XV

THE PRESIDENTS

Presidents of the Society were elected annually, until Dec., 1900, when, with the sixth P, biennial periods went into force. So it has remained ever since, with immediate reelection prohibited. The Society has had 24 presidents, each serving for two years except the second P, Dr. McClintock, who held the office for four consecutive terms. At the time of their first election to the office their ages varied from 38.6 (Fiske) to 62.8 (Newcomb), the average age being 49.7 years; for the last ten presidents, this age has been 51.6 years. Ten of the presidents have died and the average of their ages at the time of death was 72.2 years. Four presidents were born outside of the United States: one in Canada, two in England (one never naturalized), and one in Russia. Only two remained unmarried; three married Germans.

Most of the presidents have been men of national, or international, distinction. Seventeen have been members of the NAS; one has attained to a position in the Hall of Fame; two were Copley medalists of the RS London; one was a for. assoc. of the Acad. des Sci., Institut de France; one was a fellow, and two were foreign members of the RS London; five were elected correspondents of the Acad. des Sci., Institut de France; four, presidents of the AAAS; one, president of a great research institution; one, chm. of the Div. Phys. Sci. NRC; eight were awarded honorary degrees by foreign universities (Hill, Newcomb, E. H. Moore, Van Vleck, Brown, Veblen, Birkhoff, Snyder); ten were vice-presidents of AAAS and chairmen of Section A; three served as acting president or vice-president of their universities; seven have had books published in foreign languages—one P had books translated into Bohemian, Dutch, German, Japanese, Norwegian, Russian, Swedish; and one had his collected mathematical works published.

The names of the presidents, together with their periods of service, are as follows:

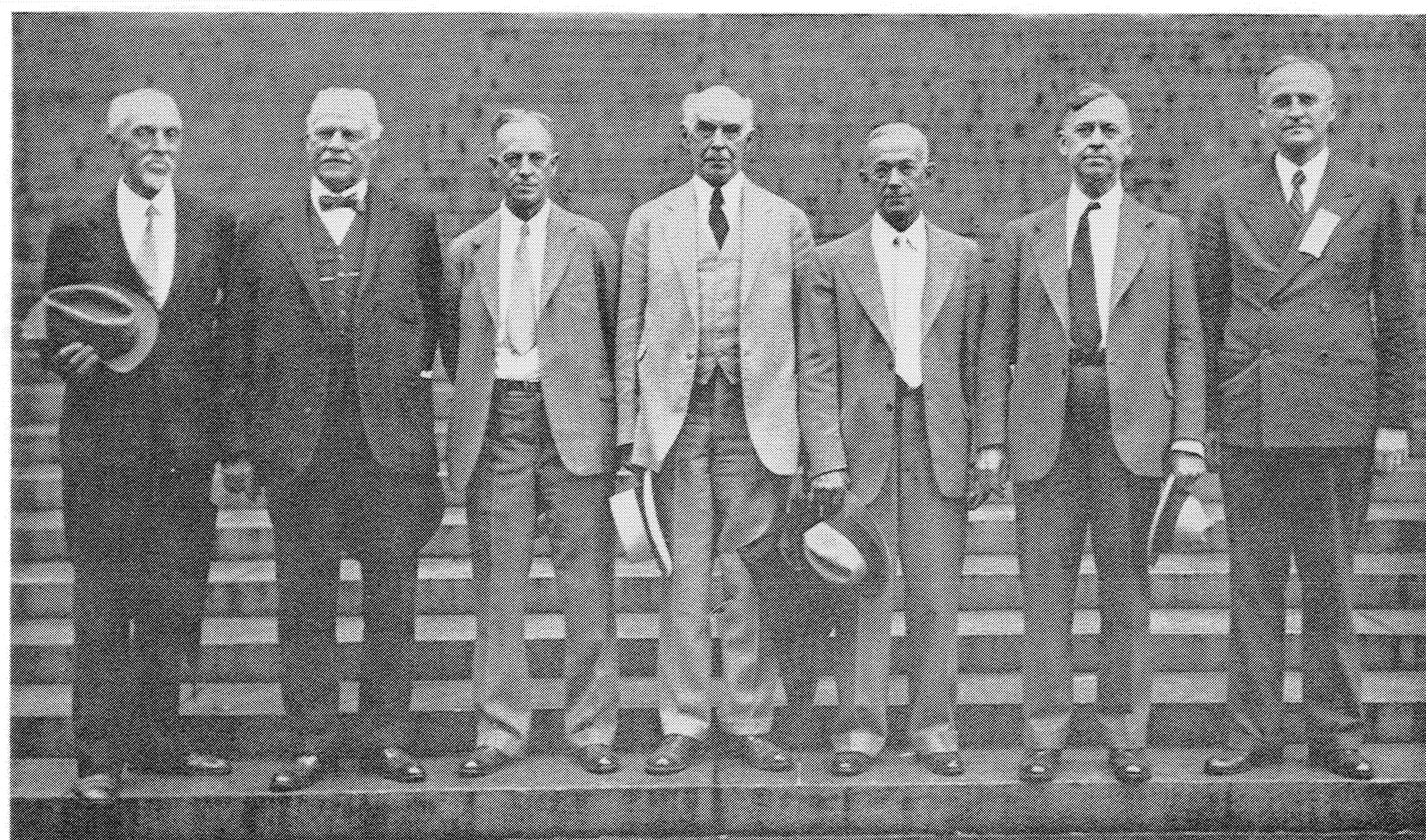
1. J. H. Van Amringe, 29 Dec. 1888–1890
2. J. E. McClintock, 1891–1894
3. G. W. Hill, 1895–1896
4. S. Newcomb, 1897–1898
5. R. S. Woodward, 1899–1900
6. E. H. Moore, 1901–1902
7. T. S. Fiske, 1903–1904
8. W. F. Osgood, 1905–1906
9. H. S. White, 1907–1908
10. M. Bôcher, 1909–1910
11. H. B. Fine, 1911–1912
12. E. B. Van Vleck, 1913–1914
13. E. W. Brown, 1915–1916
14. L. E. Dickson, 1917–1918
15. F. Morley, 1919–1920
16. G. A. Bliss, 1921–1922
17. O. Veblen, 1923–1924
18. G. D. Birkhoff, 1925–1926
19. V. Snyder, 1927–1928
20. E. R. Hedrick, 1929–1930
21. L. P. Eisenhart, 1931–1932
22. A. B. Coble, 1933–1934
23. S. Lefschetz, 1935–1936
24. R. L. Moore, 1937–1938

