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(71) Applicant: **Dredging International N.V.**

**2070 Zwijndrecht (BE)**

(72) Inventors:

- **Heude, Nick**  
**2070 Zwijndrecht (BE)**
- **Verboomen, Bart**  
**2070 Zwijndrecht (BE)**

(74) Representative: **Brants, Johan P.E. et al**

**De Clercq, Brants & Partners cv**  
**Edgard Gevaertdreef 10a**  
**9830 Sint-Martens-Latem (BE)**

(54) **Method of mining the sea bed**

(57) The present invention relates to a method of determining an efficient extraction of solid material from a seabed (12) by means of a vessel (1) equipped with a dredging unit (3) for removing a suspension of solid material from the seabed (12), which method comprises the steps i) measuring the rate at which solid material is ex-

tracted *i.e.* the throughput, and ii) determining an efficient extraction if the throughput is above a defined level. It also relates to a method for making a survey map, a device and computer program implementing the method.

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## Description

**[0001]** Aggregate products such as sand and gravel are commonly manufactured by mining the seabed. A vessel equipped with a dredging unit may be employed, which dredging unit may stir up the sea bed using an agitation means and bring the resulting slurry to the surface through a suction pipe. The solid material is then separated from the water which is returned to the sea. The dredged solid material is retained. Alternatively, the pumped suspension can be conveyed by pipeline to another location, and the desired product separated at the alternate location.

**[0002]** The solid material recovered by dredging is processed by extracting desirable components such as sand and gravel. Other components may also be extracted such as clay, larger particulates etc.

**[0003]** A problem with obtaining solid material from off-shore locations is expense of the operation. The increase in demand for construction materials has brought aggregate prices down to a minimum sustainable level. This has meant looking for ways to increase the viability of offshore mining. This may entail, for example, avoiding excessive seabed excavation and reaching the maximum payload for a vessel in the shortest time. The environmental impact of sea bed mining is also a concern, possibly affecting inner shelf flows, coastal erosion and retreat and fauna, flora and water quality in the area of mining.

**[0004]** It is the aim of the present to provide a method for extracting solid materials from the seabed, which is economical and less damaging to the environment.

## BRIEF DESCRIPTION OF THE FIGURES

**[0005]**

**Fig. 1.** Schematic representation of a vessel equipped with an underwater dredging unit.

**Fig. 2.** Block diagram of a marine integrated computer system.

**Fig. 3.** Display from the screen of an human-machine interface workstation implementing the present invention.

**Fig. 4.** Display from the screen of a survey computer implementing the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

**[0006]** The present invention relates to a method for mining the seabed by means of a shipping vessel equipped with dredging unit for removing material from the seabed, which method monitors the quantity of a suspension of solid material extracted from the seabed over a period of time *i.e.* the throughput. If the throughput monitored during extraction is above a threshold value, the extraction is considered efficient; below the threshold, it is deemed inefficient. An efficient extraction means the

extraction is economic and/or has low environmental impact. Thus, the suitable regions for extraction can be determined.

**[0007]** The method can be used to make a real-time assessment, thus, it can be determined during an extraction by a dredging vessel whether or not to continue in the same area, or to extract from another area. The threshold can be set to continue only with low-environmental impact or profitable extractions or both.

**[0008]** It can also be used to prepare an excavation map of an area, indicating suitable and unsuitable extraction regions. An area of seabed may be surveyed in a short period using the method in order to provide an overview of the best and poorest areas. After suitable planning, the dredging vessel may return to perform a full extraction of the most preferred seabed regions, planning the extraction timetable and route efficiently using the map prepared during the survey.

**[0009]** The method allows dredging to continue when sufficient loose material is available. Dense or deeply seated sand, requiring extensive extraction may be set to fall below the threshold, which would stop extraction. Thus, the seabed is somewhat preserved by refraining from deep excavation. The environmental impact of mining is limited by restricting extraction to areas of relatively loose material. These regions are not as established with sealife. Consequently, implementing the present method reduces environmental impact, while restricting excavation to loose material which is more economical to extract.

**[0010]** The present method monitors several parameters during extraction in order to automatically arrive at a throughput value. There is no need to make manual adjustments to take account of seabed height, contact with the sea, or position of the suction pipe, as these are automatically implemented in the method. Thus, a dredging vessel can actively pass across a sea bed, in a survey operation or in an extraction process, and indicate throughput, while conditions such as rough seas and variable seabed depth which might otherwise affect readings are accounted in the calculation.

