old Tilbury Fort and of timber and lead from the Tower of London, was designed by Wren and built at a cost of £520, the money being derived from the sale of spoilt gunpowder.

A RESEARCH MEDICAL SOCIETY was organized recently at the Loyola University School of Medicine. The following officers were elected for the academic year 1919–20: *President,* R. M. Strong; *Vice-president,* F. M. Phifer; *Secretary,* A. B. Dawson; *Treasurer,* E. S. Maxwell; *Members of the council,* S. A. Matthews, George W. Wilson, and F. B. Lusk.

PROFESSOR FREDERIC S. LEE, of Columbia University, lectured recently on "Problems of industrial physiology" before the Royal Canadian Institute, Toronto, and the Johns Hopkins School of Hygiene and Public Health.

PROFESSOR H. N. HOLMES, head of the chemistry department in Oberlin College, has recently lectured at Case School of Applied Science, Cleveland, and before the Cincinnati section of the American Chemical Society on "The industrial applications of colloid chemistry."

AN address on the "Theories regarding the formation of phosphate deposits" was given at the Ohio Agricultural Experiment Station on February 16, by Dr. Walter H. Bucher, of the department of geology of the University of Cincinnati.

PROFESSOR H. SHIPLEY FRY, director of chemical laboratories, University of Cincinnati, lectured on "The electronic conception of valence and the constitution of benzene" before a joint meeting of the Leigh Chemical Society and the Lexington, Kentucky, section of the American Chemical Society at Georgetown College on February 13.

AT a meeting of the Faculty Club of the University of Mississippi on February 2, 1920, Dr. Hiram Byrd, director of the department of hygiene, delivered a lecture on "Rattlesnakes."

THE president of the Royal College of Physicians, London, has appointed Dr. F. W. Andrews to be Harveian orator, and Dr. R. C. Wall to be Bradshaw lecturer for this year. The council has appointed Dr. Martin Flack to be Milroy lecturer for 1921. The Oliver-Sharpey prize for 1920 has been awarded to Professor Emil Roux, of the Pasteur Institute, Paris.

UNIVERSITY AND EDUCATIONAL NEWS

MR. J. OGDEN ARMOUR has made a further gift of six million dollars to the Armour Institute of Chicago. A new site for the school has been purchased at the cost of one million dollars, and five million dollars will be expended on buildings.

AT YALE UNIVERSITY, Dr. W. H. Sheldon, of Dartmouth College, has been appointed professor of philosophy. Dr. W. R. Longley, has been promoted to a full professorship of mathematics.

DR. E. F. HOPKINS, associate plant pathologist at the Alabama Polytechnic Institute and Experiment Station, has been appointed plant pathologist and assistant professor of botany at the University of Missouri. Dr. Hopkins will begin his work on April 1.

DR. C. L. METCALF has been promoted to be professor of entomology in the Ohio State University.

DR. H. G. FITZGERALD has received an appointment as profesor of hygiene at the University of Toronto, to succeed Dr. J. A. Amyst, who has been appointed deputy minister of health in the Federal Department of Health, Ottawa.

DISCUSSION AND CORRESPONDENCE

A PROPOSED METHOD FOR CARRYING TRIANGULATION ACROSS WIDE GAPS

So far as is known, the possibility of extending an arc of triangulation across straits or arms of the sea has been limited in the past to cases in which one shore is visible from the other, or at most where the masts of a vessel anchored in mid-channel are visible from both shores. It has occurred to us that much wider

gaps may be bridged by the use of lights raised to a high altitude by aircraft or pilot balloons. For example, the distance between the Florida reefs and Cuba is about 90 miles, and the shores not high enough to permit of intervisibility. From an aircraft at a height of 5,000 feet or more above the middle of the straits both sides would be readily visible in clear weather. Suppose now that a series of stations along the Florida coast had been connected in the usual manner with the triangulation net of the United States, and that another series of points on the Cuban coast had been connected with a triangulation covering the island. A light carried by a dirigible or pilot balloon above the middle of the straits could be observed from two or more stations on each shore, and its position accurately fixed with respect to both systems of triangulation. If two or three such aerial points at distances of 30 or 40 miles along the axis of the channel have been tied in this fashion to both triangulations, a strong connection will have been established between them.

It is obviously necessary either that the "aerial point" should remain fixed while observations are being made on it, or that the observations at the different stations should all be exactly synchronized. The first is impossible, but the second alternative can easily be realized by using practically instantaneous flashes as signals and observing them photographically. A quantity of flash powder sufficient to produce a signal which could be photographed from 50 miles distance could probably be carried by an unmanned balloon of moderate size and cost, or failing this, a series of such charges attached to parachutes and ignited by time fuses could be dropped from a dirigible.

