A NEW MAGNETIC SURVEY AIRCRAFT FOR THE UNITED STATES NAVY HYDROGRAPHIC OFFICE

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IHB Note. — Henry P. STOCKARD was born in Birmingham, Alabama in 1924. He received a B. S. degree in geology from the University of Alabama in 1950. Since 1951 he has been employed as a geophysicist at the U. S. Navy Hydrographic Office where he has been associated with the planning and execution of geomagnetic surveys. At present Mr. Stockard is Deputy Head of the Geomagnetics Branch of the Navigational Science Division at the Hydrographic Office.

Floyd B. WOODCOCK was born in Atlantic City, New Jersey in 1930. He received his B. A. degree in physics from Amherst College in 1953 and continued graduate studies in physics at Rensselaer Polytechnic Institute until 1954.

Since 1954 he has been employed as a geophysicist at the U. S. Navy Hydrographic Office where he has been engaged largely in the development of improved instrumentation and techniques for geomagnetic surveying. He has also participated in airborne geomagnetic surveys. At present, Mr. Woodcock is assigned to the Development Section of the Geomagnetics Branch, Navigational Science Division at the Hydrographic Office.

Project MAGNET, the United States Navy Hydrographic Office's Airborne Geomagnetic Survey Program (*), was established in 1951 to provide urgently needed geomagnetic data over the world's ocean areas. Survey operations commenced in mid-1953 using a P2V *Neptune* aircraft. The P2V was retired from survey use in June 1954 after having flown approximately 60 000 nautical miles of survey track over the North Atlantic Ocean. In the fall of 1955 and R5D *Skymaster* aircraft became operational and resumed the survey of the North Atlantic. With this aircraft the survey of the North Atlantic from the equator to 70° N latitude was completed, the Mediterranean Sea was surveyed, and approximately 20 000 nautical miles of survey track were flown over the Pacific Ocean.

In late 1957, a WV-2 *Super Constellation* aircraft was assigned to Project MAGNET. This aircraft is well adapted for long over-water flights. It is capable of flights in excess of 4 000 nautical miles and is generously endowed with such necessary crew comforts as a complete galley, tables, reclining seats, and bunks, all of which make the long and tedious survey flights more endurable. The WV-2, with its excellent range capabilities, provides access to hitherto inaccessible regions of the world.

(*) See *International Hydrographic Review*, Vol. XXXIII, No. 2, November 1956, pp. 143 and ff.

FIG. 1. — Project *Magnet* WV-2 Survey Aircraft.

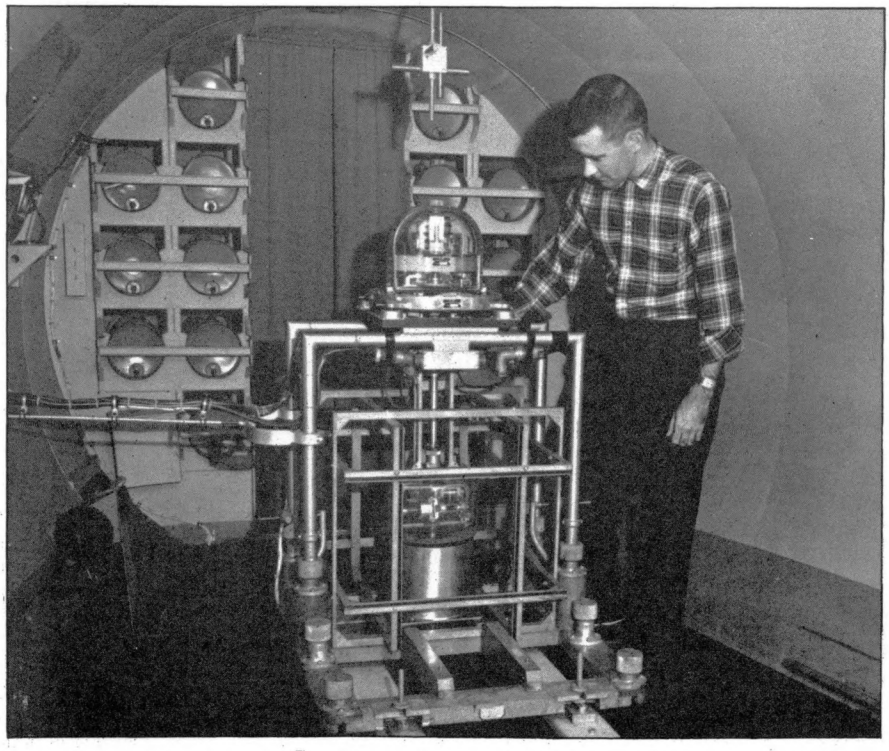

FIG. 2. — Vector Airborne Magnetometer Detector Mechanism.

