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Application No.: 07 113 031.4

Patent No.: EP-B-1 850 151

Direct decision:

☐ **yes** ☒ **no**

Interlocutory decision in opposition proceedings (Art. 101(3)(a) and 106(2) EPC)

The Opposition Division - at the oral proceedings dated 10.09.2014 - has decided:

Account being taken of the amendments made by the patent proprietor during the opposition proceedings, the patent EP-B-1 850 151 and the invention to which it relates are found to meet the requirements of the Convention.

The currently valid documents are:

Auxiliary Request 1

Description, Pages

1, 2, 4-8	of the patent specification	
3a-3c	filed during Oral proceedings on	17-09-2014

Claims, Numbers

1-26	filed during Oral proceedings on	17-09-2014

Drawings, Sheets

1/3-3/3	of the patent specification

The Grounds for the decision (Form 2916) are enclosed.

09/10/2014
Date

Chairman	1st Examiner	2nd Examiner	Legally qualified member
de Jong, Frank	Vollmer, Thorsten	Meyer, Matthias	

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(12) EUROPEAN PATENT SPECIFICATION

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(54) Control system for positioning of marine seismic streamers

Steuerungssystem zur Positionierung mariner seismischer Streamer

Système de contrôle de la position des flûtes sismiques marines

(84) Designated Contracting States:
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(56) References cited:
WO-A1-97/30361
US-A- 4 890 568
US-A- 5 138 582
US-A- 5 532 975
US-A- 5 790 472

- **COURT I.: "Applications of Acoustics to Streamer/Source Positioning" SEG EXPANDED ABSTRACTS, 1 January 1989 (1989-01-01), pages 610-612, XP002480425**

EP 1 850 151 B1

Description

BACKGROUND OF THE INVENTION

[0001] This invention relates generally to systems for controlling seismic data acquisition equipment and particularly to a system for controlling a marine seismic streamer positioning device.

[0002] A marine seismic streamer is an elongate cable-like structure, typically up to several thousand meters long, which contains arrays of seismic sensors, known as hydrophones, and associated electronic equipment along its length, and which is used in marine seismic surveying. In order to perform a 3D marine seismic survey, a plurality of such streamers are towed at about 5 knots behind a seismic survey vessel, which also tows one or more seismic sources, typically air guns. Acoustic signals produced by the seismic sources are directed down through the water into the earth beneath, where they are reflected from the various strata. The reflected signals are received by the hydrophones, and then digitized and processed to build up a representation of the subsurface geology.

[0003] The horizontal positions of the streamers are typically controlled by a deflector, located at the front end or "head" of the streamer, and a tail buoy, located at the back end or "tail" of the streamer. These devices create tension forces on the streamer which constrain the movement of the streamer and cause it to assume a roughly linear shape. Cross currents and transient forces cause the streamer to bow and undulate, thereby introducing deviations into this desired linear shape.

[0004] The streamers are typically towed at a constant depth of approximately ten meters, in order to facilitate the removal of undesired "ghost" reflections from the surface of the water. To keep the streamers at this constant depth. control devices known as "birds", are typically attached at various points along each streamer between the deflector and the tail buoy, with the spacing between the birds generally varying between 200 and 400 meters. The birds have hydrodynamic deflecting surfaces, referred to as wings, that allow the position of the streamer to be controlled as it is towed through the water. When a bird is used for depth control purposes only, it is possible for the bird to regularly sense its depth using an integrated pressure sensor and for a local controller within the bird to adjust the wing angles to maintain the streamer near the desired depth using only a desired depth value received from a central control system.

[0005] While the majority of birds used thus far have only controlled the depth of the streamers, additional benefits can be obtained by using properly controlled horizontally steerable birds, particularly by using the types of horizontally and vertically steerable birds disclosed in our published PCT International Application No. WO 98/28636. The benefits that can be obtained by using properly controlled horizontally steerable birds can include reducing horizontal out-of-position conditions that necessitate reacquiring seismic data in a particular area (i.e. in-fill shooting), reducing the chance of tangling adjacent streamers, and reducing the time required to turn the seismic acquisition vessel when ending one pass and beginning another pass during a 3D seismic survey.

[0006] It is estimated that horizontal out-of-position conditions reduce the efficiency of current 3D seismic survey operations by between 5 and 10%, depending on weather and current conditions. While incidents of tangling adjacent streamers are relatively rare, when they do occur they invariably result in prolonged vessel downtime. The loss of efficiency associated with turning the seismic survey vessel will depend in large part on the seismic survey layout, but typical estimates range from 5 to 10%. Simulations have concluded that properly controlled horizontally steerable birds can be expected to reduce these types of costs by approximately 30%.

[0007] One system for controlling a horizontally steerable bird, as disclosed in UK Patent GB 2093610 B, is to utilize a manually-operated central control system to transmit the magnitudes and directions of any required wing angle changes to the birds. While this method greatly simplifies the circuitry needed within the bird itself, it is virtually impossible for this type of system to closely regulate the horizontal positions of the birds because it requires manual input and supervision. This becomes a particularly significant issue when a substantial number of streamers are deployed simultaneously and the number of birds that must be controlled goes up accordingly.

[0008] Another system for controlling a horizontally steerable bird is disclosed in our published PCT International Application No. WO 98/28636. Using this type of control system, the desired horizontal positions and the actual horizontal positions are received from a remote control system and are then used by a local control system within the birds to adjust the wing angles. The actual horizontal positions of the birds may be determined every 5 to 10 seconds and there may be a 5 second delay between the taking of measurements and the determination of actual streamer positions. While this type of system allows for more automatic adjustment of the bird wing angles, the delay period and the relatively long cycle time between position measurements prevents this type of control system from rapidly and efficiently controlling the horizontal position of the bird. A more deterministic system for controlling this type of streamer positioning device is therefore desired.

[0009] It is therefore an object of the present invention to provide for an improved method and apparatus for controlling a streamer positioning device.

[0010] An advantage of the present invention is that the position of the streamer may be better controlled, thereby reducing the need for in-fill shooting, reducing the chance of streamer tangling, and reducing the time needed to turn

the seismic survey vessel.

[0011] Another advantage of the present invention is that noise in marine seismic data associated with streamer position over-correction and streamer positioning errors can be significantly reduced.

SUMMARY OF THE INVENTION

[0012]
According to the invention, there is provided a method defined by claim 1 and an array of seismic streamers defined by claim 14.

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