The above mentioned features of the invention, as well as others, will appear more clearly from the following description of an embodiment, the description being made in conjunction with the accompanying drawings, wherein:

FIG. **1** is a perspective schematic view of an apparatus according to the invention, comprising a buoy,

FIG. **2** is a geometrical diagram illustrating the operation of the measuring apparatus,

FIG. **3** is a graph illustrating one aspect of the operation of the measuring apparatus, and

FIGS. **4***a*–**4***g* are a flow diagram which illustrates the operation of the processor of the measuring apparatus.

Referring FIG. **1**, the measuring apparatus comprises a buoy **1** that is essentially comprised of a floating disc **2** supporting a mast **3** oriented along the disc revolution axis. On the disc **2**, are mounted three orthogonal accelerometers G1, G2 and G3, and three magnetometers B1, B2 and B3. The accelerometer G3 and the magnetometer B3 are oriented along axis Oz of the mast **3**. The accelorometer G1 and the magnetometer B1 are oriented in the same direction Ox, and the accelerometer G2 and the magnetometer B2 are oriented in the same direction Oy. The directions Ox and Oy are in the plane of the disc **2** and also are perpendicular to each other. Also, the measuring apparatus comprises an electronic cabinet **4** which contains the power supplies for operating the accelorometers and the magnetometers. The recorded signals are processed in a digital processor which may be located within the cabinet or remotely located. Last, the apparatus comprises a data transmitter **5** connected to an aerial **6** mounted at the top of the mast **2**. When the data processor is mounted within the cabinet **4**, the data transmitted from **5** are those delivered from the processor. When the processor is remote located, the data to be transmitted are delivered from the individual recording circuits.

Since the accelerometers G1, G2, G3 are fixed to the buoy, the values they supply are related to the rectangular-coordinate system Ox, Oy, Oz, FIG. **2**, which is inherently a mobile reference system. The measurements related to the mobile reference system Ox, Oy, Oz are converted into measurements related to an absolute reference rectangular-coordinate system OX, OY, OZ, FIG. **2**, wherein axis OZ is coincident with the vertical line at the anchoring spot of the buoy. To make this conversion an auxiliary reference is used, which is the magnetic field vector $\vec{B}$ assumed to be defined at the anchoring spot, such a vector being measured by the magnetometers B1, B2, B3 fixed in the mobile reference system Ox, Oy, Oz.

In the buoy **1**, shown in FIG. **1**, the mass of the floating disc **2** is preponderant with respect to the sum of the masses of the other components of the buoy. The buoy follows the profile of the free surface of the sea; such a fact is taken into account as will appear in the following specification.

As it is to be expected, it will be assumed that the acceleration of the free surface of the water, and thus of the center O of the buoy, is always in the vertical plane containing the direction of the line having the greatest slope at the free surface.

In the geometrical diagram shown in FIG. **2**, the following vectors and angles are indicated:

- $\vec{G}x$ representing the acceleration measured by accelerator G1,
- $\vec{G}y$ representing the acceleration measured by accelerator G2,

- $\vec{G}z$ representing the acceleration measured by accelerator G3,
- $\vec{G}$ representing $(\vec{G}x+\vec{G}y+\vec{G}z)$
- $\vec{g}$ representing the gravity acceleration, oriented in the negative direction along axis OZ,
- $\vec{h}$ representing the difference $(\vec{G}-\vec{g})$, i.e. the acceleration of the free surface at the point O,
- $\vec{B}x$ representing the magnetic field component measured by magnometer B1,
- $\vec{B}y$ representing the magnetic field component measured by magnometer B2,
- $\vec{B}z$ representing the magnetic field component measured by magnometer B3,
- $\vec{B}$ representing the sum $(\vec{B}x+\vec{B}y+\vec{B}z)$, i.e. the magnetic field at the point O,
- $\vec{B}'$ representing the projection of $\vec{B}$ on the horizontal plane OX, OY,
- p representing the angle between $\vec{Oz}$ and $\vec{OZ}$,
- $\vec{Oz}'$ representing the projection of $\vec{Oz}$ on the horizontal plane OX, OY,
- $\vec{d}$ representing the angle between $\vec{Oz}'$ and $\vec{B}'$.

The following conventional signs have been chosen for the calculations:

- OZ and Oz are positively oriented upwards which does not involve any limitation since the absolute value of the slope p is limited to a value which is less than 90°,
- the horizontal plane OX, OY is oriented in the trigonometric direction derived from the orientation of axis OZ, and
- the vertical plane containing the direction of the swell is oriented by axis OZ and an axis positively oriented in the direction of the swell.

As it will be seen in the following, the values of the vector $\vec{G}x$, $\vec{G}y$, $\vec{G}z$, $\vec{B}x$, $\vec{B}y$, $\vec{B}z$, $\vec{B}$, $\vec{B}'$ and g will make possible to successively calculate in the rectangular-coordinate system Ox, Oy, Oz related to the buoy:

- $\vec{Z}$ representing the unitary vector of the ascending vertical line of the place,
- $\vec{V}_z$ representing the vertical speed of the buoy, with its sign,
- p° representing the absolute value of the slope of the swell,
- p as hereabove defined,
- $\vec{z}'$ representing the projection of the unitary vector $\vec{z}$ of Oz, on the horizontal plane OX, OY of the place,
- $\vec{B}'$ as hereabove defined,
- d° representing the absolute value of the angle of $\vec{B}'$ on $\vec{z}'$, and
- d as hereabove defined.

It will be seen that, in practice, the calculation of Z results in two solutions.

Referring to FIG. **3**, two successive conditions a and b of the buoy are illustrated, the condition a occuring later than the condition b, that being implicitly indicated by the direction of the arrow "swell direction":

(1) when $V_Z>0$, then $p<0$ the buoy going up before it passes at the crest where $p=0$,

(2) when $V_Z<0$, then $p>0$ the buoy going down before it passes at the trough where $p=0$.

Furthermore, the direction of the swell d, i.e. the direction which the swell is coming from, will be:

(1) $d=(\vec{B}', \vec{z}')$, when $p>0$, i.e. $V_Z<0$, and

(2) $d=(\vec{B}', \vec{z}')+\pi$, when $p<0$, i.e. $V_Z>0$.

Considering the bearing or magnetic heading of the direction from which the swell is coming the result will be:

(1) $d=(\vec{B}', \vec{z}')$, when $V_Z<0$, and