-continued

phase 0_+	L' = 1, Oz is crossing the vertical line,
	L' < 1, Oz being inside the cone,
phase 2_+	L' = 1, Oz is crossing OZj "up",
	L' > 1,
phase 2_-	L' = 1, Oz is crossing OZj in the opposite direction,
	L' < 1, Oz being inside the cone,
phase 0_-	L' = 1, Oz is crossing the vertical line in the opposite direction.

One or the other motion mode will be the good one, depending on the sea condition and swell direction. Even in a light seas condition, the second root is the most probable as the well direction turns toward EAST or WEST whichever is closest. Of course, L' is permanently equal to 1 for a swell coming directly from the EAST or WEST.

In the calculations, the phase $0_{(\pm)}$ will be distinguished from the phase $2_{(\pm)}$ through V_{Zj}. Indeed, in phase **2**, a speed $V_{Zj}=0$ will be found for the value $\lambda=0$, while a speed $V_{Zj}\neq 0$ will be found in phase **0**.

Thus the root will be searched in such a way that, at time t**0**:

$$L'=1, \text{ for } t=t0$$

$$L'>1, \text{ for } t<t0$$

$$L'<1, \text{ for } t>t0$$

$$\lambda i=0$$

$$V_{Zj}=0$$

Then the correct root for the period L'<1 is the one which is related to the so predetermined value λi. It is also the root for the preceding period (L' 1), save when $\Delta=K^2L^2+(1-L^2).(Go^2+K^2)$ has become nil, giving a double root to equation (5).

That procedure becomes ineffective when L'=1 and Δ=0 simultaneously. But those equalities lead to K=0, indicating that the projections of B and G on the plane OXY are orthogonal, that plane being the horizontal plane at this time, which also means that B' and Go are orthogonal. Therefore, during the entire cycle, the swell comes from either the EAST or the WEST, and **λ1=λ2.**

It may also be settled that a change of root will be possible only when the instantaneous direction of the swell will pass through the EAST or WEST. Then a check of L' crossing the value **1** will make it possible to clear the correct root for the period following Δ crossing zero.

Before describing a flow diagram for determining p and d from the above considerations and equations, a number of possible simplifications in those equations will be stated assuming that the acceleration vector $\vec{h}$ is perpendicular to the free sea surface. That hypothesis is based upon the theory stating that the acceleration $\vec{h}=d\vec{V}/dt$ is perpendicular to the profile of the free sea surface, according to Bernouilly. Since that profile is an isobar, the speed in such an isobar is tangential to the free sea surface at any point.

In such a case, at any time, the measures are:

$$\vec{G}=\vec{g}+\vec{h}=-g.\vec{Z}+h.\vec{z},$$

$$Gx=-ag$$

-continued

i.e. $Gy=-bg$

$$Gz=-cg+h$$

It is clear that that leads to one root only for a, b and c. It corresponds to the root $\lambda=-1/g$.

The swell slope may be estimated with the accelerometer indications only, because:

$$c=+\sqrt{1-(a^2+b^2)}=\sqrt{1-\frac{Gx^2+Gy^2}{g^2}}$$

$$V_{Z(t)}=\int_0^+ \vec{h}.\vec{Z}.dt=\int_0^+ c.(Gz+cg).dt$$

i.e.

$$p(t)=-(\text{sign of } V_{Z(t)}) \text{ Arc cos } c$$

or

$$p(t)=-(\text{sign of } V_{Z(t)}) \text{ Arc sin } (Gx^2+Gy^2)^{\frac{1}{2}}/g$$

The swell direction is then given, within the interval $(-\pi,+\pi)$, by:

$$\cos d=-g\frac{Bz+c.B.\cos A}{Go.B.\sin A} \text{ when } V_Z>0$$

$$\cos d=+g\frac{Bz+c.B.\cos A}{Go.B.\sin A} \text{ when } V_Z<0$$

with sign of d=sign of (Gy.Bx−Gx.By)

It must be noted that, with such a simplifying hypothesis, $\vec{Bx}$ and $\vec{By}$ are no longer used in the calculations, i.e. the components of $\vec{B}$ in a plane perpendicular to the axis of the buoy. If the values $\vec{Bx}$ and $\vec{By}$ are measured, a check can be made for proving the simplifying hypothesis. From the above equation (4), it results that $\vec{Bx}$ and $\vec{BY}$ must verify the following equation:

$$Bx.Gx+By.Gy=g.\left(B.\cos A+Bz.\sqrt{1-\frac{Gx^2+Gy^2}{g^2}}\right)$$

The flow diagram of the FIG. **4***b* indicates how the ranks N of the stored samples are derived, when the buoy is on a crest or in a trough, from the difference between the projection of the acceleration G that the buoy undergoes and the gravity. The value **R1** gives the number of swell crests and troughs which occur during the twenty recording minutes. The value Q is equal to the average value of the vertical projection of the magnetic field.

The flow diagram of FIG. **4***c* defines, with some uncertainty, when the vertical acceleration is null, with the vertical projection of the magnetic field on the axis of the buoy being equal to the projection of the field on the vertical line, when the buoy is vertical.

The flow diagram of FIG. **4***d* analyzes how the difference between said projections varies about a high or low point.

The flow diagram of FIGS. **4***e* and **4***f* make it possible to remove the uncertainty of 180°, and to determine the angle corresponding to the tangent defined by the projections of the magnetic field on the axis Ox and Oy which are always horizontal on a crest or in a trough.

Referring to FIG. **4***g*, the output data are defined, i.e. **T1** and **L1** which are the direction **D1** corresponding to