypothetical uniform incoming water flow, but has an inclination relative to such a reference edge. According to the invention, the angle of said inclination, in the range of the sweepback leading edge where the delta-wing type vortex is generated, preferably is higher than 45 degrees, more preferably higher than 50 degrees, yet more preferably higher than 55 degrees, and still yet more preferably higher than 60 degrees. Note that herein the “angle of said inclination” between the sweepback leading edge and said reference edge is taken to be the smaller one of the two possible 180 degrees complementary angles. E.g., if the two lines could at the same time be said to locally make an angle of 70 degrees and 110 degrees, the “angle of said inclination” as meant here is 70 degrees, not 110 degrees.

Reference is now made to Figs. 4A-4K, which respectively show, in views similar to the view of Fig. 1A, examples of 2nd-12th embodiments, respectively, of a deltalike-wing for use in a method and in a system according to the invention. These examples of Figs. 4A-4K are shown to illustrate some of the various possible variations in the designs of a deltalike-wing as used in the present invention. These deltalike-wings of Figs. 4A-4K, their sweepback leading edges, their trailing edges and their root edges, respectively, are indicated in Figs. 4A-4K by reference numerals 103-106, 203-206, 303-306, 403-406, 503-506, 603-606, 703-706, 803-806, 903-906, 1003-1006, and 1103-1106, respectively.

Fig. 4A shows the deltalike-wing 103 according to the 2nd embodiment. The deltalike-wing 103 of Fig. 4A differs from the delta-wing 3 of Fig. 1A in that a corner part of the wing, where the leading edge and trailing edge meet, has been cut off. Accordingly, in aerodynamical applications, this type of a cut-off delta-wing sometimes is referred to as "cropped delta". In the shown example, the leading edge 104 is a piecewise linear combination of the shown linear parts 104A and 104B.

Fig. 4B shows the deltalike-wing 203 according to the 3rd embodiment. The wing 203 of Fig. 4B differs from the wing 103 of Fig. 4A in that its leading edge 204 has a smooth curve instead of an angle.

Fig. 4C shows the deltalike-wing 303 according to the 4th embodiment. The deltalike-wing 303 of Fig. 4C differs from the delta-wing 3 of Fig. 1A in that a corner part of the wing, where the leading edge and root edge meet, has been cut off. In the shown example, the leading edge 304 is a piecewise linear combination of the shown linear parts 304A and 304B.

Fig. 4D shows the deltalike-wing 403 according to the 5th embodiment. The wing 403 of Fig. 4D differs from the wing 303 of Fig. 4C in that its leading edge 404 has a smooth curve instead of an angle.

Fig. 4E shows the deltalike-wing 503 according to the 6th embodiment. The deltalike-wing 503 of Fig. 4E differs from the delta-wing 3 of Fig. 1A in that the leading edge 504 is a piecewise linear combination of the shown linear parts 504A and 504B. The anterior leading edge part 504A has very high sweepback, while the posterior leading edge part 504B has less sweepback. Accordingly, in aerodynamical applications, this type of delta-wing sometimes is referred to as “compound delta”.

Fig. 4F shows the deltalike-wing 603 according to the 7th embodiment. The wing 603 of Fig. 4F differs from the wing 503 of Fig. 4E in that a corner part of the wing, where the leading edge and trailing edge meet, has been cut off (comparable to the “cropped delta” embodiment of Fig. 4A).

Fig. 4G shows the deltalike-wing 703 according to the 8th embodiment. The wing 703 of Fig. 4G differs from the wing 603 of Fig. 4F in that its leading edge 704 has a smooth curve instead of two angles. Accordingly, in aerodynamical applications, this type of delta-wing sometimes is referred to as “ogee delta” or “ogival delta”.

Fig. 4H shows the deltalike-wing 803 according to the 9th embodiment. The wing 803 of Fig. 4H differs from the wing 703 of Fig. 4G in that its trailing edge 805 is not a straight line anymore.

Fig. 4I shows the deltalike-wing 903 according to the 10th embodiment. The wing 903 of Fig. 4I differs from the wing 803 of Fig. 4H in that its root edge 906 is not a straight line anymore.

