Curve (a) is a graph of the X-ray intensity in mr/hr plotted against the thickness of Al filter in mg/cm². These data were obtained by using the Model 356 meter. The beam current for this series of measurements was 100 μa, and the distance was 20 cm. This was a convenient set of values to use so that the middle range of the instrument could be employed.

Curve (b) is similar to curve (a) except that a Victoreen Model 247A meter was used. A beam current of 300 μa and a distance of 10 cm were convenient for this instrument. In curve (b) the circles represent the data obtained with the aluminum case of the instrument removed. The squares represent the data obtained with the aluminum case on the instrument. The consistency of these two sets of data indicated that the case was equivalent to 1.34 g/cm² of Al filter. In plotting the squares, this equivalent filter weight was added to the actual weights of the filters used.

The range of attenuation in curve (b) is sufficient to show a decrease in the slope of the curve with increasing weight of the Al filter. This change of slope is due to the fact that the softer components of the X-rays are filtered out more quickly than the more penetrating hard components remaining in the X-ray beam. To obtain an approximate estimate of the proportion of soft and hard components, curve (b) was analyzed in the usual way producing curves (c) and (d). Curve (c) represents the more rapidly attenuated soft component, and curve (d) the harder component. Since the X-rays are of the continuous type arising from the bombardment of bronze in the electron microscope by 50-kv electrons, the division of the X-rays into two components, hard and soft, is just a convenient approximation and is an empirical representation of the data.

Mass absorption coefficients, μ_m, computed from the slopes of the curves (a), (c), and (d) are tabulated:

Curve	μ_m *in cm²/g*	*Distance in cm*
(a)	1.5	20
(c)	2.5	10
(d)	1.5	10

This corresponds to half-value thicknesses of Al of 1.0 and 1.7 mm for the soft and hard components respectively. Apparently the X-rays at 20 cm from the port of the primary viewing screen are qualitatively like the hard component of the beam at 10 cm. Using standard tables for the mass absorption coefficient of Al, this set of values corresponds to a wavelength range of 0.45–0.50 A for the X-rays. This is approximately the wavelength range in which one may expect to find the peak energy for a continuous X-ray spectrum arising from 50-kv electrons (*1*).

A ½-in.-thick plug of lead glass was placed in each viewing port. The dosage at the ports was then reduced to less than 1 mr/hr. The high dosage had been due to the accidental use of ordinary glass instead of lead glass in the assembly of this instrument by the manufacturer.

It is suggested that electron microscopists survey the radiation from the viewing ports to determine whether or not the X-ray intensity exceeds the accepted tolerance dosage.

Reference

1. COMPTON, ARTHUR H. and ALLISON, SAMUEL K. *X-Rays in theory and experiment.* New York City: Van Nostrand, 1935.

Airborne Magnetometer for Measuring the Earth's Magnetic Vector

E. O. Schonstedt and H. R. Irons

Naval Ordnance Laboratory
Silver Springs, Maryland

An airborne instrument which continuously records geomagnetic information from which all magnetic components may be determined has been developed at the Naval Ordnance Laboratory. The instrument is a modified form of the airborne total field magnetometer developed by the Naval Ordnance Laboratory and Bell Telephone Laboratories during World War II for the location of submerged submarines by the detection of their anomalous fields. Since the war, this submarine detector, with slight changes, has been used for geophysical prospecting.

The basic feature of the new magnetometer is that it now determines the total magnetic field vector instead of only the intensity. This is done by measuring the intensity and the direction of the total magnetic field vector with respect to a set of coordinate axes stabilized with respect to the surface of the earth.

The sensitive measuring element of the magnetometer is a saturable inductor which is excited by a 1000-c current of sufficient amplitude to saturate its permalloy core. A 2000-c voltage is generated by the inductor, the amplitude of which is proportional to the strength of the magnetic field along its axis. The inductor is mounted in a gimbaled arrangement driven by servo motors to maintain its detection axis parallel to the earth's magnetic field. The gimbaled arrangement with its servo motors is called the detector head and is secured to the frame of the aircraft. Potentiometers and their associated electronic circuits measure the amount of angular displacement of the detection element about the two axes of the gimbals in which the detector is carried. By means of these angles the total magnetic field vector can be projected onto a system of coordinate axes fixed with respect to the aircraft.

In order to make use of these data, the orientation of the aircraft with respect to vertical and true north must be determined. A vertical reference is provided by a gyroscope controlled by gravity-actuated devices so as to maintain the spin axis of the rotor of the gyroscope vertical. Potentiometers on the roll and pitch axes of the gyroscope measure the inclination of the aircraft with respect to vertical. These angular measurements are used to refer the magnetic data to a coordinate system stabilized with respect to the surface of the earth.

