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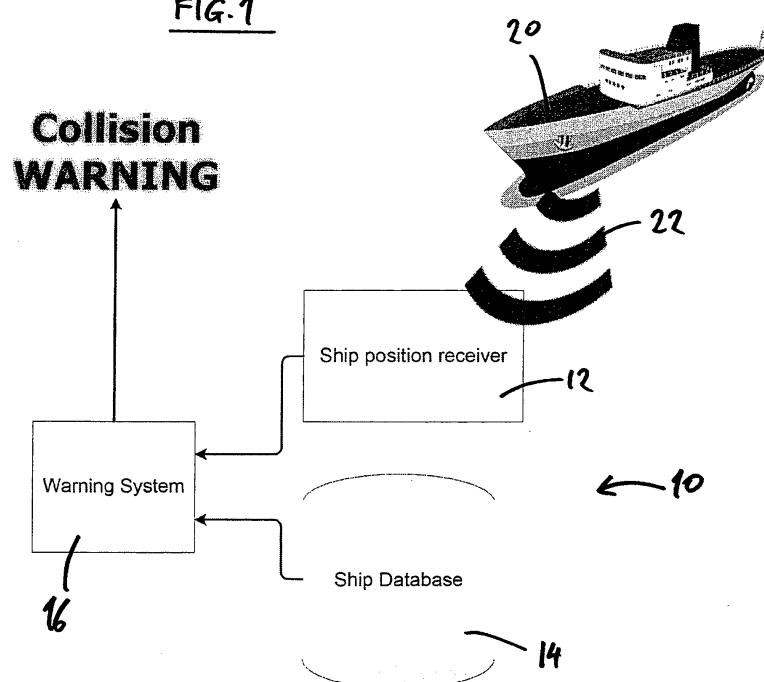
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(54) **Apparatus and method for warning aircraft**

(57) Apparatus (10) for warning an aircraft comprises a warning system (16), storage means (14) storing a database of ship identities and corresponding height data, and a ship position receiver (12). An Automatic Identification System (AIS) signal (22) emitted from a ship (20) carries information corresponding to the identity and the position of the ship. If the ship lies on, or within a pre-determined vicinity of, the horizontal trajectory of the aircraft, the warning system uses the ship's identity derived

from the AIS signal to look up the height of the ship in the database. If the altitude of the aircraft does not exceed the height of the ship by more than a pre-determined value, the warning system generates a warning signal. The apparatus allows a commercial AIS signal to be used to warn an aircraft of a ship, but avoids false alarms in the event that the altitude of the aircraft significantly exceeds the height of the ship.

FIG. 1



Description

[0001] The invention relates generally to apparatus for, and methods of, warning aircraft of obstacles.

[0002] It is known that tall objects having fixed positions on the earth's surface, such as wind turbines, present a serious danger to aircraft. It is known to provide an aircraft with a warning system which includes a database of the positions and heights of such objects so that a pilot may avoid them.

[0003] A similar problem arises with movable objects on the earth's surface. In particular tall ships can be a danger to aircraft, particularly in regions where there is significant offshore industry, such as oil and gas industry. Ships involved in industrial activity can have height dimensions which present danger to aircraft, due to the presence of cranes and other tall structures (such as parts of oil rigs) carried on such ships. Collisions between ships can be avoided, or least reduced, by use of commercial Automatic Identification Systems (AISs). A ship carrying an AIS transponder emits a signal on a dedicated VHF channel, the signal containing information corresponding to the ship's position, speed, direction and identity. The AIS transponder also receives such signals from other ships. Trajectories of ships can therefore be compared and suitable action taken to avoid collisions. It is also known for aircraft to receive AIS information from ships in order to prevent collisions between ships and aircraft. However, because commercial AIS signals contain no information about the height of a ship, comparing the trajectories of aircraft with those of ships using AIS information leads to a high false alarm rate because many ships will not have a height dimension that results in a danger to aircraft. It is also possible for very tall and movable objects on land to pose a danger to aircraft; currently no system exists to warn aircraft of such objects.