Fig. 4J shows the deltalike-wing 1003 according to the 11th embodiment. The wing 1003 of Fig. 4J differs from the wing 203 of Fig. 4B in that its trailing edge 1005 is located significantly farther downstream of its leading edge, which results in significantly larger “chord lengths” of the wing 1003 as compared to the wing 203.

Fig. 4K shows the deltalike-wing 1103 according to the 12th embodiment. The wing 1103 of Fig. 4K differs from the wing 1003 of Fig. 4J in that a corner part of the wing, where the trailing edge and root edge meet, has been cut off. In the shown example, the trailing edge 1105 is a combination of the shown parts 1105A and 1105B.

According to the invention, many different combinations of the different respective variations in the sweepback leading edges, trailing edges and root edges, respectively, as shown in Figs. 4A-4K, are possible. For example, for each of the wings shown in Figs. 4A-4K, any one of its sweepback leading edge and/or its trailing edge and/or its root edge may be replaced by a sweepback leading edge and/or a trailing edge and/or a root edge, respectively, of the types as shown in any one of the other of Figs. 4A-4K.

While the invention has been described and illustrated in detail in the foregoing description and in the drawing figures, such description and illustration are to be considered exemplary and/or illustrative and not restrictive; the invention is not limited to the disclosed embodiments. For example, according to the invention, it is possible to place the deltalike-wing in many different orientations relative to an incoming flow for generating a delta-wing type vortex out of said incoming flow. Also, according to the invention, it is possible to apply a deltalike-wing not having a straight wing plane, but a three-dimensionally curved wing plane.

Furthermore, the support structure may be a mobile device relative to the earth, for example a surface vessel, subsurface vessel, vehicle moving over a bottom of a water, or the like, which mobile device thus can move the deltalike-wing relative to the earth, while holding it. Such a mobile device may e.g. be a remotely operated device/vehicle. Methods according to the invention may optionally even be carried out during the movement of the mobile device, in which case the movement of the device may substantially contribute to the incoming flow onto the deltalike-wing.

Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word “comprising” does not exclude other elements or steps, and the indefinite article “a” or “an” does not exclude a plurality. A single processor or other unit may fulfill the functions of several items recited in the claims. For the purpose of clarity and a concise description, features are disclosed herein as part of the same or separate embodiments, however, it will be appreciated that the scope of the invention may include embodiments having combinations of all or some of the features disclosed. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures can not be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. A method of controlling a height distribution of a bottom (53) of a water (50), wherein a support structure (2) is installed in or near the water, said support structure holding a deltalike-wing (3; 103; 203; 303; 403; 503; 603; 703; 803; 903; 1003; 1103) under an angle of incidence relative to an incoming flow (54), caused by at least a prevailing current of the water, said deltalike-wing comprising a sweepback leading edge (4), a trailing edge (5) and a root edge (6), which three edges are mutually arranged in delta-winglike fashion, in such manner that at the sweepback leading edge of the deltalike-wing a delta-wing type vortex (77) is generated out of said incoming flow, wherein the action of said delta-wing type vortex is effective for the purpose(s):

- of maintaining the suspension of already suspended sediment within said prevailing current; and/or
- of suspending sediment from a targeted first area (51) of said bottom of said water; and/or
- of depositing suspended sediment within said prevailing current onto a targeted second area (52) of said bottom of said water.

2. A method according to claim 1, wherein said prevailing current (54) is a tidal current.

3. A system for controlling a height distribution of a bottom (53) of a water (50), the system (1) comprising:

- a support structure (2) being installed in or near the water; and
- at least one deltalike-wing (3; 103; 203; 303; 403; 503; 603; 703; 803; 903; 1003; 1103) being held in the water by said support structure, said deltalike-wing comprising a sweepback leading edge (4), a trailing edge (5)

and a root edge (6), which three edges are mutually arranged in delta-winglike fashion;

wherein the system is configured, arranged and effective to generate, out of an incoming flow (54) under an angle of incidence relative to the deltalike-wing, which incoming flow is caused by at least a prevailing current of the water, at the sweepback leading edge of the deltalike-wing a delta-wing type vortex (77), wherein the action of said delta-wing type vortex is effective for the purpose(s):

- of maintaining the suspension of already suspended sediment within said prevailing current; and/or

- of suspending sediment from a targeted first area (51) of said bottom of said water; and/or

- of depositing suspended sediment within said prevailing current onto a targeted second area (52) of said bottom of said water.