### *Vessel and dredging unit*

**[0011]** The various embodiments of the present invention are made with reference to **Fig. 1**. The embodiments below and drawing are not at all intended to be limiting. The skilled person may adapt the present method and constituent components and features according to the common practices of the person skilled in the art. When mining the sea bed according to the present invention, use is made of a dredging unit **3** suspended from the vessel **1**, which moves across the sea bed **12** principally in concert with the movements of the vessel **1**. Solid material present on the seabed **12** is optionally stirred up, and a suspension thereof is sucked up and deposited for storage and/or processing in the vessel **1**. A pipe **2**, suspended from the vessel **1** couples the underwater dredging unit **3** to extraction pumps **13** located on the vessel

**1**, through which extracted material flows from the seabed **12**.

**[0012]** The dredging unit **3** is equipped with a suction head **4** for taking up loosened solid material and water *i.e.* the suspension. The material may be loose *per se*, or may become loose with the contact of the dredging unit **4** with seabed **12**, for example, by the dragging-effect of the unit across the seabed by the vessel. The dredging unit **4** may optionally be equipped with a means to agitate the seabed **12**, which means loosens solid material for subsequent take-up by the suction head **4**. The agitation means can be any suitable means, for example, water jets, rotating metal blades, compressed air, or metal scoops. To minimise environmental impact and to minimise wear and maintenance, water jets may be the most suitable agitation means.

**[0013]** The position of the dredging unit **3** may be adjustable independently of the position of the vessel to allow a fine control of the position of the unit. The independent movement can be achieved, for example, by the use of local (underwater) hydraulic joints or by propulsion means located in the underwater dredging unit **3**.

**[0014]** As already mentioned above, the dredging unit **3** is connected to the vessel **1** by means of a pipe **2**. The pipe **2**, and associated supply cables and/or piping **11**, can be the only principal means of attachment to the vessel **1**, necessitating requirements of strength and durability of the pipe **2** and joints. The pipe **2** can be flexible, in which case the pipe **2** is preferably suspended substantially horizontally from the vessel by means of cables **8, 9** which are unwound or wound from winches **5, 6** present on the vessel **1**. A pipe **2** having a comparative long length can be supported by a few spaced-apart cables **8, 9** by disposing the pipe **2** in the longitudinal direction of the vessel. When the vessel **1** has arrived at the desired location, the pipe **2** can be lowered by paying out cables **8, 9** by means of the winches **5, 6**. The position of the pipe underwater can be horizontal or at an incline to the sea surface as is indicated in Fig. 1.

#### *Swell compensation*

**[0015]** Underwater, the flexible pipe **2** is preferably suspended short of the seabed **12**, *e.g.* 1 to 3 m at the lowest point above the sea bed, while the dredging unit **3** is allowed to contact the seabed **12**. The cables **8, 9** connected to the pipe **2** are continually adjusted by a swell compensation device so that the weight of the pipe **2** is compensated by the pull-force in the cables **8, 9**. As the vessel rises and falls, the pipe **2** remains at essentially the same distance from the seabed **12** owing to the system. Such swell compensation systems are known in the art of dredging, and can be, for example, the DEICO system.

**[0016]** The dredging unit **3**, on the other hand, is allowed to contact the seabed **12**. Thus, a separate cable **10** may be connected to the dredging unit **3**, which allows contact of the dredging unit **3** with the seabed **12**. The

same swell compensation device can be implemented in the cable **10** attached to the dredging unit **3**, such device maintains the contact of the dredging unit **3** with the seabed **12**, and can indicate when the dredging unit **3** contacts the seabed **12** or not.

#### *Calculating throughput at one location*

**[0017]** The present invention determines the throughput achieved during extraction at a particular location by monitoring:

- i) the volume of the suspension of water and solid material obtained over a defined time *i.e.* the suspension speed, measured in volume per time unit (*e.g.* m<sup>3</sup>/h), and
- ii) the mass of solid material present the suspension *i.e.* suspension concentration, measured in mass per volume of suspension units (*e.g.* kg/m<sup>3</sup> or tonnes/m<sup>3</sup>).