[0004] A first aspect of the present invention provides apparatus for warning an aircraft of an obstacle on the earth's surface, the apparatus comprising a warning system arranged to:

(i) receive first information corresponding to the obstacle's identity and the obstacle's position and second information corresponding to the aircraft's horizontal and vertical position as a function of time; and

(ii) calculate an aircraft trajectory for the aircraft using the second information; characterised in that

(iii) the apparatus further comprises storage means storing a database of obstacle identities and corresponding height data;

(iv) the warning system is arranged to retrieve a height dimension of the obstacle from the database using the obstacle's identity as derived from the first information, and

(v) the warning system is arranged to generate a warning signal if the obstacle lies on or within a pre-determined vicinity of the aircraft's horizontal trajectory and the difference between the height dimension of the obstacle and the altitude of the aircraft at the obstacle position of the aircraft trajectory is less than a pre-determined value.

[0005] The invention provides the advantage that an obstacle may be assessed as a potential danger to aircraft using only information corresponding to the obstacle's position and identity; reception of information corresponding to the obstacle's height is not necessary since the obstacle's height is obtained from a database using the obstacle's identity. Since a warning signal is generated only if the aircraft's altitude is comparable to the obstacle's height, and not simply if the obstacle lies on the aircraft horizontal trajectory, the incidence of false alarms is reduced compared to prior art methods which only utilise the obstacle's position in order to decide whether the obstacle presents a danger to aircraft.

[0006] Preferably, the warning system is arranged to receive third information corresponding to the obstacle's speed and direction and to use the first and third information and the aircraft's horizontal trajectory to calculate whether the aircraft and the obstacle will coincide in horizontal position at a coincidence point, and to generate a warning signal if the aircraft and obstacle are calculated so to coincide and the difference between the height dimension of the obstacle and the altitude of the aircraft at the coincidence point is less than a pre-determined value. This provides for additional assessment of the obstacle as a danger to aircraft by assessing whether it will coincide with the aircraft in horizontal position.

[0007] The warning system is preferably arranged to derive the first information, or as the case may be, the first and third information, from an Automatic Identification System (AIS) signal. AISs are commercially available and are used on ships to provide position, direction, speed and identity information primarily to other ships, but also to aircraft. In accordance with the invention, a commercial AIS signal may be used without modification to warn aircraft of ships that may present danger due to their heights, without a high rate of false alarms, even though an AIS signal does not include any information about the height of ship.

[0008] The apparatus may comprise a position receiver arranged to receive AIS signals and to pass the AIS signals to the warning system.

[0009] Conveniently, the storage means is comprised within the warning system.

[0010] A second aspect of the invention provides a method of warning an aircraft of an obstacle on the earth's surface, the method comprising the steps of:

(i) receiving first information corresponding to the obstacle's identity and the obstacle's position and second information corresponding to the aircraft's hori-

zontal and vertical position as a function of time; and

(ii) calculating an aircraft trajectory for the aircraft using the second information; characterised in that the method further comprises the steps of:

(iii) retrieving a height dimension of the obstacle from a database of obstacle identities and corresponding height data using the obstacle's identity as derived from the first information; and

(iv) generating a warning signal if the obstacle lies on or within a pre-determined vicinity of the aircraft's horizontal trajectory and the difference between the height dimension of the obstacle and the altitude of the aircraft at the obstacle position of the aircraft trajectory is less than a pre-determined value.

[0011] Preferably the method further comprises the steps of receiving third information corresponding to the obstacle's speed and direction, and using the first and third information and the aircraft's horizontal trajectory to calculate whether the aircraft and the obstacle will coincide at a horizontal position at a coincidence point, and generating a warning signal if the aircraft and obstacle are calculated so to coincide at the coincidence point and the difference between the height dimension of the obstacle and the altitude of the aircraft at the coincidence point is less than a pre-determined value.

[0012] The first information, or as the case may be the first and third information, may be conveniently derived from an AIS signal.

[0013] Embodiments of the invention are described below by way of example only and with reference to the accompanying drawings in which:

Figure 1 shows a block diagram of an apparatus of the invention;
 Figure 2 illustrates generation of a warning signal based on the position and height of a ship; and
 Figures 3 & 4 illustrate generation of a warning signal based on the trajectory and height of a ship.