4. A system according to claim 3, wherein the deltalike-wing (3) is supported by said support structure (2) from below.

5. A system according to claim 3 or 4, wherein the deltalike-wing is suspended from said support structure.

6. A system according to any one of the claims 3-5, further comprising:

- an actuatable adjustor (8), which is configured, arranged and effective to adjust the orientation and/or the position of the deltalike-wing (3) relative to the earth, for influencing the characteristics of the generated delta-wing type vortex (77) and/or for interchanging between an operative condition and a stowed condition of the deltalike-wing.

7. A system according to claim 6, further comprising:

- a sensor (9), configured, arranged and effective to sense at least one property of said incoming flow (54) in the water (50); and

- a controller (10), which is communicatively connected to said sensor and to said actuatable adjustor (8), and which is configured, arranged and effective to control actuation of said actuatable adjustor based on said at least one property sensed by said sensor.

8. A system according to any one of the claims 3-7, wherein the at least one deltalike-wing is a plurality of such deltalike-wings, which respectively generate a corresponding plurality of such delta-wing type vortices, which respectively provide a corresponding plurality of such actions, the interaction of which is effective for the said purpose(s).

Fig. 1A

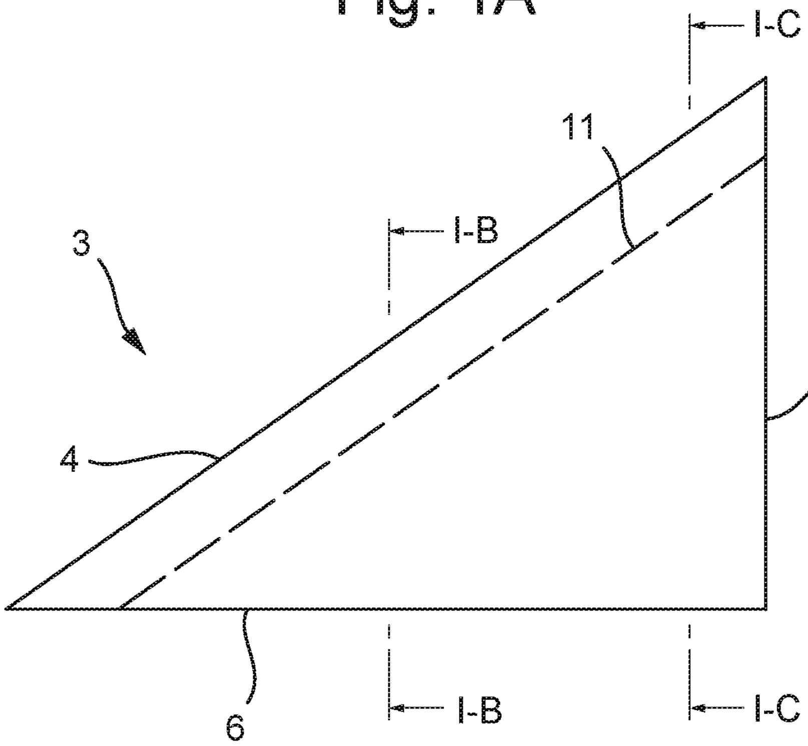
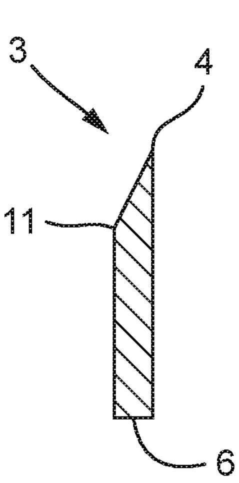
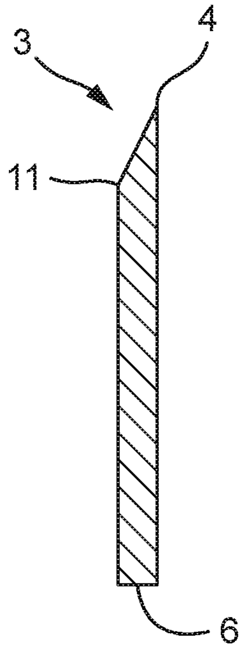