**[0018]** The suspension speed (i) can be measured using in-line detectors present in the pump or tubing, giving a real-time indication. Alternatively, it may be determined by monitoring the change in level of suspension in on-board storage tanks and noting the time. The suspension concentration (ii) can be measured by also by use of inline detectors which calculate a proportion of solid matter to water in the flow through. Alternatively, it may be determined by monitoring the changing mass storage tanks as they fill, and comparing the mass with the mass expected for the same volume of sea water. Other techniques and devices for measuring (i) and (ii) are known in the art, and may be implemented in the present invention.

**[0019]** From (i) and (ii), the rate of extraction of solid material *i.e.* the throughput at a particular location is obtained. It can be measured, for example in kg/hour or tonnes/hour. From the throughput, it can be determined whether the material is sufficiently loose to warrant an economical / low environmental impact extraction, or whether another site should be chosen.

#### *Calculating throughput for a moving vessel*

**[0020]** When extraction is performed at the same time as the vessel **1** moves, the throughput calculation is distorted owing to periods of non-contact by the dredging unit **3** with the seabed **12**. Non-contact can arise, for example, due to pitching of the vessel **1**. The inventors have discovered that monitoring the swell compensation device associated with the cable **10** attached to the dredging unit **3**, gives an indication of contact with the seabed **12**. Rather than try to compensate for every episode of non-contact by paying out more cable, or introducing a linear correction factor, the inventors have found it is most efficient to set a threshold for implementing swell compensation for only larger changes in the depth of the seabed.

Thus, for minor variations in sea bed depth, the mixture concentration and mixture speed data are ignored for the periods when the dredging unit 3 is not engaged with the seabed 12.

[0021] Another embodiment of the present invention is a method as described herein, where mixture concentration and mixture speed data are ignored for the periods when the dredging unit 3 does not contact the seabed 12. Thus, the calculation of throughput may be derived from intermittently collected data. The state of contact of the dredging unit 3 with the seabed 12 can be determined from the swell compensation device e.g. the DEICO system.

#### *Preparation of a survey map*

[0022] The throughput data can advantageously be indicated on a survey map of a region. The survey map allows an operator to most efficiently mine the seabed using a planned route, and also estimate time it would take to obtain the payload limit. Where the survey site is large, and regions of suitable material are located in separate, discrete areas, such map can indicate the viability of a complete or targeted extraction.

[0023] As the throughput is measured, the position of the vessel is known using a satellite navigation system such as, for example, global positioning satellite system (GPS), Galileo, Beidou etc. Such navigation system is routinely present on shipping vessels. However, given the position of the dredging unit 3 can be significantly displaced from the satellite receiver on the vessel 1, a correction to the co-ordinate of the vessel 1 is applied in the present invention, to yield more precise co-ordinates of the dredging unit 3.

[0024] The displacement of the dredging unit 3 from the satellite receiver can be derived by any known technique. For example, signal from a radio beacon placed on the dredging unit 3 may be detected by two or more receivers on the vessel, and the location of the unit calculated by triangulation. Alternatively, the length of cable and the angle of inclination gives the displacement of the dredging unit 3 by simple geometry.

[0025] Thus, using valid throughput data and with knowledge of the position of the dredging unit, a survey map of a region indicating suitable regions for extraction can be calculated.

[0026] The map can be represented in any suitable form. For example, as a series of throughput contours, as a coloured 'heat' map, as a relief map etc. The throughput values may be converted into particle density, and displayed so. The map may display regions above a certain threshold in one colour (e.g. green), and below such threshold in an alternate indication (e.g. red). Further indicated may be depth of the sea bed, relief features of the sea bed, water currents, wind speeds, atmospheric pressured, or adapted as required.

[0027] The method described herein allows determination of the most efficient areas for mining, and can be

implemented economically using systems and technologies which already exist on most vessels.

[0028] The method can be incorporated into a device which is configured to carry out the steps of the method. Such device receives information allowing a calculation of throughput.

#### *Implementing the invention in a dredging vessel*

[0029] A dredging vessel typically comprises a marine integrated computer system which receives information from a variety of ship sensors such as the satellite navigation system and dredging sensors; it presents pertinent information to one or more operators, and can accept commands for controlling devices which as steering, engine speed or other aspects of interest. The system comprises several components as indicated in Figure 2, including:

[0030] Integrated I/O-systems: This is an array of computers 21 disposed with input/output (I/O) modules which communicate with a plurality of hardware devices. It may receive input sensor data from, for example, a satellite navigation system, fathometer, gyrocompass, velocity profiler, temperature sensor, dredging unit etc. It may provide output data to control the steering, engine speed, suction pipe depth etc.

