avoiding action was made by Rear Admiral J. A. Gauw, R. Neth. N. in this *Journal*, 8, 178.

(2) *Proposed new radar display*. This ingenious and interesting variation (which may well be called the Calvert Display) clearly merits extensive simulator and sea trials. The chief advantage over other displays appears to be in the clear indication given of whether the avoiding action taken is effective or not.

from Dr. H. C. Freiesleben

(*German Hydrographic Institute*)

THE nautical referees of the journal *Der Seewart* believe that the proposals made by Mr. Calvert are not an improvement on the present Rules of the Road. These rules are the simplest that may be imagined. The evaluation of collisions which have occurred in spite of radar, demonstrates that it is not the fault of the Regulations but of ignoring these rules. If, in conformity with Calvert's proposals, in future both partners to a possible collision have to manœuvre, the possibility of errors and mistakes will be doubled. Overtaking to starboard and crossing ahead are moments of great danger. Moreover, Calvert's proposals have the disadvantage of being inflexible regulations, whereas the present rules give way to the variety of actual circumstances, e.g. the different reactions of a ship to the alteration of course or velocity, with regard to the state of loading or the drift due to current and wind, &c. The desire to introduce, additional to the three existing radar presentations (heading-upward, north-upward relative and true-motion), a fourth seems to be critical at least for a transition period. In spite of these objections and those made by Capt. Harries, the editorial staff of *Der Seewart* estimates Mr. Calvert's ideas to be so important that they will inform the readers in the next issue by a short essay stating the *pro* and *contra*.

A Miniature Stabilized Platform

from T. McClymont

(*English Electric Aviation Limited*)

THE platform shown in Fig. 1 is one of a series of miniature platforms developed for inertial guidance and weighs only 28 lb. It is a three-axis, four-gimbal platform permitting complete freedom of manœuvre without gimbal lock. Three miniature integrating gyroscopes are used for stabilizing the gimbal system (Fig. 2) and three miniature pendulous accelerometers provide voltage outputs proportional to accelerations experienced by the platform.

These six instruments, together with their amplifiers are carried on the innermost gimbal, which has freedom in azimuth and is surrounded in turn by the inner roll, pitch and outer roll gimbals. The azimuth, inner roll and pitch gimbals are driven by torque motors in response to signals from the three gyroscopes whereas the outer roll gimbal is servo-driven from a synchro resolver on the inner roll gimbal so as to maintain the latter normal to the pitch gimbal.

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This arrangement prevents gimbal lock in any attitude of the platform case and maintains the three inner gimbal axes orthogonal.

The control torques for the platforms are provided by direct drive d.c. motors and gimbal angle information by synchros mounted on each axis. The pancake direct drive units are small in size and avoid the penalties of geared drives, including chatter, blacklash error, friction and reflected inertial forces when the platform is rotated.