Among living presidents Lefschetz is the youngest, and then Birkhoff, both b. in 1884; R. L. Moore, b. 1882, comes next. According to colleges or universities where the presidents received their first degrees, four each were from Columbia U. (Van Amringe, McClintock, Woodward, Fiske), and Harvard U. (Newcomb, Osgood, Bôcher, Birkhoff—see also Veblen, below); two each from U. Cambridge (Brown, Morley), Gettysburg C. (Eisenhart, Coble), U. Texas (Dickson, R. L. Moore), and Wesleyan U. (White, Van Vleck); one each from U. Chicago (Bliss), École Centrale (Lefschetz), U. Iowa and Harvard U. (Veblen), Iowa State C. (Snyder), U. Michigan (Hedrick), Princeton U. (Fine), Rutgers C. (Hill), and Yale U. (E. H. Moore).

Among the first twelve presidents E. H. Moore and Van Vleck were the only ones who were not from the "East"; among the next twelve there were five—Dickson, Bliss, Hedrick, Coble, R. L. Moore. The universities or organizations with which the presidents were connected when elected, are as follows: U. California at L. A. (Hedrick), U. Chicago (E. H. Moore, Dickson, Bliss), Columbia U. (Van Amringe, Woodward, Fiske), Cornell U. (Snyder), Harvard U. (Osgood, Bôcher, Birkhoff), U. Illinois (Coble), JHU (Newcomb, Morley), Mutual Life Insurance Co. of N. Y. (McClintock), Nautical Almanac Office (Hill, Newcomb), Princeton U. (Fine, Veblen, Eisenhart, Lefschetz), U. Texas (R. L. Moore), Vassar C. (White), U. Wisconsin (Van Vleck), Yale U. (Brown). Five of the presidents received their doctor's degrees under three other presidents, viz.: under E. H. Moore (Dickson, Veblen, Birkhoff); under Veblen at Chicago (R. L. Moore); and under Morley (Coble). Five presidents took their degrees under Klein (Bôcher, Fine, Van Vleck, Snyder, White). Among the others who guided presidents to the doctorate were H. A. Newton (E. H. Moore), M. Noether (Osgood), O. Bolza (Bliss), D. Hilbert (Hedrick), T. Craig (Eisenhart), W. E. Story (Lefschetz).