[0031] Human-Machine Interface (HMI) Workstations: These are work stations or terminals 23 which can display I/O information, for example, as a processed graphical or numerical representations. This can inform an operator about the status of the vessel such as sailing course, vessel speed, wind speed, sea depth, depth of dredging unit etc. The HMI workstations also allow the operator to provide commands, which are passed via the integrated I/O systems to the relevant device. Thus, a command to steer the ship can be received by an HMI workstation 23, which command is passed 22 to an integrated I/O system 21 for remote control of, for example, a rudder.

[0032] Survey computer: This is a computer 24 which displays geographical information, for example, a map indicating the position and direction of the vessel to the dredge master and steer officer, ensuring the course of the vessel is correct. It may also indicate zones suitable for dredging determined, for instance, by satellite imagery. It may also be capable of receiving information 25 from the integrated I/O systems such as satellite navigation data. A common version of a survey computer is a Dredge Track Presentation System (DTPS).

[0033] On board a dredging vessel, the present invention may be implemented into the HMI workstation 23 and/or into the survey computer 24. Alternatively, it can be implemented on any computer capable of receiving data from the relevant sensors.

55 - Implementation into an HMI workstation

[0034] The program typically used in marine HMI workstations (e.g. SCADA) allows the operator to change the

configuration of the display and input choices for a particular task. Thus, by a simple extension to the program, data from sensors pertinent to the present invention *i.e.* those which measure the suspension speed, suspension concentration, swell compensation, and optionally location of the vessel can be processed and displayed by an existing HMI workstation. An example of a display from HMI workstation implementing the present invention as an extension is given in Figure 3. Such displayed data can allow an operator to monitor the dredging process, which can be controlled. Therefrom, the operator can determine an economical dredging operation.

- Implementation into a survey computer

**[0035]** The standard survey visualisation program which is used by the dredge crew can be modified to process sensor data, and display information obtained by the present invention. The survey computer indicates the route and course of the vessel, providing additional information such as depth and differential height data as an overlay.

**[0036]** The survey computer may be connected to the integrated I/O-systems, thus data from sensors pertinent to the present invention *i.e.* those which measure the suspension speed, suspension concentration, swell compensation, and location of the vessel can be processed and displayed by the survey computer. According one aspect of the present invention, an extra visualisation layer may be added which indicates suitable regions for extraction based on the calculation of throughput from the I/O data. The throughput information may be provided in graded colours *e.g.* from green (best) to red (worst) overlaid on the map. The data can be that obtained from an earlier survey, or from a survey in progress.

**[0037]** For a survey in progress, an overlay may indicate blue for a throughput of, for example, 1000 tonnes/h which is updated with another colour when the throughput changes. The number of colours can be user defined (*e.g.* just two colours, a pallet of colours, or a smooth gradient of colours). Where a vessel has one dredging unit, one track can be indicated; more than one dredging unit can be reflected by displaying throughput of each unit separately. An example of a survey chart is provided in Figure 4.

**[0038]** It is within the scope of the invention to provide other software modules which can interface with HMI workstation and /or survey computer. These modules might be present in the HMI workstation, in the integrated I/O systems or in the survey computer. The use of modules permits faster and/or more complex processing, and may allow smooth communication between the various hardware and software elements making up the systems.

**[0039]** While the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications, and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace

all such alternatives, modifications, and variations in the spirit and scope of the appended claims.

## SUMMARY OF SOME EMBODIMENTS OF THE INVENTION

**[0040]** One embodiment of the present invention is a method of determining an efficient extraction of solid material from a seabed (12) by means of a vessel (1) equipped with a dredging unit (3) for removing a suspension of solid material from the seabed (12), which method comprises the steps:

- i) measuring the rate at which solid material is extracted *i.e.* the throughput, and
- ii) determining an efficient extraction if the throughput is above a defined level.

**[0041]** Another embodiment of the present invention is a method as described above, wherein the throughput is determined by measuring a speed and concentration of extracted suspension passing through a suction pipe (2) connecting the dredging unit (3) to the vessel (1), in order to arrive at the throughput.