[0014] Figure 1 shows an apparatus of the invention indicated generally by 10 and comprising a ship position receiver 12, storage means 14 storing a database of ship identities and corresponding height data, and a warning system 16. The warning system 16 is a standard commercial collision warning system, for example a Helicopter Terrain Avoidance and Warning System (HTAWS). In Figure 1, a ship 20 comprises a commercial Automatic Identification System (AIS) transponder (not shown), which emits an AIS signal 22 on a dedicated channel such as a VHF channel. The AIS signal 22 comprises information regarding the position, speed, direction and

identity of the ship 22. The apparatus 10 is carried on an aircraft (not shown). The ship position receiver 12 receives the AIS signal 22 and passes a corresponding signal to the warning system 10. The warning system 16 also receives information corresponding to the altitude of the aircraft, and its horizontal position (e.g. latitude and longitude) as a function of time.

[0015] Referring to Figure 2, an aircraft 50 fitted with the apparatus 10 of Figure 1 and having a horizontal trajectory 52 receives a respective AIS signal from each of ships 54, 56. The ship 54 does not lie on the horizontal trajectory 52 and therefore no warning signal is generated in respect of the ships 54. However the ship 56 does lie on the horizontal trajectory 52. In this case the warning system uses the identity of the ship 56 obtained from the AIS signal to look up the height dimension of the ship 56 using the database held in the storage means 14. The height dimension of the ship 56 is then compared to the altitude of the aircraft 50 and a warning is generated if the altitude of the aircraft 50 does not exceed the height dimension of the ship 56 by more than a pre-determined value.

[0016] Figures 3 and 4 illustrate how a warning may be generated based on the trajectory of a ship in addition to its height. An aircraft 60 fitted with the apparatus 10 has a horizontal trajectory 62 and receives respective AIS signals from ships 64, 66. In this case the warning system 16 of the apparatus is arranged to assess the trajectories of the ships 64, 66 using the respective AIS signal of each ship, and to compare the trajectories to the horizontal trajectory 62 of the aircraft 60. The warning system 10 is arranged to establish whether the horizontal trajectory 62 of the aircraft 60 intersects the trajectory of either ship 64, 66, and whether the aircraft 60 will intercept either ship 64, 66 based on their speeds and the speed of the aircraft 60.

[0017] The trajectory and speed of ship 64 are such that the ship 64 and aircraft 60 will coincide. The warning system 16 of the apparatus 10 therefore generates a warning signal provided the altitude of the aircraft 60 does not exceed the height of the ship 64 by more than a pre-determined value. In such a case the aircraft 60 may make an avoiding manoeuvre 63 to avoid collision with the ship 64.

[0018] Although the trajectory of the ship 66 intersects the aircraft horizontal trajectory 62, the aircraft 60 and ship 66 will not coincide at a particular horizontal position (e.g. a particular latitude and longitude) and therefore no warning signal is generated in relation to the ship 66.

Claims

1. Apparatus (10) for warning an aircraft of an obstacle on the earth's surface, the apparatus comprising a warning system (16) arranged to:

(i) receive first information corresponding to the

- obstacle's identity and the obstacle's position and second information corresponding to the aircraft's horizontal and vertical position as a function of time; and
- (ii) calculate an aircraft trajectory for the aircraft using the second information;
- characterised in that**
- (iii) the apparatus further comprises storage means (14) storing a database of obstacle identities and corresponding height data;
- (iv) the warning system is arranged to retrieve a height dimension of the obstacle from the database using the obstacle's identity as derived from the first information, and
- (v) the warning system is arranged to generate a warning signal if the obstacle lies on or within a pre-determined vicinity the aircraft's horizontal trajectory and the difference between the height dimension of the obstacle and the altitude of the aircraft at the obstacle position of the aircraft trajectory is less than a pre-determined value.
2. Apparatus according to claim 1 wherein the warning system is arranged to receive third information corresponding to the obstacle's speed and direction and wherein the warning system is arranged to use the first and third information and the aircraft's horizontal trajectory to calculate whether the aircraft and the obstacle will coincide in horizontal position at a coincidence point, and to generate a warning signal if the aircraft and obstacle are calculated so to coincide and the difference between the height dimension of the obstacle and the altitude of the aircraft at the coincidence point is less than a pre-determined value.
3. Apparatus according to claim 1 or claim 2 wherein the warning system is arranged to derive the first information, or as the case may be, the first information and the third information, from an Automatic Identification System (AIS) signal.
4. A system according to claim 3 wherein the apparatus comprises a position receiver arranged to receive AIS signals and to pass the AIS signals to the warning system.
5. A system according to any preceding claim wherein the storage means is comprised within the warning system.
6. A method of warning an aircraft of an obstacle on the earth's surface, the method comprising the steps of:
- (i) receiving first information corresponding to the obstacle's identity and the obstacle's position and second information corresponding to the aircraft's horizontal and vertical position as a function of time; and
- (ii) calculating an aircraft trajectory for the aircraft using the second information;
- characterised in that** the method further comprises the steps of:
- (iii) retrieving a height dimension of the obstacle from a database of obstacle identities and corresponding height data using the obstacle's identity as derived from the first information; and
- (iv) generating a warning signal if the obstacle lies on or within a pre-determined vicinity of the aircraft's horizontal trajectory and the difference between the height dimension of the obstacle and the altitude of the aircraft at the obstacle position of the aircraft trajectory is less than a pre-determined value.
7. A method according to claim 6 further comprising the steps of receiving third information corresponding to the obstacle's speed and direction, and using the first and third information and the aircraft's horizontal trajectory to calculate whether the aircraft and the obstacle will coincide in horizontal position at a coincidence point, and generating a warning signal if the aircraft and obstacle are calculated so to coincide at the coincidence point and the difference between the height dimension of the obstacle and the altitude of the aircraft at the coincidence point is less than a pre-determined value.
8. A method according to claim 6 or claim 7 comprising the step of deriving the first information, or as the case may be, the first information and the third information, from an Automatic Identification System (AIS) signal.