Fig. 1C

Fig. 1B





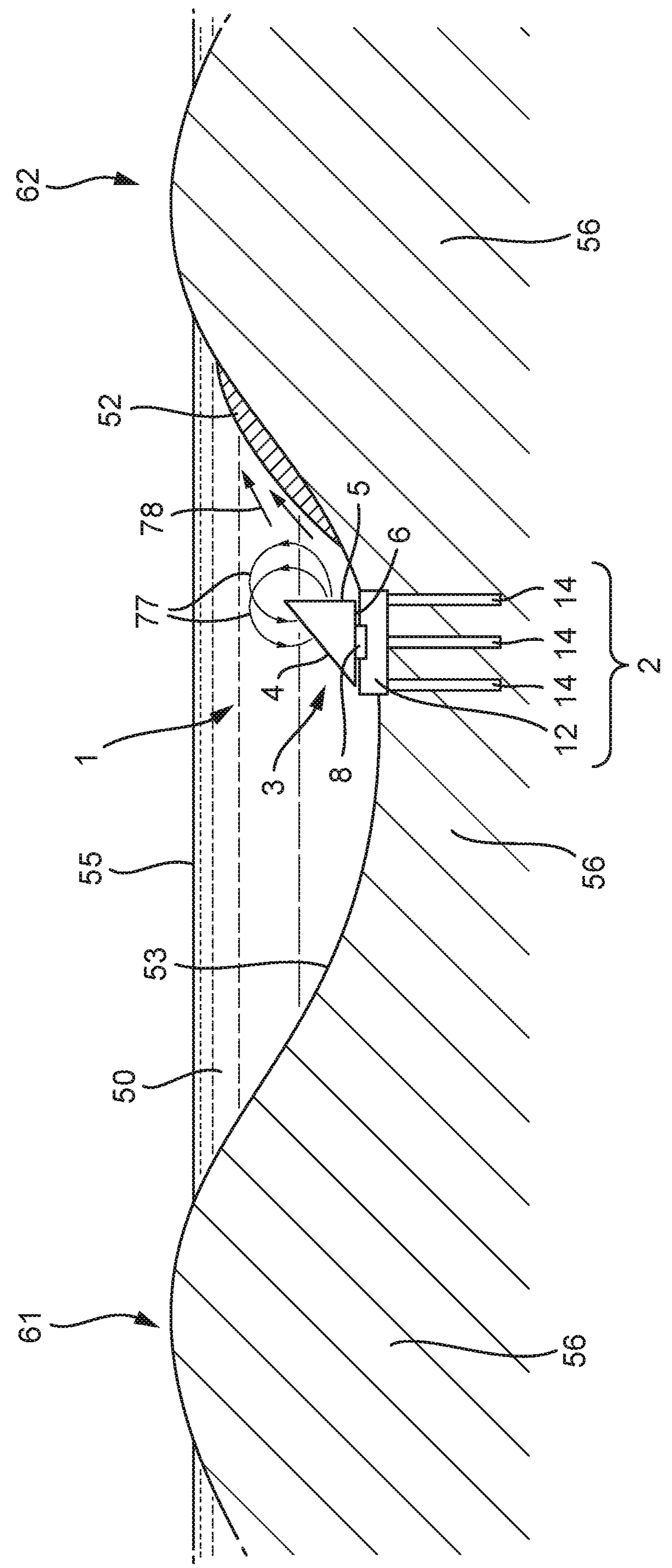