**[0042]** Another embodiment of the present invention is a method as described above, wherein the suspension speed and suspension concentration data are excluded from determining throughput for periods when the dredging unit (3) does not contact the seabed (12).

**[0043]** Another embodiment of the present invention is a method as described above, wherein the dredging unit (3) is suspended from the vessel (1) by a cable coupled to a swell compensation system and the contact of the dredging unit (3) with the seabed (12) is determined from said swell compensation system.

**[0044]** Another embodiment of the present invention is a method for creating a survey map of a seabed (12) indicating efficient areas for extraction of solid material comprising the steps of performing the method of claim 1, while identifying the location of the dredging unit (3).

**[0045]** Another embodiment of the present invention is a method for creating a survey map as described above, wherein the location of the dredging unit (3) is identified by applying an offset to the location of the vessel (1) as determined by a satellite navigation system.

**[0046]** Another embodiment of the present invention is a survey map of a seabed (12) indicating efficient areas for extraction of solid material obtained using a method for creating a survey map as described above.

**[0047]** Another embodiment of the present invention is a device configured to perform a method according to any of the methods described above.

**[0048]** Another embodiment of the present invention is a computer program stored on a computer readable storage device capable of performing any of the methods described above.

**[0049]** Another embodiment of the present invention is a marine human-machine interface workstation (23)

configured to perform any of the methods described above.

**[0050]** Another embodiment of the present invention is a marine survey computer (24) configured to perform any of the methods described above.

according to any of claims 1 to 6.

**10.** A marine human-machine interface workstation (23) configured to perform a method according to any of claims 1 to 6.

**11.** A marine survey computer (24) configured to perform a method according to any of claims 1 to 6.

## Claims

1. Method of determining an efficient extraction of solid material from a seabed (12) by means of a vessel (1) equipped with a dredging unit (3) for removing a suspension of solid material from the seabed (12), which method comprises the steps:
  - i) measuring the rate at which solid material is extracted *i.e.* the throughput, and
  - ii) determining an efficient extraction if the throughput is above a defined level.
2. Method according to claim 1 wherein the throughput is determined by measuring a speed and concentration of extracted suspension passing through a suction pipe (2) connecting the dredging unit (3) to the vessel (1), in order to arrive at the throughput.
3. Method according to claim 1 or 2, wherein the suspension speed and suspension concentration data are excluded from determining throughput for periods when the dredging unit (3) does not contact the seabed (12).
4. Method according to claim 3, wherein the dredging unit (3) is suspended from the vessel (1) by a cable coupled to a swell compensation system and the contact of the dredging unit (3) with the seabed (12) is determined from said swell compensation system.
5. Method for creating a survey map of a seabed (12) indicating efficient areas for extraction of solid material comprising the steps of performing the method of claim 1, while identifying the location of the dredging unit (3).
6. Method according to claim 5 wherein the location of the dredging unit (3) is identified by applying an offset to the location of the vessel (1) as determined by a satellite navigation system.
7. A survey map of a seabed (12) indicating efficient areas for extraction of solid material obtained using a method of claims 5 or 6.
8. A device configured to perform a method according to any of claims 1 to 6.
9. Computer program stored on a computer readable storage device capable of performing a method ac-

