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Patent
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF:
Oyvind Hillesund

SERIAL NO. 09/787,723

FILED: July 2, 2001

FOR: Control System for Positioning Marine Seismic Streamers

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§ EXAMINER: Sotelo, Jesus D.
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§ GROUP ART UNIT: 3617
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§ *Via Facsimile: 703.305.3597*

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Sir:

RESPONSE TO OFFICE ACTION DATED FEBRUARY 26, 2003

Applicant files this Response to the Office Action dated February 26, 2003, and having a three month shortened statutory period for response set to expire on May 26, 2003. Please enter the amendments and consider the remarks on the pages that follow.

IN THE CLAIMS:

Please amend the claims according to the following replacement claim set:

25. (Currently Amended) A method of controlling the positions of marine seismic streamers in an array of such streamers being towed by a seismic survey vessel, the streamers having respective streamer positioning devices disposed therealong and each streamer positioning device having a wing and a wing motor for changing the orientation of the wing so as to steer the streamer positioning device laterally, said method comprising the steps of:

obtaining a predicted position of the streamer positioning devices;

obtaining an estimated velocity of the streamer positioning devices;

for at least some of the streamer positioning devices, calculating desired changes in the orientation of their wings using said predicted position and said estimated velocity; and

actuating the wing motors to produce said desired changes in wing orientation.

26. (Original) A method as claimed in claim 25, wherein said estimated velocity is calculated using a vessel speed received from said seismic survey vessel's navigation system.

27. (Original) A method as claimed in claim 26, in which said estimated velocity is a water referenced towing velocity that compensates for the speed and heading of marine currents acting on said streamer positioning devices.

28. (Original) A method as claimed in claim 27, in which said estimated velocity is compensated for relative movement between said seismic survey vessel and said streamer positioning devices.

29. (Original) A method as claimed in claim 28, in which said step of calculating a desired change in wing orientation further uses an estimate of the crosscurrent velocity at the respective streamer positioning device.

30. (Original) A method as claimed in claim 29, in which said step of calculating a desired change in wing orientation is regulated to prevent the wing from stalling.

31. (Currently Amended) A method as claimed in claim 30, in which said step of calculating a desired change in wing orientation is regulated by a global control system located on or near said seismic survey vessel that ~~may be~~ is configured into a feather angle mode, wherein said global control system attempts to direct the streamer positioning devices to maintain each of said streamers in a straight line offset from the towing direction of said marine seismic vessel by a certain feather angle, and into a turn control mode, wherein said global control system directs said streamer positioning devices to generate a force in the opposite direction of ~~the~~ a turn at the beginning of the turn.

32. (Currently Amended) A method as claimed in claim 31, in which said global control system is ~~may~~ further ~~be~~ configured into a streamer separation mode, wherein said global control system attempts to direct said streamer positioning device to maintain a minimum separation distance between adjacent streamers.

33. (Original) A method as claimed in claim 32, further including the step of displaying the position of said streamer positioning devices on said seismic survey vessel.

34. (Original) A method as claimed in claim 33, in which each streamer positioning device is attached to and unable rotate with respect to its streamer and further comprising the step of monitoring twist in said marine seismic streamers and calculating a desired change in the orientation of the wings of the streamer positioning devices to reduce said twist.

35. (Original) A method as claimed in claim 34, further including the step of obtaining estimates of the respective current positions of at least some of said streamer positioning devices and the step of obtaining the desired positions of each of said at least some streamer positioning devices.

36. (Original) A method as claimed in claim 35, wherein the estimate of the current position of a streamer positioning device and the desired position of that same streamer positioning device are used to produce a desired force to be applied to its streamer by that streamer positioning device.

37. (Original) A method as claimed in claim 36, in which said desired force is projected onto the current force axis and the wing orientation is calculated that will produce said projected force at said estimated velocity.

38. (Original) A method as claimed in claim 37, in which the streamer positioning device is rotated to align the current force axis with said desired force and its wing orientation is changed as the current force axis becomes more closely aligned with said desired force.

39. (Currently Amended) Apparatus for controlling the positions of marine seismic streamers in an array of such streamers being towed by a seismic survey vessel, the streamers having respective streamer positioning devices disposed therealong and each streamer positioning device having a wing and a wing motor for changing the horizontal orientation of the wing so as to steer the streamer positioning device laterally, said apparatus comprising:

means for obtaining a predicted position of the streamer positioning devices;

means for obtaining an estimated velocity of the streamer positioning devices,

means for calculating desired changes in the orientations of the respective wings of at least some of the streamer positioning devices using said predicted position and said estimated velocity; and

means for actuating the wing motors to produce said desired changes in wing orientation.

40. (Original) Apparatus as claimed in claim 39, in which each streamer positioning device has a first wing and a second wing, said first wing and said second wing being independently moveable to steer the streamer positioning device laterally and vertically.

41. (Original) Apparatus as claimed in claim 40, wherein each streamer positioning device is rigidly attached to and unable to rotate with respect to its streamer.

42. (Original) Apparatus as claimed in claim 41, further including means for determining the angular velocity of each streamer positioning device.

43. (Original) Apparatus as claimed in claim 42, wherein a global control system is located on or near said seismic vessel and a respective local control system is located within or near each streamer positioning device and said global control system and said local control systems communicate using a respective communication line passing through each streamer.

44. (Currently Amended) Apparatus as claimed in claim 43, in which ~~program units~~ input values for said local control systems ~~may be~~ are downloaded over said communication lines.

45. (Original) Apparatus as claimed in claim 44, further including a respective backup communications channel in each streamer between the global control system and the local control systems of the streamer positioning devices of the streamer.

46. (Original) Apparatus as claimed in claim 45, in which each local control system has a cycle rate that is at least 10 times greater than the data transfer rate of said communication line.

47. (Original) Apparatus as claimed in claim 46, in which each local control system comprises a microprocessor programmed to monitor the current orientation of the wing of its streamer positioning device and to calculate desired changes to the orientation of said wing based on inputs from said global control system.

48. (Original) Apparatus as claimed in claim 47, further including means for producing a weight function filtered depth value.

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