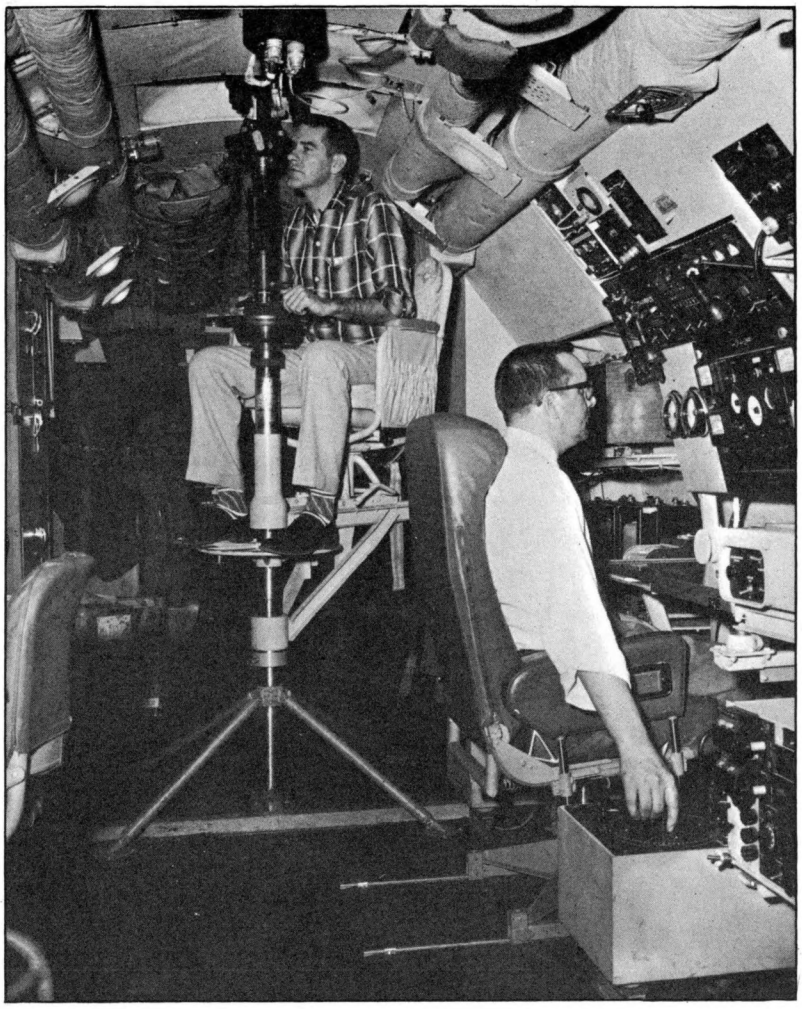

FIG. 3. — Periscopic Sextant and Magnetometer Control Station.

In order to make the WV-2 a suitable magnetic-survey aircraft, a substantial amount of modification was required. Two enormous radomes and several tons of radar and electronic equipment were removed, the skin was rebuilt in several areas, and, in general, the clean, familiar lines of the *Super Constellation* were reclaimed. To minimize the magnetic effects of the aircraft itself, virtually all nonessential magnetic parts were removed from the aft portion of the aircraft. Where possible, essential parts made of magnetic materials were relocated forward or refabricated of nonmagnetic materials. Practically all electrical systems aft of the wing were rewired to provide ground returns other than the airframe thus minimizing magnetic fields and noise of electrical origin. The detecting mechanism of the Vector Airborne Magnetometer (VAM), which measures the strength and direction of the earth's magnetic field, was installed in the nonmagnetic area in the aft portion of the pressurized fuselage. The controls and recorders for the VAM are located about 35 feet forward of the detector. To determine precisely the heading of the aircraft, a specially modified, auto-