The true heading of the aircraft is obtained by periodic astral observations. A continuously recording directional gyroscope maintains a record of the aircraft heading between astral observations. The position of the aircraft is determined by one or a combination of astral observations, loran fixes, radar, visual observation, and photography, depending upon the area to be surveyed.

During flight the total magnetic field intensity, the aircraft heading, and the angular displacements about the gimbal axes of the detector head and the gyro vertical are continuously recorded by graphic milliammeters. The process of determining the various magnetic quantities from these data is carried out after the flight is completed.

The vertical reference gyroscope used to measure the inclination of the aircraft is subject to certain errors so an alternate system for establishing a vertical reference was developed employing an oil-damped pendulum. The pendulum will produce true readings only when the aircraft is in a state of nonaccelerated flight. The directional and vertical gyroscopes are used, therefore, to ascertain when the accelerations due to changing attitude are at a minimum. Points are selected during these periods for computing the magnetic quantities.

In order for the magnetometer to be employed to the greatest advantage, a stable aircraft and smooth flight conditions are required.

Charts showing the components of the earth's magnetic field are issued periodically by the Navy Hydrographic Office and the U. S. Coast and Geodetic Survey. The angle of declination or magnetic variation is of primary importance because of its requirement for navigational purposes. The other components, angle of dip, total intensity, and vertical and horizontal fields were formerly of more or less academic interest but are now finding increasing use in specialized fields of research, development, and geophysical exploration.

Up to the present time, the great bulk of magnetic surveys for chart-making purposes have been conducted employing instruments consisting of rotating coils or the deflection and oscillation of small magnets. Although these instruments are capable of highly precise measurements on the ground, they have not been particularly adaptable for use in aircraft for the determination of the earth's complete magnetic field vector. They also require that surveys be conducted on a point-by-point basis, which is time-consuming.

Surveys of oceanic areas have been made with similar types of instruments and have required the use of nonmagnetic ships. Such measurements were terminated in 1929 when the only existing nonmagnetic vessel, the "Carnegie," burned off the island of Samoa. Similar to ground measurements, the data taken at sea is a point-by-point process with one set of observations made each 200 to 300 miles. Measurements made at sea, however, were less accurate than those made on land.

The airborne measurements are expected to be of the order of accuracy of those made at sea. The airborne surveys, however, will have the advantage of greater speed, continuous recording, and the avoidance of small magnetic anomalies near the surface of the earth.

Due to the constantly changing nature of the earth's magnetic field, the problem of tying a large number of observations made at widely separated times to a common time base should be considerably simplified with the use of airborne instruments due to the fact that vast areas may be mapped in a short period of time.

At the present time the magnetometer is limited to operation in areas of dip angles of about 50° and greater. With additional development the range of operation can be extended to all areas of the earth. Only one instrument has been constructed, and it is undergoing flight tests at the present time.

Avoiding Trial-and-Error in Inframicroscopic Photography[1]

E. Ross Jenney

Division of Tuberculosis, U. S. Public Health Service, Washington, D. C.

The phenomenal surge of interest in the general field of photography that preceded World War II was not followed as closely as might have been expected by a corresponding development in photomicrography. New lenses and other factors produced an infinite variety of "close-ups" achieved with techniques which were used to scientific advantage but were pursued largely as a hobby, to obtain unusual patterns in subject matter. The field of photomicrography scarcely developed in these years beyond the needs of those who required the technique for teaching purposes or to illustrate scientific publications.

Strictly speaking, this was true of America more than of Europe, owing, perhaps, to the available equipment there, particularly that of German origin. For some years before the war even the person who pursued photomicrography as a hobby was accustomed to replacing the lens of his Leica with a suitably threaded adapter, which contained a shutter and an indirect-vision aperture and which fitted, in turn, the eyepiece of the microscope. In this instance all three elements—the camera, the adapter, and the microscope—were manufactured by the same firm, Ernst Leitz of Wetzlar, although adapting devices were generally available for most cameras. Much of the work in America was, and still is, accomplished by connecting the camera to the microscope by means of a flexible sleeve, often an automobile radiator hose. While excellent photographs can be obtained with this simple device, the technique has certain serious disadvantages, particularly in regard to stability and variable focusing, difficulties which now can be remedied with several types of standard equipment.

Between the range of the close-up and that of true

[1] Use of this particular camera does not imply its endorsement by the U. S. Public Health Service.