In 1903 when 80 of the leading mathematicians were listed according to their rated achievements at that time (*Amer. Men Sci.*, 5th ed.), 16 of the names of the presidents appeared in the following order: 1. E. H. Moore, 2. Hill, 3. Osgood, 4. Bôcher, 5. Newcomb, 6. Morley, 7. Brown, 8. White, 9. Dickson, 11. Van Vleck, 17. McClintock, 21. Woodward, 22. Fiske, 29. Fine, 38. Hedrick, 41. Snyder. Under Astronomy Newcomb and Hill were bracketed equal in first place among 50; and under Physics Woodward was no. 11 among 150.

In the following pages an attempt is made to bring together in very compact form an array of material which may suggest the career, achievements (and their recognition), and some characteristics, of each P. For the most part the Bibliographies of publications are fairly complete—about 2000 out of some 2400 items (395 by Newcomb were omitted). References to most "abstracts" have been omitted. The presidents published about 140 v. (a quarter of them by Newcomb) and nearly two scores of pamph-



FORMER PRESIDENTS OF THE SOCIETY AT HARVARD UNIVERSITY SEPTEMBER 1936

WHITE FISKE BLISS OSGOOD COBLE DICKSON BIRKHOFF lets. It is believed that these Bibliographies, especially in the case of members of the NAS, may be very suggestive of the development of mathematical research in America during the past half century. A few brief notes draw attention to some of the most important items, or to others which, for one reason or another, appear to be of some interest. Doctoral dissertations and the Society's Presidential addresses are specially noted. The first of these addresses was given by McClintock, the second P, in 1894, at the close of his fourth term as P. Since the By-Laws thereafter stated that "it shall be the duty of each President to deliver an address before the Society at the annual meeting next succeeding his first election as president of the Society", the third, fourth and fifth presidents each served another year after the delivery of his address. Three changes in the By-Laws then introduced provided that the president be elected for a term of two years, that he be ineligible for immediate reelection, and that he be required to deliver an address "at the annual meeting at which his term of office expires." This applied to the succession of presidents sixth to nineteenth inclusive, but the following four exceptions had to be made: (i) on account of illness the delivery of President Osgood's address was postponed from Dec. 1906 to April 1907; (ii) President Bôcher was requested by the Council to postpone his address from the annual meeting of 1910 to an especially arranged meeting of the Society in April 1911; this wise move for promoting good feeling in the Chicago group was brought about by Professor Van Vleck; (iii) President Fine being absent in Europe during 1912–13, his address was delivered at the annual meeting of 1913 instead of that in 1912; (iv) because of President Snyder's absence in Europe at the time of the annual meeting in 1928, his retiring address was a feature of the following summer meeting. The next form of By-Law in this connection was equally inflexible, "It shall be the duty of the President to deliver an address . . . at the annual meeting one year after his term of office expires"; on this mandate Professor Hedrick, the twentieth P, delivered his retiring address in 1931. But the next retiring address was delivered by Professor Eisenhart at the annual meeting of 1932 because the By-Laws had once again been changed, stating that the address was to be given "at the close of his term of office or within one year thereafter." Such a By-Law from the first would, without special actions, have covered all exceptional cases which had earlier occurred.

Each living ex-president was a member of the Council of the Society from April 1900 to the end of 1923; since then, the period of such membership has been limited to the six years after the expiration of his presidential term. Thus there are at most three ex-presidents who are *ex officio* members of the Council.