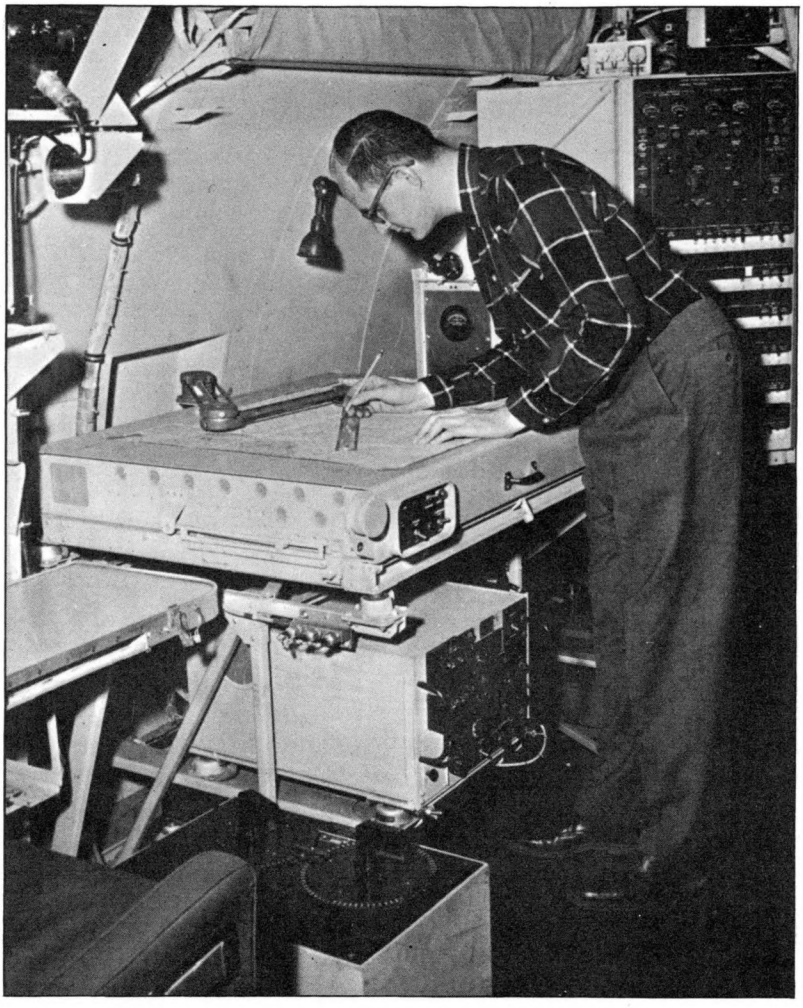

FIG. 4. — Dead-Reckoning Tracer.

matically leveled periscopic sextant has been installed near the VAM control station. This sextant provides accurate celestial-bearing data which are recorded along with the magnetic data. To augment the periscopic sextant, a Kollsman photoelectric sextant has been modified to provide accurate celestial bearings and installed in the WV-2. Data from the latter are synchronized in time with the VAM. To assist in location and identification of stars, a star clock has been installed which continuously provides approximate azimuths and altitudes of selected stars.

In order to achieve world-wide operational capability, it was necessary to utilize navigational aids which are not dependent upon highly specialized ground-based stations. Therefore, the navigational techniques rely principally on self-contained aids. For directional data and control, the WV-2 is equipped with two complete N1 compass systems which can provide either precise compensated directional gyro heading or gyro-stabilized magnetic heading. Accurate dead-reckoning capability is provided by an AN/APN-67 Doppler Radar Navigation System. This system, utilizing headings supplied