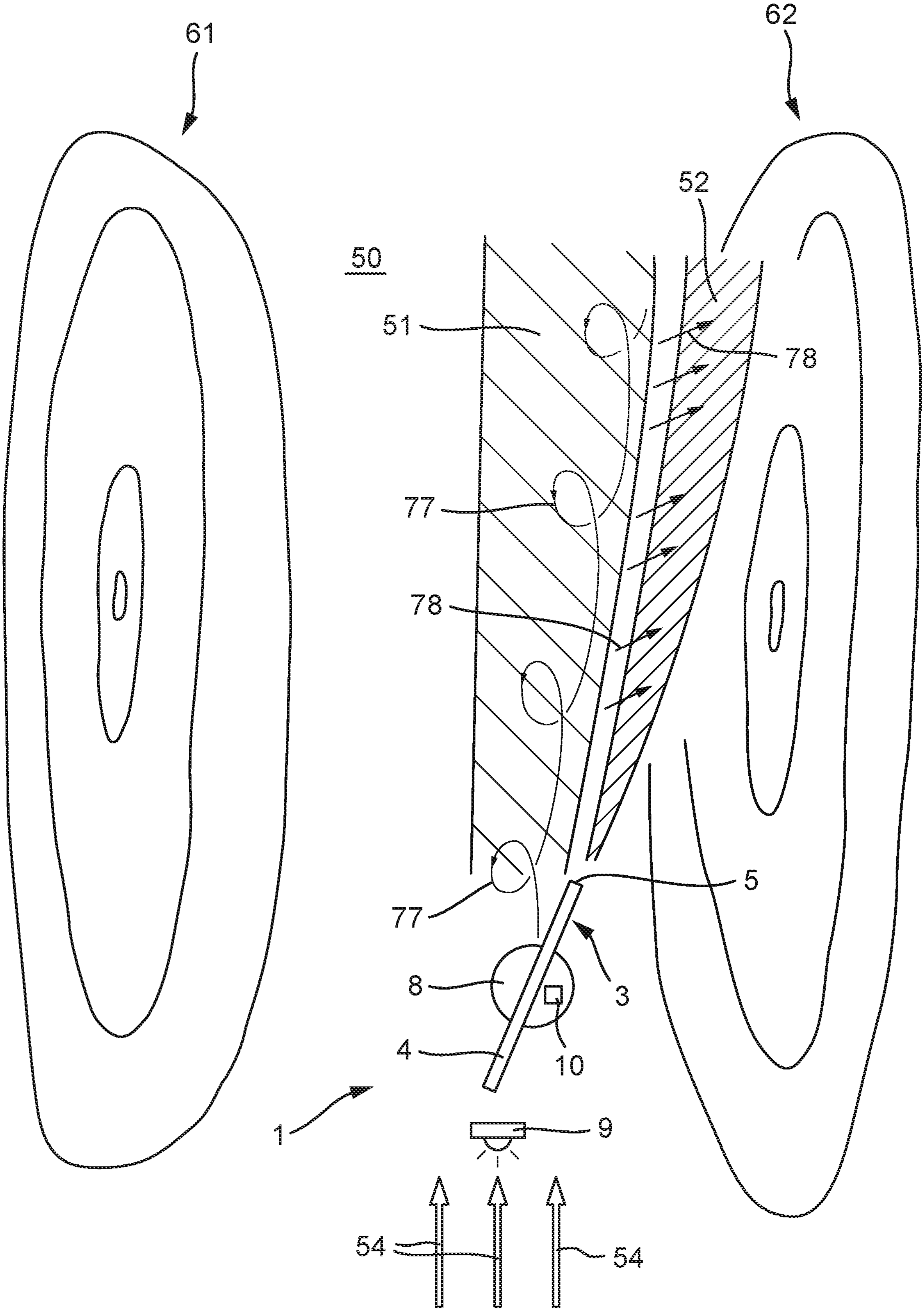