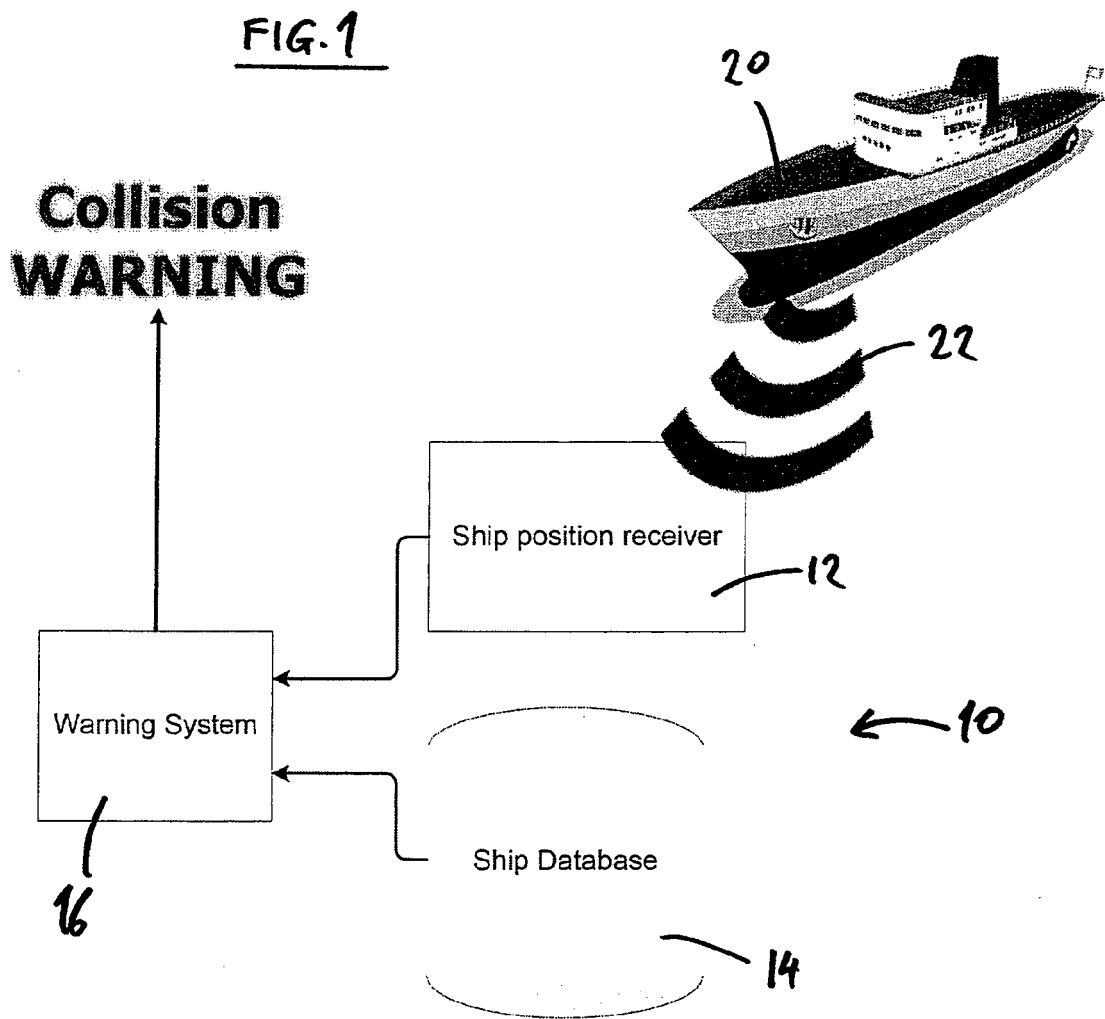


FIG. 2

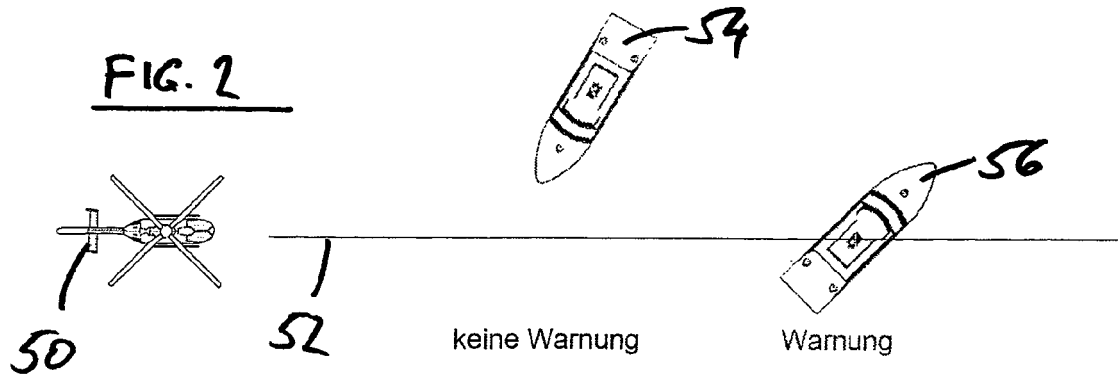


FIG. 3

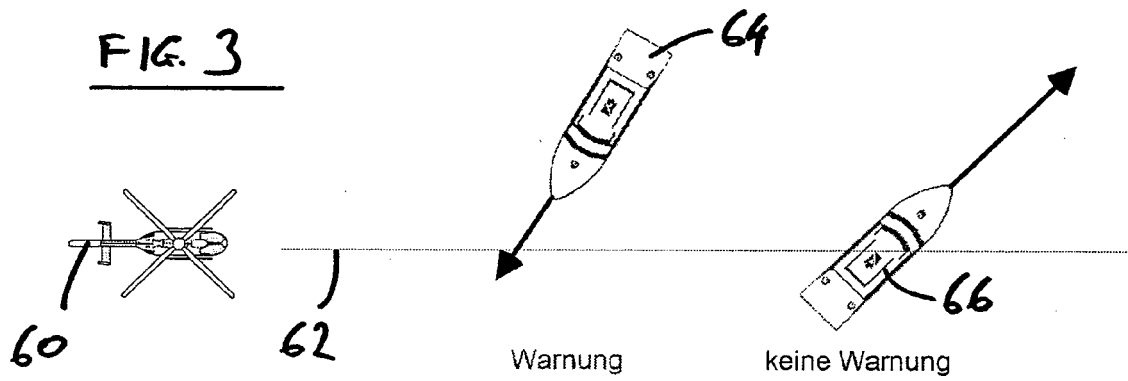
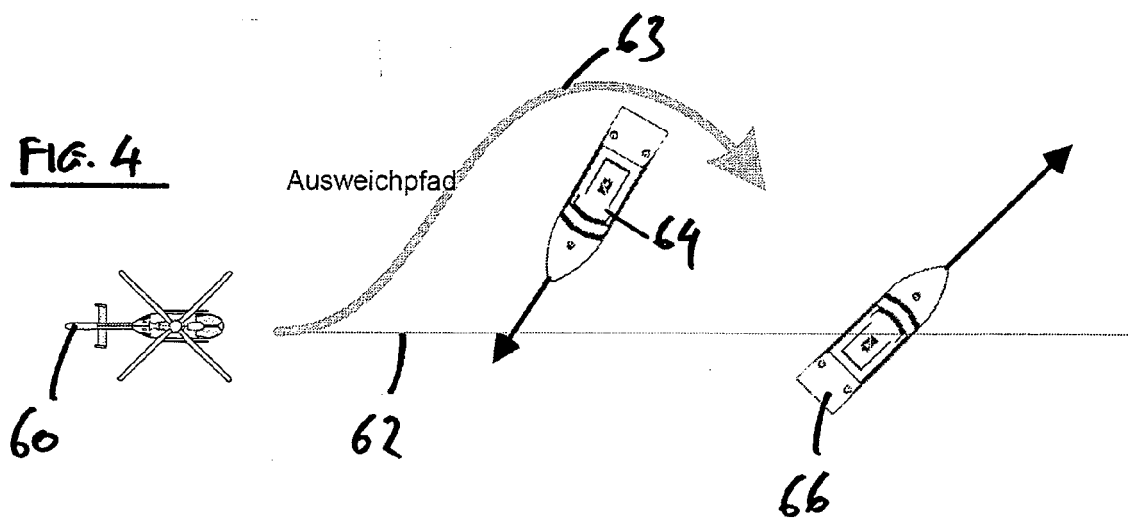