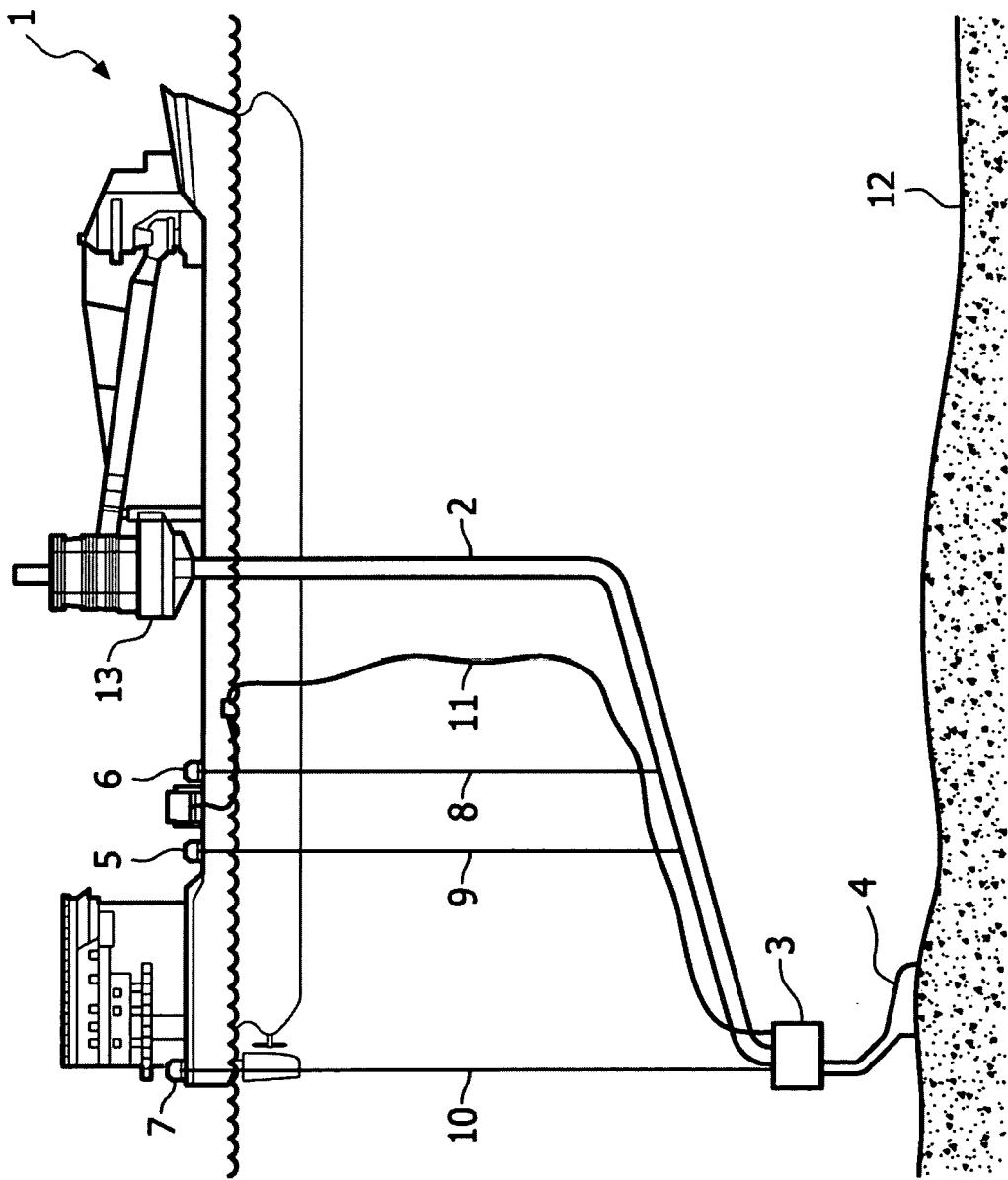


FIG. 1

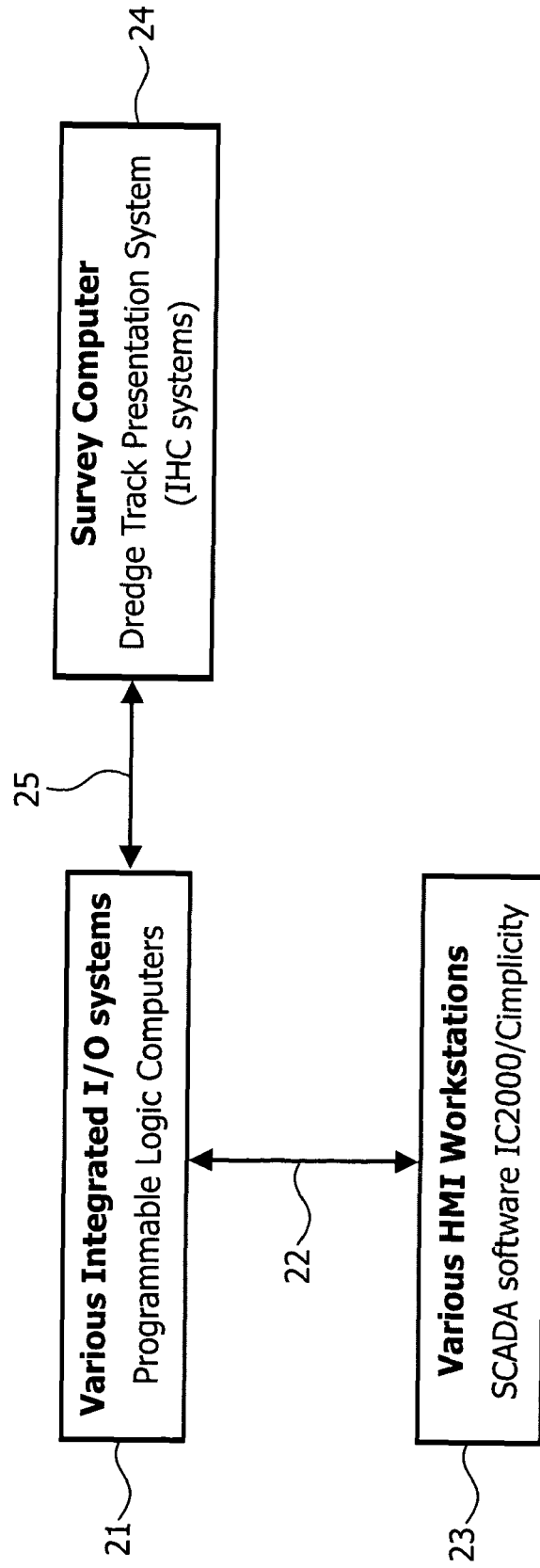


FIG. 2



## DENSITY CHART CONTROL

### Ship configuration

|                                    |                         |
|------------------------------------|-------------------------|
| Ship name                          | Uilenspiegel            |
| Distance draghead to density meter | ► 50 m                  |
| Reference density if not dredging  | ► 1.021t/m <sup>3</sup> |
| Dredge status from diagnostic PLC  | ■                       |
| Communication interval             | ► 5 sec                 |

### Targets & Filters

| Parameter name             | Filter   | Measuring              | Filtered               | Target                  | Active |
|----------------------------|----------|------------------------|------------------------|-------------------------|--------|
| Density measurement        | ► 36 sec | 1.756 t/m <sup>3</sup> | 1.756 t/m <sup>3</sup> | ► 1.600t/m <sup>3</sup> | ■      |
| Velocity measurement       | ► 34 sec | 1.2 m/sec              | 1.2 m/sec              | ► 0.3 m/s               | ■      |
| Draghead depth             | ► 15 sec | 90.0 m                 | 90.0 m                 | ► 80.0 m                | ■      |
| Swell compensator position | ► 30 sec | 0.30 m                 | 0.30 m                 | ► 0.20 m                | ■      |

### DCC Diagnostic

| Parameter name            | Status | Force                    |
|---------------------------|--------|--------------------------|
| Production parameters age | 9 sec  | ► 23 sec                 |
| Draghead on the ground    | ■      | Draghead on the ground   |
|                           |        | Draghead from the ground |
| Dredge status             | 6      | Dredging active          |
| DCC enabled               | ■      | Rho enabled              |
| DCC serial output active  | ■      | DCC output               |

