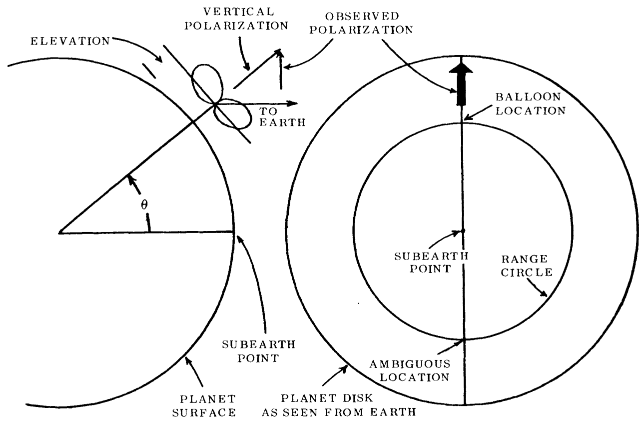

Fig. 2. Position determination by ranging and polarization.

Note that there will be a small region in the vicinity of the subearth point, $\theta=0$, where the antenna's zenith null will be directed toward earth. There will not be sufficient signal strength to carry out the polarization measurement in this region. However, if the link transmitter is sized to operate at a low antenna gain when transmitting carrier only, this region can be made quite small. A -2 dB antenna gain, for example, will allow operation to within 5° of subearth. A second antenna having an axial beam would be used for data and ranging transmission for $\theta<45°$. Near the limbs, multipath problems will limit operations to a maximum θ of about 80°.

Accuracy of the polarization direction determination is estimated to be about 3° for a 2 minute averaging time. This will give a position error of 300 km or less, depending on balloon location.

In implementing the position-determination technique suggested here, it would be desirable to supplement the measurements occasionally by simultaneous ranging from two earth stations. This would remove the location ambiguity inherent in the range-polarization fix (though taken by itself it also has an ambiguity), and would permit extension of coverage into the zenith null region. However, the accuracy requirement for the ranging measurement is much more severe for a two-station fix, which is equivalent to an interferometer, than for the range-polarization fix. It therefore requires a much wider band ranging signal, with a consequent substantial increase in acquisition time and transponder transmission time. The penalty for this, primarily an increase in floated battery weight, would have to be weighed against the possible value of the information in determining whether or not to include the two-station capability in a given mission design.

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Correction to "Stabilization of Precision Electro-optical Pointing and Tracking Systems"

C. E. Kaplow of the Hughes Aircraft Company has brought to my attention that the kinematic torque equation given in the Appendix of the above paper[1] is incomplete.

The torque equation should be

$$\bar{L}=\frac{d}{dt}(\bar{H})_s+(\bar{V}_P\times\Sigma M_i\bar{V}_{C_i}),$$

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[1] A. K. Rue, *IEEE Trans. Aerosp. Electron. Syst.*, vol. AES-5, pp. 805–819, September 1969.