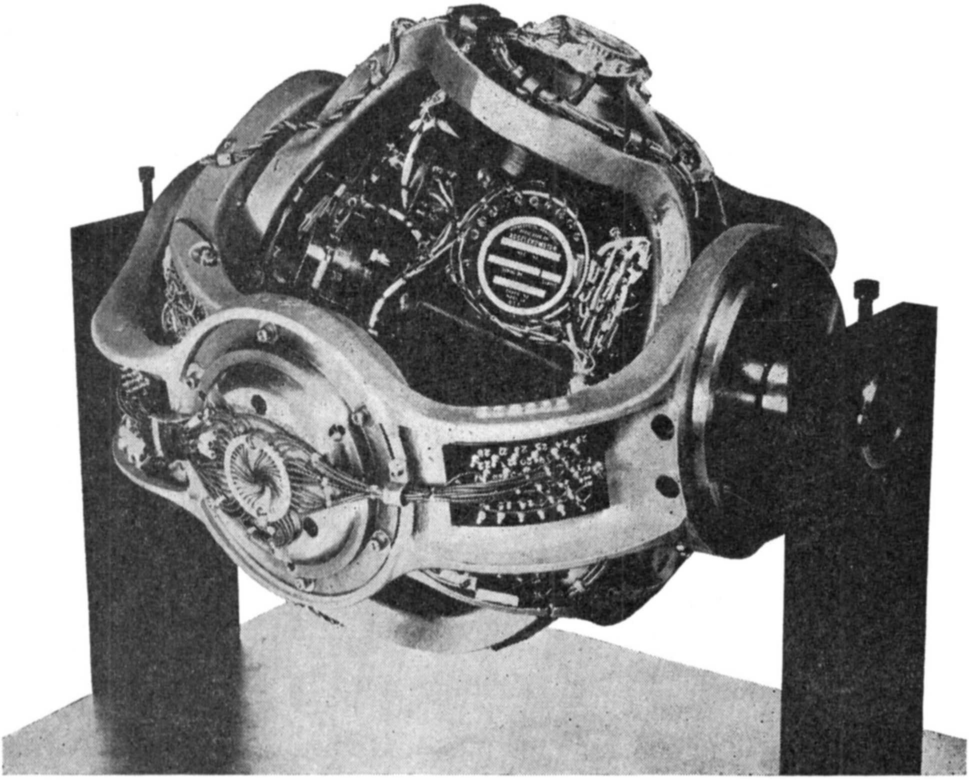

Fig. 1. Miniature platform for inertial guidance.

The platform was conceived as an integral unit, the specifications for the gyros and accelerometers together with the gimbal system having been derived from the overall platform specification. Common power supplies have therefore been provided for all components, an advantage in view of the fact that slip rings must be used to transfer power from the external source, through the gimbal bearings to the gyros and accelerometers. The components also operate at a uniform temperature of 180°F. at which the platform is maintained by an internal heater. The high operating temperature facilitates use in applications where high ambient temperatures are expected, since it avoids the need for refrigeration.

The remarkable sensitivity and accuracy of modern gyros and accelerometers has made inertial navigation possible and these components form the nerve centre of an inertial platform.

Fig. 3 shows a fully floated miniature rate-integrating gyroscope designed specifically for stabilized platform application; it is in production both in this country and the U.S.A. It is 2¾ in. long, 1¾ in. diameter and weighs less than

¼ lb. The rate-integrating gyroscope measures the time integral of the input rate and its output is proportional to the angular displacement of the gimbal. The instrument in question was described in the last number of the *Journal* (13, 219). The spin motor or gyro wheel is a hysteresis type motor operating at 24,000 r.p.m. and is contained in a helium-filled gimbal which is pivoted inside the hermetically sealed outer case. The gyroscope is filled with a viscous fluid which provides damping, gimbal flotation and protection against shock, bellows being provided to accommodate the expansion of the fluid on warm-up.