FIG. 4





EUROPEAN SEARCH REPORT

 Application Number
EP 14 00 1651

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2012/215436 A1 (FLOTTE LAURENT [FR] ET AL) 23 August 2012 (2012-08-23) * paragraphs [0011], [0022], [0023], [0027] - [0034] *	1-8	INV. G08G5/04 G08G5/00 G08G7/02 G08G3/02
Y	US 2013/096814 A1 (LOUIS XAVIER [FR] ET AL) 18 April 2013 (2013-04-18) * paragraphs [0014], [0115], [0116], [0119], [0126] - [0131], [0132], [0170], [0174] *	1-8	
A	EP 2 136 222 A1 (SAAB AB [SE]) 23 December 2009 (2009-12-23) * paragraph [0061] *	1-8	
A	WO 2014/067996 A1 (DEUTSCHES ZENTRUM FÜR LUFT UND RAUMFAHRT E V [DE]) 8 May 2014 (2014-05-08) * page 13, lines 9-10 * * page 10, lines 18-30; figure 1 *	1-8	
A	EP 2 648 174 A2 (HUGHEY & PHILLIPS LLC [US]) 9 October 2013 (2013-10-09) * paragraphs [0063] - [0094]; figures 10-16 *	1-8	TECHNICAL FIELDS SEARCHED (IPC) G08G
A	WO 2009/090185 A2 (WIPF HEINZ [CH]; SEITERLE ALFRED [CH]) 23 July 2009 (2009-07-23) * page 16, line 1 - page 17, line 24; figure 9 *	1-8	
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 3 September 2014	Examiner Pariset, Nadia
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 14 00 1651

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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03-09-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012215436 A1	23-08-2012	FR 2932279 A1	11-12-2009
		US 8249762 B1	21-08-2012
US 2013096814 A1	18-04-2013	FR 2917222 A1	12-12-2008
		US 2008306691 A1	11-12-2008
		US 2013096814 A1	18-04-2013
EP 2136222 A1	23-12-2009	EP 2136222 A1	23-12-2009
		EP 2506032 A1	03-10-2012
		ES 2400310 T3	09-04-2013
		US 2011163908 A1	07-07-2011
		US 2014070979 A1	13-03-2014
		WO 2009154547 A1	23-12-2009
WO 2014067996 A1	08-05-2014	DE 102012110384 A1	30-04-2014
		WO 2014067996 A1	08-05-2014
EP 2648174 A2	09-10-2013	CA 2788240 A1	28-02-2014
		EP 2648174 A2	09-10-2013
WO 2009090185 A2	23-07-2009	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82