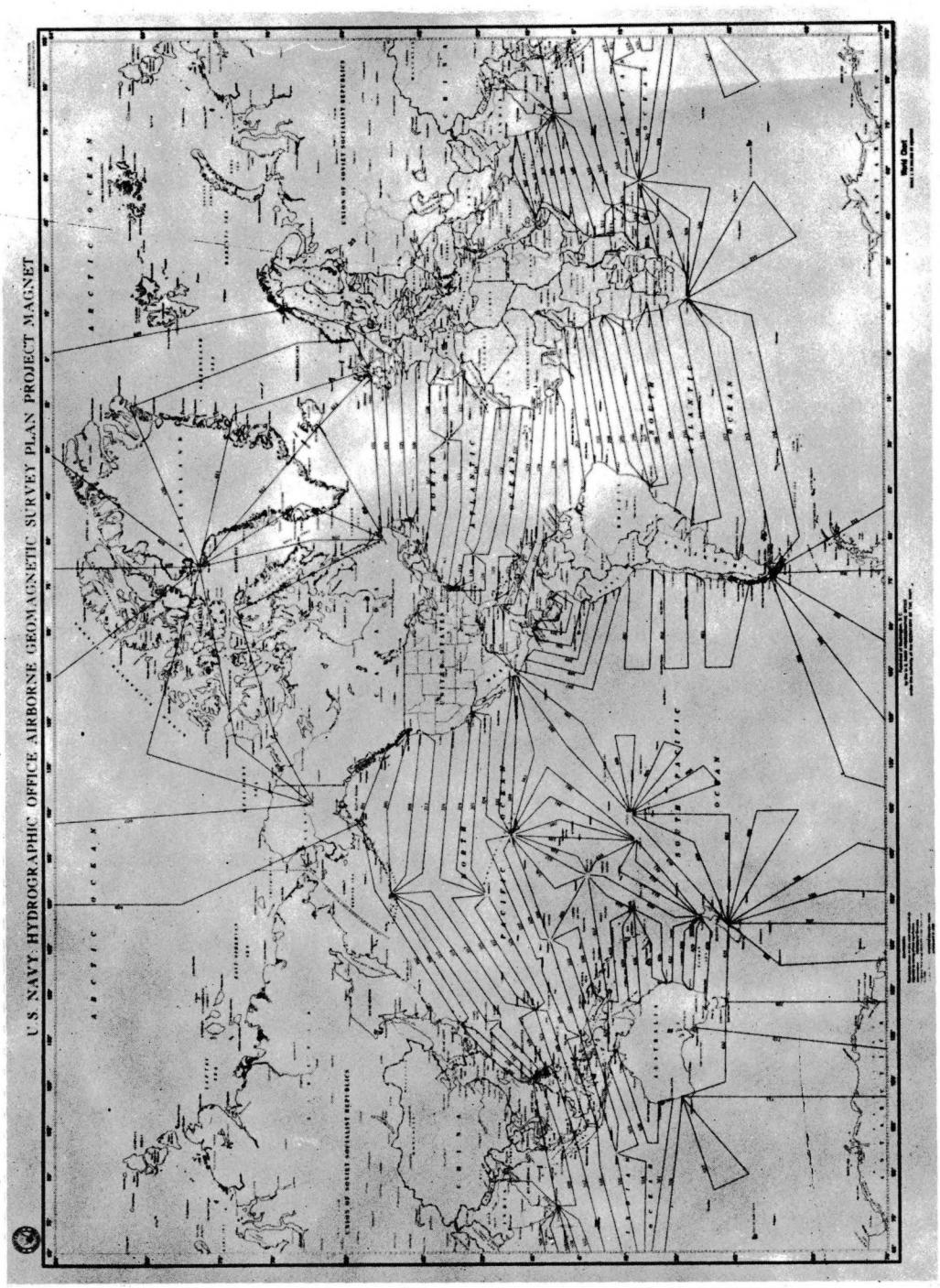
U.S. NAVY HYDROGRAPHIC OFFICE AIRBORNE GEOMAGNETIC SURVEY PLAN PROJECT MAGNET
ARCTIC OCEAN
UNION OF SOVIET SOCIALIST REPUBLICS
PACIFIC OCEAN
SOUTH PACIFIC OCEAN
INDIAN OCEAN
AUSTRALIA

FIG. 5

by an N1 compass, computes and indicates ground speed, drift angle, latitude, longitude, course, and distance traveled. A graphic record of aircraft position is obtained from an AN/ASA-14 Dead-Reckoning Tracer (DRT) operating in conjunction with the APN-67. The DRT maintains a continuous plot of the aircraft's track on a Mercator plotting sheet. Standard flight instruments provide airspeed, pressure and ratio altitude, and outside air temperature. A standard Kollsman periscopic sextant permits the aircraft's navigators to obtain frequent celestial-fix data. Celestial altitudes can also be obtained from the photoelectric sextant. An AN/APS 42-B radar equipped with a camera provides a means for obtaining and recording radar fixes when available. An AN/APN-70 Loran receiver is used for position fixing wherever suitable Loran coverage is available. TACAN supplements the other navigational equipment in certain areas. Periodically, a data-recording camera, synchronized in time with the VAM, automatically records data from the flight instruments, the APN-67, and the photoelectric sextant. These data combined with the navigator's enroute log and fix data permit an accurate determination of the aircraft's track. Flight control is provided by a PB-10A autopilot which is provided with heading control by an N1 compass system.

The WV-2 is equipped with a variety of supplementary equipment such as VOR, ADF, and ILS as well as excellent communications equipment. An auxiliary power unit provides ground power for equipment tests and checks and for starting engines.

Under sponsorship of the Office of Naval Research, a neutron monitor system was developed by the Bartol Research Foundation for installation on the Project MAGNET WV-2. This system, employing neutron detectors imbedded in a lead and paraffin pile, detects and records neutron flux produced in the pile by the nucleonic component of cosmic rays. These cosmic ray data are gathered simultaneously with the primary geomagnetic data.

The flight test program of the WV-2, during which magnetic compensation of the aircraft was accomplished, indicated that the aircraft fulfilled all the requirements requisite to its mission. A truly world-wide survey, consisting essentially of circumnavigations of the globe, commenced in October 1959. The initial world-wide survey is expected to be completed in time to provide data for the next complete series of world isomagnetic charts which will be issued for epoch 1965. After that, a system of repeat surveys will begin to maintain the accuracy and up-to-dateness of world geomagnetic data.