last century and rose to distinction in his profession, though I have no evidence of his being closely related to the Maryland Mayers.

By all of the latter, except the subject of Dr. Woodward's sketch, the name was invariably spelled with an "e" in the last syllable. The future student of heredity is very likely to be misled by this change, which seems unfortunate unless there existed some sufficient reason, not apparent at this moment.

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SCIENTIFIC BOOKS

Terrestrial and Celestial Globes, their history and construction including a consideration of their value as aids in the study of geography and astronomy. By EDWARD LUTHER STEVENSON, New Haven, Yale University Press, published for the Hispanic Society of America, 1921, Volume I, xxvi + 218 pp., 95 plates; Volume II, xii + 292 pp., 72 plates.

These magnificent volumes present in a most interesting way the development of globes from earliest times up to the nineteenth century. The first volume treats terrestrial globes in antiquity, celestial in antiquity, globes of the Arabs, globes of the Christian middle ages, those constructed in the period of the great discoveries, and in four further chapters globes of each quarter of the sixteenth century. The second volume discusses globes of the seventeenth and eighteenth centuries in two chapters each, with a final chapter on the technic of globe construction, including materials and methods particularly of making the gores.

A bibliographical list, which makes no pretense of being exhaustive, gives approximately 600 titles; an "Index of Globes and Globe Makers" occupies 25 pages; and finally a "General Index" follows, occupying 16 pages. For use as an ordinary index the inclusion of items of the bibliographical list and names given in the index of globes and globe makers would have been highly desirable. As it is all three indices must be consulted to determine whether given items are mentioned in the work.

The section devoted to Arabic globes and the section relating to globes in antiquity are based upon material of thirty years ago and longer. There is more recent material, and the use of modern works would have improved these chapters. In particular no mention is made of Suter's great work on the mathematicians and astronomers of the Arabs[1] which includes the references of the Fihrist. Suter mentions as writers on the use of the armillary sphere, or on the planisphere or astrolabe, Al-Sufi and Al-Fazari (p. 3) of the eighth century, Al-Nairizi of the tenth (p. 45) and also Al-Biruni, Al-Zarkali of the eleventh, and Ibi- al-Bannah, whose activity extended into the fourteenth century. Al-Zarkali's instruments were famous and one of his works discussing instruments was published in Latin translation by Johann Schoner at Nürnberg in 1534.

With reference to the Greek conception of a globular earth the works of both T. L. Heath[2] and of the late Pierre Duhem[3] contain the latest and best information by the highest authorities on these matters. It may be of interest to note that Theon of Smyrna C. 150 A.D. (ed. J. Dupuis, Paris, 1892, p. 287) states that the Babylonians "explained celestial phenomena" and were able "to predict celestial phenomena to come, the Chaldeans by the aid of arithmetical methods, the Egyptians by graphical methods."

The bibliography could easily have been extended to give more adequate conception of the wide interest in globes, and the large amount of literature bearing directly upon globes in works of the sixteenth to nineteenth centuries.

Probably the most notable omission is that of any reference to one of the earliest works in the English language containing an extensive discussion of both celestial and terrestrial globes. Robert Recorde, an English physician,

[1] Suter: "Die Mathematiker und Astronomen der Araber," *Abhandl. zur Geschichte der Math. Wissenschaften*, Vol. 10, 1900.

[2] T. L. Heath: "Aristarchus of Samos, . . . A History of Greek Astronomy to Aristarchus, etc.," Oxford, 1913; "A History of Greek Mathematics," Oxford, 1921, 2 vols. In Vol. II, pp. 17-18, Heath states that Archimedes wrote a work on *Sphere-making* which is lost.

[3] "Le Système du Monde," 5 vols., Paris, 1913-1917.

wrote in English treatises on Arithmetic, Algebra, Geometry and Astronomy which were the most widely used of sixteenth century English text-books on mathematics. The titles were intended to be attractive: The Grounde of Artes, the Whetstone of Witte, The Pathwaie to Knowledge, and The Castle of Knowledge. The last mentioned is the astronomical work, published in London in 1556, and contains a section on pages 35-60, "The Seconde treatise of the Castle of Knowledge wherein is taughte the makinge of the materiall sphere, as well in sounde or massy forme, as also in ryng forme with hoopes." Recorde discusses the mounting of such spheres as well as the use of them.

An earlier Englishman who deserves passing mention is William Batecombe or Badecumbe who is reputed to have written about 1420 two works evidently on spheres: De Sphæra Solida and De Sphæra Concava fabrica et usu. The former of these works is reported by Bale to have been in the library of Robert Recorde.

Another sixteenth century writer who deserves mention is Fr. Baroccius whose Cosmografia published at Venice in 1585 contains material on globes and a passage (p. 227-228) "vsi sumus globo terrestri, quem Gaspar Vopelius Mathematicus anno 1553 ab ortu Christi construxit." No globe of this date by Vopel is known; while Stevenson, following Fiorini, ascribes an armillary sphere to one Giovanni Maria Baroccius, it might equally well be due to this astronomer.

The bibliographical list is unsatisfactory in several points. The items are not included in the final index; many items relate to works not cited in the text, and the title as given frequently does not indicate why the work should be included; many treatises and discussions of globes widely used and easily accessible in New York are not included.

As an illustration of a title which does not indicate the reason for its inclusion, take the Cosmografia of Peter Smit. The 1720 edition which is available to me here includes in the title the phrase "Als mede het maken van de Hemelsche en Aardsche Globe," but this is left out in the bibliography.