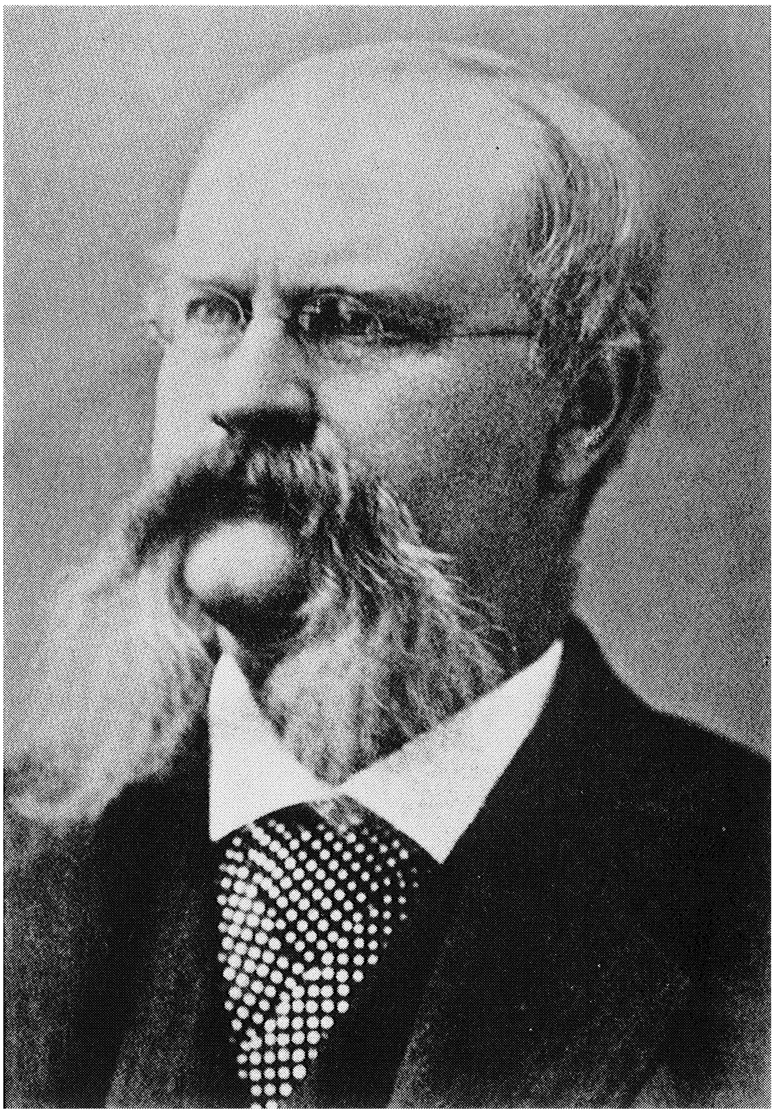
In connection with the following sketches the "Sources" contain references to fuller information in different directions. There were ten "Presidents" at the summer meeting of 1936 at Harvard U. (Fiske, Osgood, White, Brown, Dickson, Bliss, Birkhoff, Hedrick, Coble, Lefschetz). A group picture of seven of these, taken at that time, is reproduced in this v.

1. John Howard Van Amringe

Curriculum Vitae.—B. Philadelphia, Pa. 3 Apr. 1835 (not 1836); d. Morristown, N.J. 10 Sept. 1915. Educated by his father and at Montgomery Academy, N.Y., whence he entered Yale in 54. He remained two years. After a two-year interlude of teaching he entered Columbia C. (58–60, A.B. 60; tutor in math. 60–63, A.M. 63). At Columbia he was adjunct prof. 63–65, prof. of math. in the School of Mines 65–73, and in the School of Arts 73–10; emeritus prof. of math. 10–15; head of the dept. math. 92–10; dean of the School of Arts 94–96; dean of Columbia C. 96–10.

Honors.—Secy. Alumni Assoc. Columbia C. early 70's. Hon. Ph.D. U. State of N.Y. 77. One of the charter members and first P NYMS Dec. 88–90; mem. its Council 91–93. Hon. L.H.D. Columbia C. 90. P Alumni Assoc. Columbia C. 91–93; P Alumni Council 95–13. Hon. LL.D. Union C. 95. Vestryman of the Parish of Trinity Church, New York 99–15. Acting P Columbia U. for a short time 99. Portrait painted by Eastman Johnson, now in South Hall, College Lib. 00; best portrait. P Columbia U. Club in New York City from its foundation to his death 01–15. Mem. board managers St. Luke's Hospital 01–15; VP 12–14. Mem. executive comm. N.Y. Hist. So. Dec. 05–Feb. 09. P Church Club of N. Y. 06–08. Hon. LL.D. Columbia U. 10. Bust executed by W. O. Partridge and two casts made, one for Hamilton Hall and one for the Columbia U. Club 11; the first of these was placed in the Van Amringe Memorial in the middle of the Van Amringe quadrangle in front of Hamilton Hall, in 22. This Memorial, a circular structure of classic design, was dedicated in 18; north and south of it are stone benches containing inscriptions taken from Van Am's speeches, (see J. W. Robson's *A Guide to Columbia University*, 1937, p. 91–92). VP Century Assoc. 12–15. P Alumni Federation 13–15. Among other positions of honor which he held are the following: trustee of the Protestant Episcopal So. for the Promotion of Religion and Learning in the State of New York; trustee of the N.Y. Protest. Episcopal Public School; mem. board managers, N.Y. Bible and Common Prayer Book So.; trustee General Theological Seminary of the Protest. Episcopal Church in the U.S.