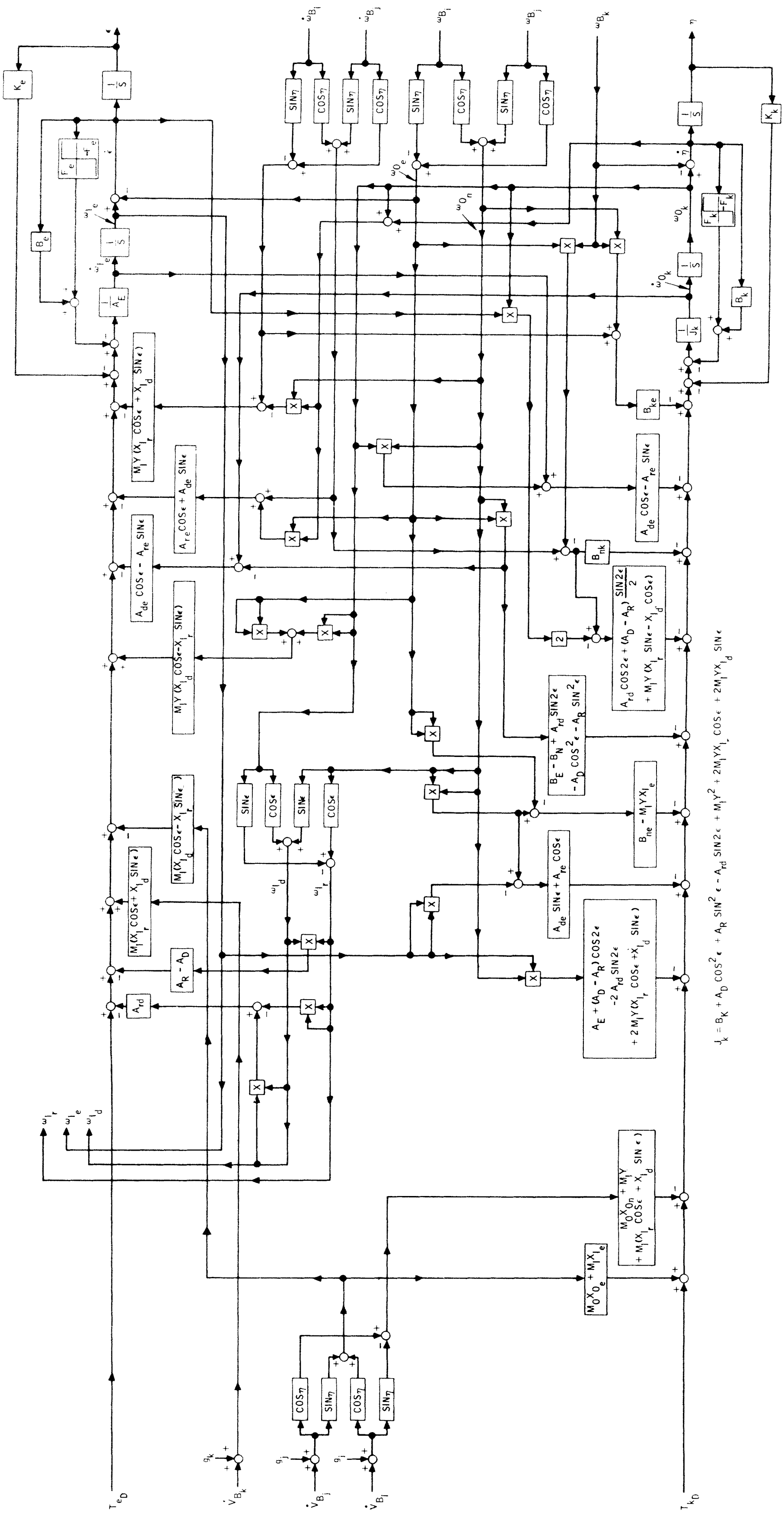

Fig. 1. Block diagram of gimbal kinematics.

where

$\bar{V}_P$ = vector linear velocity, relative to inertial space, of the origin about which the angular momentum is computed
M_i = individual mass elements of the body
$\bar{V}_{C_i}$ = vector linear velocity, relative to inertial space, of the center of mass for mass element M_i.

For the inner and outer gimbals, the respective linear velocity terms are

$$(\bar{V}_P \times \Sigma M_i \bar{V}_{C_i}) = [\bar{V}_B \times (\bar{\omega}_I \times \bar{x}_I)]M_I + [(\bar{\omega}_0 \times \bar{y}) \times (\bar{\omega}_I \times \bar{x}_I)]M_I,$$

and

$$(\bar{V}_P \times \Sigma M_i \bar{V}_{C_i}) = [\bar{V}_B \times (\bar{\omega}_0 \times \bar{x}_0)]M_0 + [\bar{V}_B \times (\bar{\omega}_0 \times \bar{y})]M_I + [\bar{V}_B \times (\bar{\omega}_I \times \bar{x}_I)]M_I.$$

On the basis of these relationships, the corrected kinematic torque equations are

$$\bar{L}_I = (\bar{x}_I \times \dot{\bar{V}}_B)M_I + [\bar{x}_I \times (\dot{\bar{\omega}}_0 \times \bar{y})]M_I + \{\bar{x}_I \times [\bar{\omega}_0 \times (\bar{\omega}_0 \times \bar{y})]\}M_I + \bar{J}_I\dot{\bar{\omega}}_I + (\bar{\omega}_I \times \bar{J}_I\bar{\omega}_I)$$

and

$$\bar{L}_0 = (\bar{x}_0 \times \dot{\bar{V}}_B)M_0 + (\bar{y} \times \dot{\bar{V}}_B)M_I + [\bar{y} \times (\dot{\bar{\omega}}_0 \times \bar{y})]M_I + \{\bar{y} \times [\bar{\omega}_0 \times (\bar{\omega}_0 \times \bar{y})]\}M_I + [\bar{y} \times (\dot{\bar{\omega}}_I \times \bar{x}_I)]M_I + \{\bar{y} \times [\bar{\omega}_I \times (\bar{\omega}_I \times \bar{x}_I)]\}M_I + \bar{J}_0\dot{\bar{\omega}}_0 + [\bar{\omega}_0 \times (\bar{J}_0\bar{\omega}_0)] + \bar{L}_I.$$

The revised gimbal kinematic block diagram, Fig. 1 (Fig. 9 of the paper), reflects these corrections. The significant changes in the figure are the elimination of all torque terms that occur due to the products of base linear velocities and gimbal angular rates.

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