A work on the globe which went through three editions by 1661 is Pierre Bourdin's Traité de l'usage du globe terrestre, included in his Le Cours de Mathématique (Bibl. Chem. Math., 2 vols. 1921). Such a work should be included.

Of English discussions of globes Sotheran's recent catalogue mentions two that are anonymous: The antiquity and excellency of globes, 26 pp., 1652, and Treatise of the Descriptive Use of both Globes, 1718. I have an anonymous treatise in German, Einleitung zur Erkent. und Gebrauch der Erd und Himmels-Kugeln, Nürnberg, 1767, which mentions Lowiz and also a Professor Hasen in Wittenberg as designers of the Homann globes.

In view of the distinguished author's connection with the Hispanic Society the references to Spanish works treating globes are surprisingly limited in number. Among Spanish treatises on the subject which apparently enjoyed wide popularity in the eighteenth century may be mentioned Thomas Vicente Tosca's discussion. This appeared in the eighth volume (out of nine volumes) in the third edition of Tosca's Compendio Mathematico published at Valencia in 1757; it is in the geography, Libro IV, pp. 157-184, under the title, "De la fabrica y uso del Globo Geographico, y de todo genero de Mapas." The writer treats the making both of gores and of moulds.

A similar and contemporary German work which went through numerous editions was Johann Christian Wolff's Elem. Math. Universæ. The edition published in five folio volumes in Verona, 1746-1751, contains De Globi terrestri artificialis constructione et usu, in Vol. IV and De Globo coelesti artific, in Vol. III, with discussion of gores.

No uncertainty need be entertained as to the date when Lalande made his celestial globe (II, p. 182), as in his Astronomie, Paris, 1792, Vol. I, p. 247, Lalande says: "J'ai publié un nouveau globe celeste en 1775." On pages 616-617 of Vol. III Lalande discusses the manufacture of globes. But more interesting is the price list of globes in 1791 which he gives in Vol. I, pp. lx-lxiii. The celestial and terrestrial mounted, etc., of Robert of Vaugandy, the two for 300 livres in size 17½ ponces; the one foot size, corrected by Messier, the two for 80 livres; 10 inch at 15 livres each. The

then more recent globes of Bonne and Lelande were sold in the one foot size at 100 livres the pair; 10 inch at 18 livres; 8 inch at 10 livres; 6 inch at 7 livres. The prices are more than double those quoted by Stevenson (II, 136) from Moxon, a century earlier.

Lalande cites among the enormous globes one at Cambridge and one at Lyon by Picpus de la Guillotiere. Lalande further states that the finest of the large terrestrial globes is that made in 1787 by D. Bergerin. The Cambridge celestial globe was made, according to the *Encyclopedia Britannica* (IX edition, Vol. X, Globes, p. 683) about 1764 by Dr. Roger Long, professor of astronomy and master of Pembroke College. This globe was 18 feet in diameter, lined with tin. No one of these three men is mentioned by Stevenson.

Nowhere does the author touch upon early appearances of globes in America, North or South. One would expect to find the earliest references in Mexico or Peru; certainly in North America globes must have been imported in the eighteenth century and possibly even constructed here. In the geography by John Payne, revised by James Hardie, that appeared in New York in 1798, there is a figure of an artificial sphere and pages xxxi-xxxviii are devoted to the use of the globe; other references could doubtless be found.

These additions have been made to indicate the wide appeal which globes have made in the past as instruments of instruction. Stevenson's work may well stimulate a revival of interest in globes for instruction purposes.

The two volumes constitute an enduring monument of American scholarship. The press work and the plates are up to the highest standards of the finest presses of Europe. It is to be hoped that students of astronomy and geography in American colleges will make the appearance of a second edition of more than 1,000 copies necessary. The author is to be congratulated upon having added new laurels to his crown in a field closely related to cartography wherein the name of Edward Luther Stevenson has so long stood first in America and almost alone.

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SPECIAL ARTICLES

THE EFFECT OF ABSORBED HYDROGEN ON THE THERMOELECTRIC PROPERTIES OF PALLADIUM

IT is well known that palladium will absorb relatively large quantities of hydrogen under the proper conditions. Palladium black absorbs the gas more readily and in larger quantities than the solid metal but the latter will contain several hundred times its own volume. The purpose of the work here described was to determine the effect of the absorbed gas on the thermoelectric properties of the metal.

The palladium used was in the form of a strip $0.01 \times 0.125 \times 10$ cm. It was first annealed in a vacuum at a temperature of 1,000° C., and then used in a thermo couple with a strip of platinum as the other metal. The cold junction was kept at 0° C. and the hot junction could be heated to various temperatures up to 300° C. This strip of platinum was used as a reference metal throughout all of the determinations.

After the thermoelectric power was obtained, the palladium strip was heated to a temperature of about 700° C., in vacuo, and then allowed to cool slowly in an atmosphere of hydrogen. It is well known that palladium will absorb hydrogen under these circumstances. The thermoelectric power obtained with the gas filled metal against platinum was less than with gas free metal, amounting in one case, at 0° C., for instance, to 73 per cent. of the gas free value. The palladium was then heated in vacuo to a temperature of about 700° C., to remove the hydrogen, and another determination showed the thermoelectric power to have returned to its gas free value. This process was repeated several times, the gas filled palladium having its thermoelectric power against platinum lowered each time hydrogen was absorbed, and restored again to its original value after the hydrogen had been removed.

A much greater decrease in the thermoelectric power of palladium against platinum as a reference metal was obtained when the palladium was filled with hydrogen by the electrolytic method. The palladium strip was used as the cathode in the electrolysis of water from a very dilute solution of sulphuric acid. The