FIG. 3

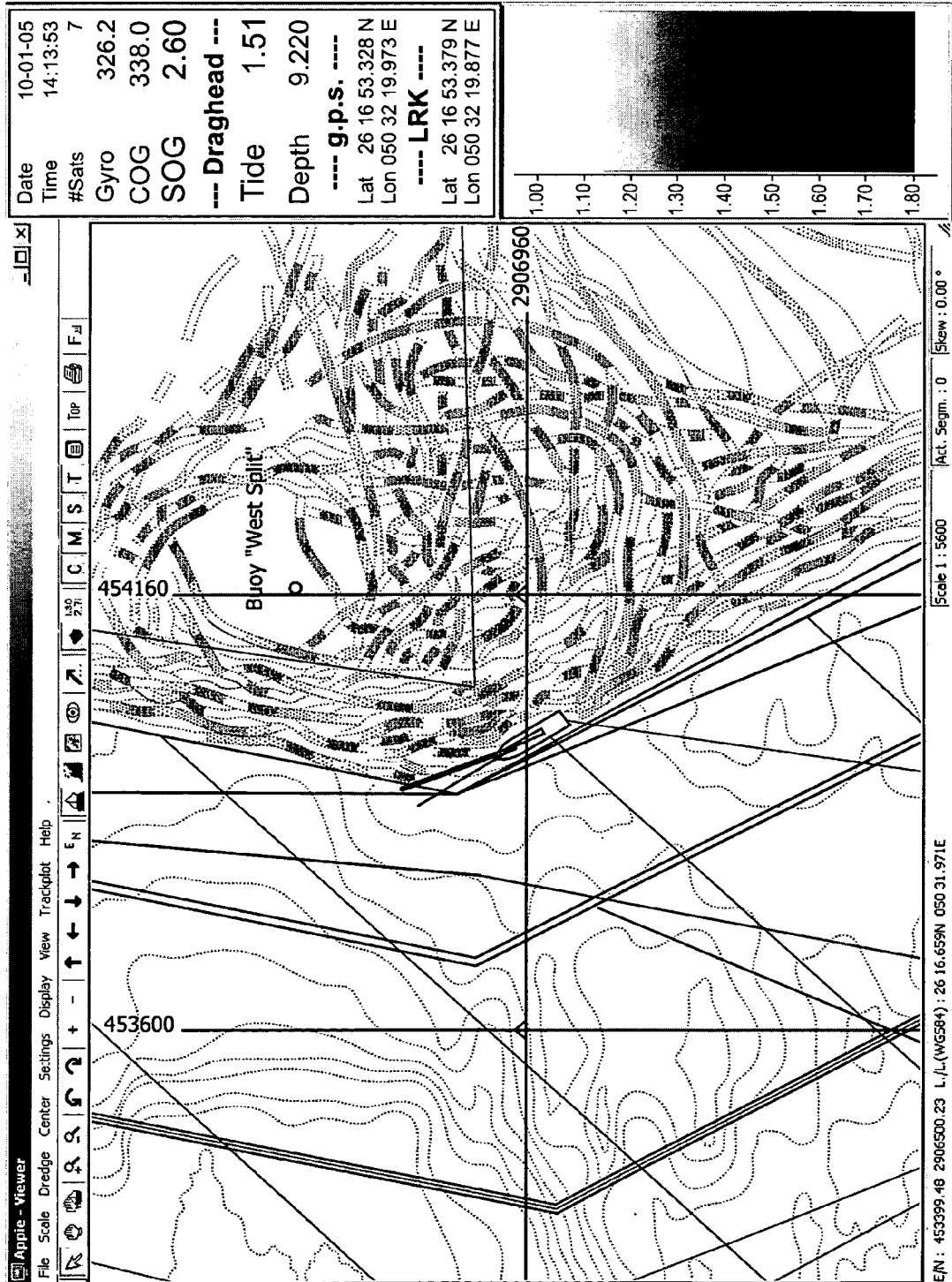


FIG. 4



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 06 44 7012

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                   |                                                  |                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Citation of document with indication, where appropriate, of relevant passages                                                                                                     | Relevant to claim                                | CLASSIFICATION OF THE APPLICATION (IPC) |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | PATENT ABSTRACTS OF JAPAN<br>vol. 1998, no. 11,<br>30 September 1998 (1998-09-30)<br>& JP 10 159125 A (HONMAGUMI:KK; KITSUTAKA KOGAKU KENKYUSHO:KK),<br>16 June 1998 (1998-06-16) | 1-3,5-11                                         | INV.<br>E21C45/00<br>E02F9/06           |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | * abstract *                                                                                                                                                                      | 4                                                |                                         |
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| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | * abstract *                                                                                                                                                                      | 4                                                |                                         |
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| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | * abstract *                                                                                                                                                                      | 4                                                | TECHNICAL FIELDS<br>SEARCHED (IPC)      |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | PATENT ABSTRACTS OF JAPAN<br>vol. 2000, no. 04,<br>31 August 2000 (2000-08-31)<br>& JP 2000 017684 A (ISHIKAWAJIMA HARIMA HEAVY IND CO LTD),<br>18 January 2000 (2000-01-18)      | 1-3,7-11                                         | E21C<br>E02F                            |
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| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 3 512 281 A (ACHILLES HADJIDAKIS)<br>19 May 1970 (1970-05-19)<br>* claims 1-5; figures 1-4 *                                                                                   | 4                                                |                                         |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                   |                                                  |                                         |
| Place of search<br>Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                   | Date of completion of the search<br>27 July 2006 | Examiner<br>Tompoulglou, C              |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                                                                   |                                                  |                                         |

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EPO FORM 1503 03.82 (P04C01)

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

EP 06 44 7012

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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27-07-2006

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