Fig. 2

Fig. 3



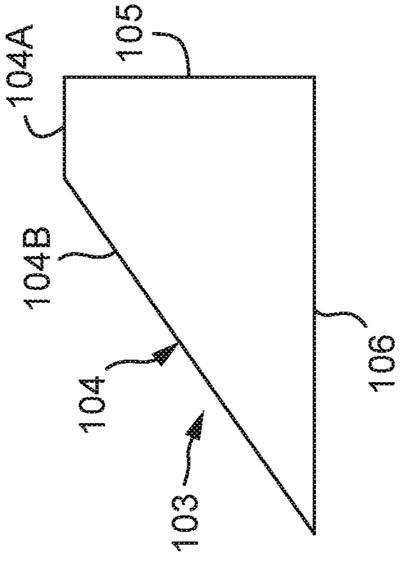


Fig. 4A

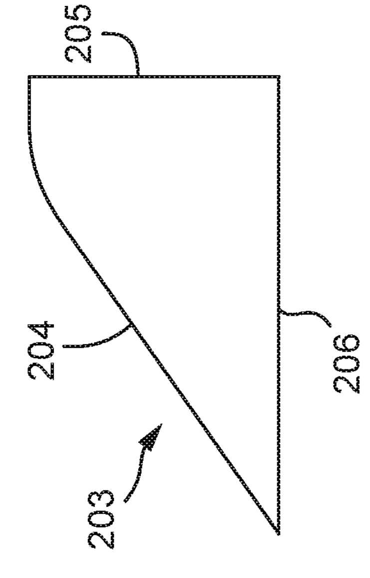


Fig. 4B

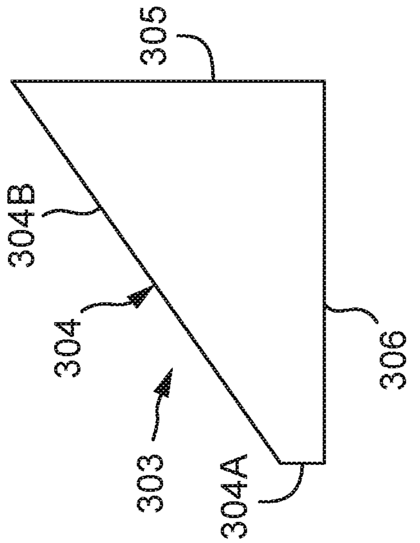


Fig. 4C

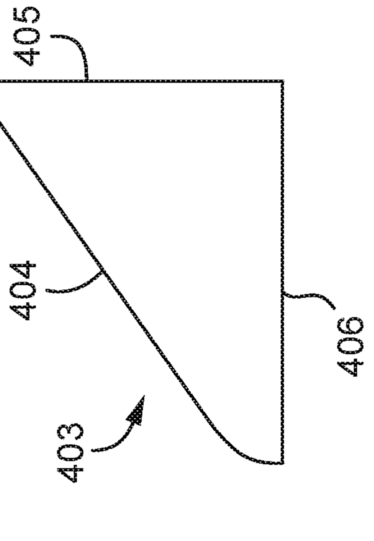


Fig. 4D

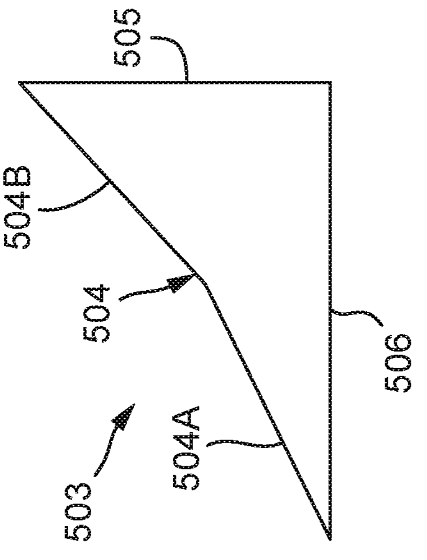


Fig. 4E

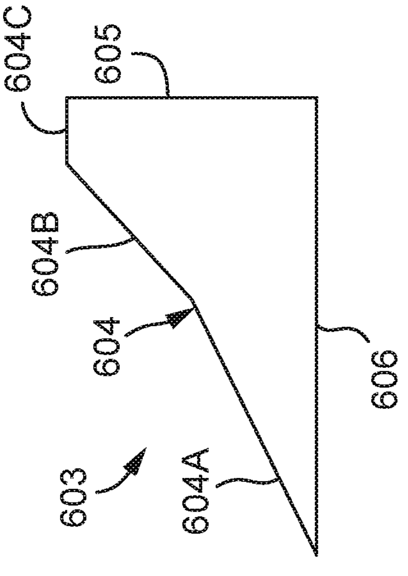


Fig. 4F

Fig. 4G

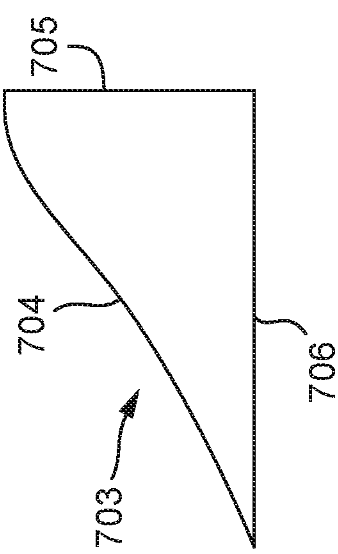


Fig. 4H

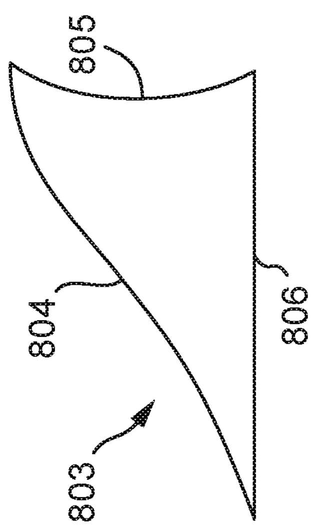


Fig. 4I

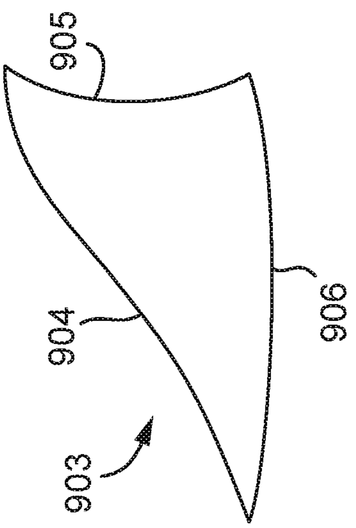


Fig. 4J

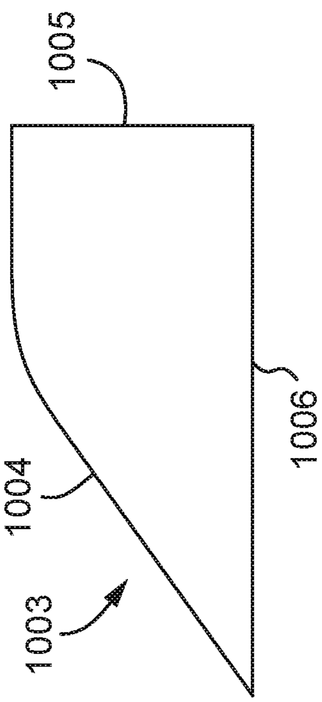
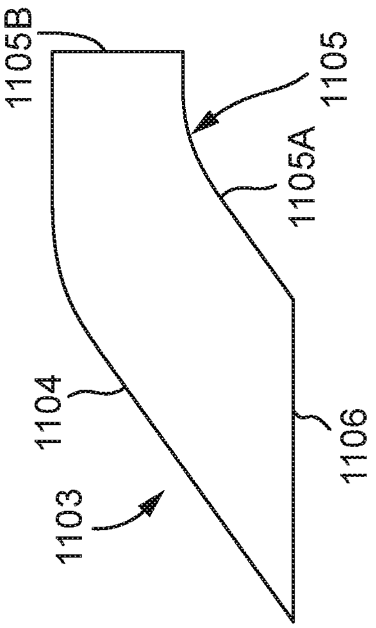


Fig. 4K



INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2014/050310

A. CLASSIFICATION OF SUBJECT MATTER
INV. E02B3/06 E02B3/02
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)
E02B

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 3 892 075 A (TIBBETT MICHAEL EDWARD) 1 July 1975 (1975-07-01) column 3, line 38 - line 53; figures 3-5 column 2, line 26 - line 61; figures 1-2 column 4, line 2 - line 11 -----	1-8
X	US 4 560 304 A (JENKINS SCOTT A [US] ET AL) 24 December 1985 (1985-12-24) column 3, line 51 - line 67; figures 1,2, 8 column 8, line 29 - line 39; figure 6 column 9, line 14 - line 33; figure 10 -----	1-8
A	US 7 242 107 B1 (DEMPSTER HARRY EDWARD [US]) 10 July 2007 (2007-07-10) column 15, line 11 - line 46; figures 10-11 ----- -/--	1-8

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"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

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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
31 July 2014	11/08/2014

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	Lieber, Gabor

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INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2014/050310

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	GB 877 057 A (CHRISTIANI & NIELSEN AS) 13 September 1961 (1961-09-13) page 5, line 74 - page 6, line 8; figures 17-24 -----	1-8

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/NL2014/050310

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