The photographic records would preferably be made with lenses of moderately large aperture and long focus, such as are used for astronomical chart work, which give a field of good definition several degrees in diameter. If the observation stations are several miles back from the shore line, a series of reference lights can be established on the shore, and their azimuths accurately determined in advance. The photographs will then show these lights as well as the distant flashes, and the angular elevation and azimuth of the latter can be determined directly from the plates themselves, in exactly the same manner in which astronomers determine the position of a planet with reference to neighboring stars. A number of successive flashes could be recorded on one plate, provided they were so spaced as to avoid confusion, with marked economy both in flying time and computation. Clear weather would be necessary, but not more so than in the case of ordinary methods of observation.

With regard to accuracy, it is well known that this standard method of determining angular position by the measurement of photographic plates is capable of very high precision. For example, at the Allegheny Observatory with a 4-inch objective the probable error of a resulting angular coordinate derived from two plates was found to be $\pm 0.2''$. The apparent angular diameter of the flash as seen from a distance of 50 miles would be roughly $1''$ for each foot of its actual linear diameter. As settings may be made on the center of a photographic image within 1 per cent. or 2 per cent. of its diameter, the azimuth of the flash should be obtainable with sufficient accuracy for purposes of primary triangulation, particularly as the mean position determined from the several successive flashes on one plate should be regarded as the real unit of observation. Irregularities in refraction are likely to be less serious than in the case of rays which pass closer to the earth's surface.

This method might also be advantageous in crossing wide areas of swamp or jungle. The limiting distance over which it is available can be determined only by actual experiment, but it is likely to exceed 100 miles, which would be great enough to permit the extension of continuous triangulation along the whole chain of the West Indies. The theoretical distance of the horizon from an altitude of 20,000 feet is over 170 miles, so that if the difficulties involved in producing flashes photographically observable at this great distance

can be surmounted, it may ultimately be possible to connect Australia with the East Indies and so with Asia.

H. L. COOKE,
HENRY NORRIS RUSSELL
PRINCETON UNIVERSITY

TWO NEW BASE MAPS OF THE UNITED STATES

AN outline base map of the United States on the Lambert Zenithal equal area projection, scale 1–7,500,000, dimensions 19¾ inches by 25¾ inches, price 15 cents, has just been issued by the Coast and Geodetic Survey.

The map covers the whole of the United States, including the northern part of Mexico. Only state names and boundaries, principal rivers, capitals, and largest cities are shown, the chief object being to furnish a base map for political, census, or statistical purposes on a projection in which the property of equivalence of area is one of the essential features. It is the first publication of a projection of this type by the Coast and Geodetic Survey.

The two errors, to one or both of which all map projections are liable, are change of area and distortion, as applying to portions of the earth's surface. Errors of distortion imply deviation from right shape in the graticules or network of meridians and parallels of the map, involving deformation of angles, curvature of meridians, changes of scale, and errors of distance, bearings, or area.

In the mercator projection as well as in the Lambert Conformal Conic projection, the changes in scale and area can not truly be considered as distortion or as error. A mere alteration of size in the same ratio in all directions is not considered distortion or error. These projections being conformal, both scale and area are correct in any restricted locality when referred to the scale of that locality, but as the scale varies in latitude from point to point large areas are not correctly represented.

In the Lambert Zenithal projection the zenith of the central point of the surface to be represented appears as pole in the center of the map; the azimuth of any point within the surface, as seen from the central point, is the same as that for the corresponding points of the map; and from the same central point, in all directions, equal great circle distances to points on the earth are represented by equal linear distances on the map. The amount of scale error, as we depart from the center of the map radially, increases (scale becoming smaller), while in a direction at right angles thereto the scale is by the same amount too great.

For a distance from the assumed center of the map equal to 22 degrees of arc of a great circle, an extent embracing the whole of the United States, the maximum scale error is but one and seven eighths per cent. The amount of this error is less than one third of the scale error in a polyconic projection of the same area, while the direction errors (errors of angles and azimuths) are likewise considerably less than in the latter projection.

An outline base map of the United States on the Lambert Conformal Conic projection, scale, 1–5,000,000, dimensions, 25 by 39 inches, price, 25 cents, has also been issued by the Coast and Geodetic Survey. This map is similar to the one on the Zenithal Equal Area projection in general treatment. It is larger in scale, however, but embraces a lesser extent of latitude, being limited to the area of the United States, whereas the zenithal equal area map includes the greater portion of Mexico.

The map is of special interest from the fact that it is based on the same system of projection as that which was employed by the allied forces in the military operations in France.

The term *conformal* has been defined as follows: If at any point the scale along the meridian and the parallel is the same (not correct, but the same in the two directions) and the parallels and meridians of the map are at right angles to one another, then the shape of any very small area on the map is the same as the shape of the corresponding small area upon the earth. The projection is then called orthomorphic (right shape).

The value of this new outline map can best be realized when it is stated that throughout