sensitive element will be acted upon by a torque as above. If, however, the course be perpendicular to the spin-axle, the torque will be zero. Representing the meridian component of the mean acceleration of the ship during the short time t by a, there will act upon the gyro a torque L which produces a precessional velocity about the vertical axis of the magnitude,

$$w_p \left[\doteq \frac{L}{h_s} \right] = \frac{mxa}{h_s}$$

In this short time t the meridian component of the velocity of the ship and of the compass changes by an amount at. During this time, the gyro-axle turns through the angle

$$\beta [= w_p t] = \frac{mxat}{h_s} = \frac{mx}{h_s}(v_t - v_0) \qquad (121)$$

Where β is the "ballistic deflection" and $(v_t - v_0)$ is the change in the meridian component of the velocity of the ship in time t.

When the meridian component of the velocity of the ship changes from v_0 to $\dot{v}_t$, the resting position of the gyro-axle is deflected through an angle $(\delta_1' - \delta_1)$, from the position δ_1, Fig. 144. Now β depends only upon the constants of the compass and the linear acceleration of the ship, whereas the meridian-steaming errors depend upon latitude and velocity. The ballistic deflection β and the deflections δ_1 and δ_1' due to changes in the meridian-steaming error are in the same direction. Consequently, a gyro-compass can be designed with such a period T_0 that, when the instrument is at some particular latitude, the ballistic deflection shall equal the change in the meridian-steaming error $(\delta_1' - \delta_1)$ produced by the change in the velocity of the ship.

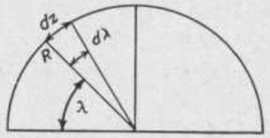

FIG. 146

If the ship, starting from rest, moves along a meridian through a distance dz in time dt, with constant linear acceleration a, the velocity at the end of time t will be

$$\frac{dz}{dt} = at$$

During the motion, the latitude of the ship has changed by the amount, Fig. 146:

$$d\lambda = \frac{dz}{R}$$

where R is the radius of the earth. The rate of change of latitude is

$$\frac{d\lambda}{dt} = \frac{dz}{R\,dt} = \frac{v'}{R} = \frac{at}{R} \qquad (122)$$

where $\frac{dz}{dt}[= at]$ is the meridian velocity v' of the ship at the end of time t. Substituting in (121) the value of at from (122), we obtain for the ballistic deflection

$$\beta = \frac{mxR}{h_s}\frac{d\lambda}{dt} \qquad (123)$$

Before equating this value of the ballistic deflection and the value of the meridian-steaming error, we shall express the latter in terms of the time rate of change of latitude. Since the meridian-steaming error δ_1 is so small that we may neglect the difference between δ_1 and $\tan \delta_1$, (118) may be written

$$\delta_1 = \frac{v'}{Rw_e \cos \lambda}$$

where the meridian component $v_s \cos \theta$ of the velocity of the ship is represented by v' and the symbol ${}_p w_e$ is abbreviated to w_e.

On substituting in this equation the value of v' from (122), we have for the meridian-steaming error

$$\delta_1 = \frac{d\lambda}{w_e \cos \lambda\, dt} \qquad (124)$$

Now equating the ballistic deflection (123) and the meridian-steaming error (124),

$$\frac{MxR}{h_s} = \frac{1}{w_e \cos \lambda}$$

or

$$h_s = mxRw_e \cos \lambda \qquad (125)$$

When the angular momentum has the value given by this equation, the spin-axle will move without oscillation to the resting position proper to the particular latitude and final velocity. On substituting this value in (88) we find that the period of the azimuthal vibration back and forth through the meridian of the undamped compass that produces zero ballistic deflection error has the value

$$T_0 = 2\pi\sqrt{\frac{R}{g}} \qquad (126)$$