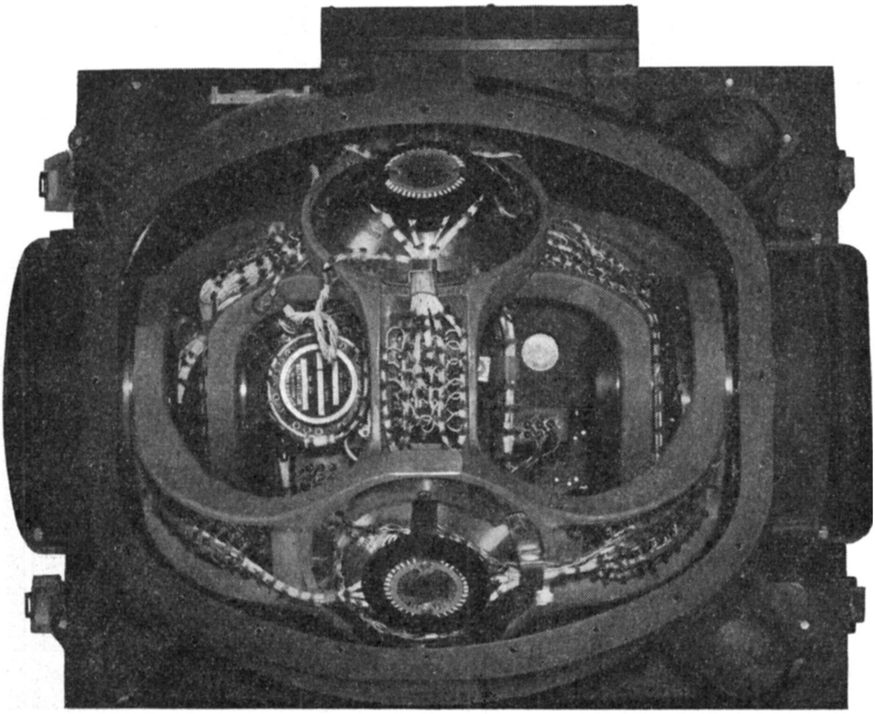

Fig. 2. Stabilization of the gimbal system.

The combined signal generator and torque motor, or dualsyn, is positioned about one end of the gyro gimbal on which is mounted the dualsyn rotor. Any rotation of the platform around the gyro-sensitive axis causes an angular displacement of the gyro gimbal around its output axis. This produces an output from the signal generator which is amplified and fed to the platform gimbal torque motor to restore the platform to its original position. The gyro torque motor is used for applying a correcting signal to back off drift-producing torques resulting from mass unbalance. An interesting feature of the dualsyn is that the a.c. signal generator windings and the d.c. torque motor windings are wound on a common core.

Temperature control of the gyro is accomplished by the use of built-in temperature sensing and heating elements. The case heater consists of two sections, one for warm up and the other for normal control. When the gyro reaches operating temperature the warm up heater is automatically switched off. Operating temperature is 180°F. ± 5° (82°C.).

The construction of the accelerometer very closely resembles that of the miniature gyroscope. Both its length and weight are in fact less. A pendulous mass replaces the gyro wheel of the gyroscope and this mass is contained in a floated cylindrical gimbal pivoted at either end in a similar manner to the gyroscope.

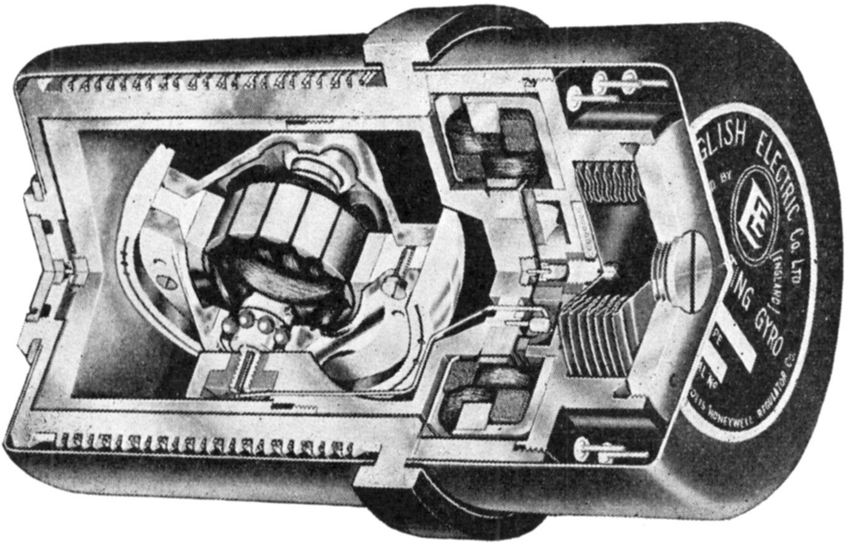

Fig. 3. Miniature rate-integrating gyroscope.

An acceleration applied along the sensitive axis will cause an angular displacement of the gimbal and in turn an output from the signal generator. This output is amplified and demodulated and the demodulated signal is fed to the accelerometer torque motor to restore the gimbal to its null position. In the steady state the torque motor torque is that required to maintain the pendulous gimbal central in its case in the presence of the applied acceleration, and is a measure of the acceleration. The torque motor current is taken as a measure of this torque and is integrated twice to obtain first speed, and secondly distance flown.