Biographical Notes.—Prof. Van Amringe's grandfather was a soldier under Frederick the Great and emigrated from Holland to America in 1791. "Van Am," as he was universally called, is a unique figure in the history of Columbia U. "Probably no other teacher of his day was so loved and revered, and 'his boys' have delighted to perpetuate his memory at Columbia in song [there's a *Van Am Columbia Songster*, 1909], and stone, and bronze, and oils. Scarcely had he become an alumnus when he began to arouse an interest in the college among the alumni, and to restore the semi-moribund alumni association; imbuing others slowly with his own enthusiasm, he made the association a vital and vivifying influence in the whole university. . . . He was a fluent orator, speaking in 'exquisitely phrased sentences, rich in thought and suggestion, often imbued with deep feeling and genial humor'." (M. H. Thomas). Although in no sense ranking with research mathematicians of his own day it was only natural that one of his prominence, occupying the position that he did, should have become our Society's first president. "In spite of life in a great city, he was a veritable provincial. . . . He knew almost nothing nor cared to know anything of any other educational institution in this country or



J. H. Van Amringe

1890

the world. He was, therefore, the ideal college patriot, and consequently the idol of the students and alumni of the college, although he was quite a disciplinarian in his classroom. . . . He was a brave man and a perfectly unselfish one. He cared nothing for money; spent his salary before he received it; and was always having some accident, such as breaking an arm or a leg. His good wife once said to me that she trembled every time the doorbell rang, lest Howard should be brought in with a broken leg. He was a great smoker and a great frequenter of clubs. He was also something of a politician and was frequently to be found at the caucuses of his party. He was a good, staunch, reliable friend and very agreeable in social intercourse. No one could know the man and not love him." (Burgess). He was very fond of outdoor life and fishing and he spent many summers in the Adirondacks, some of them in the company of Judge Gildersleeve.

One of Columbia's most popular songs is the adaptation to Van Am (by the well-known author and editor, W. A. Bradley) of "John Peel," the fine old English hunting song:

D'ye ken Van Am, with his snowy hair,
D'ye ken Van Am, with his whiskers rare,
D'ye ken Van Am, with his martial air,
    As he crosses the Quad in the morning?
Refrain: For the sight of Van Am raised my hat from my head;
And the sound of his voice often filled me with dread,
Oh! I shook in my boots at the things that he said,
    When he asked me to call in the morning.
Yes, I kenn'd Van Am—to my sorrow, too,
When I was a Freshman of verdant hue;
First a cut, then a bar, then an interview
    With the Dean in his den in the morning.
But we love Van Am from our heart and soul;
Let's drink to his health! Let's finish the bowl!
We'll swear by Van Am through fair and through foul,
    And wish him "the top o' the morning!"
D'ye ken Van Am, with his fine old way,
Dean of Columbia many a day?
Long may he live, and long may he stay
    Where his voice may be heard in the morning.

It is not a little moving to be present towards the close of a Columbia U. banquet when the great volume of the sonorous melody of this song rises and falls by candle light, and tears run down the furrowed faces of many "old grads," as their thought dwells on earlier contacts with Van Am.

SOURCES.—The best single source is *Columbia Alumni News*, 5 Nov. 1915, in which section 2, 42 p., is devoted to Van Am, containing portraits, a biography by J. B. Pine, memorial addresses by President Butler and Seth Low, the song quoted above, etc. M. H. Thomas, *DAB*, v. 19, 1936. *Nat. Cycl. Amer. Biog.*, v. 13, 1906, portrait. *Universities and their Sons*, v. 2, 1899, portrait. N. M. Butler, *Columbia Spectator*, 20 Apr. 1931. J. W. Burgess, *Reminiscences of an American Scholar*, 1934.

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2. *Life Assurance and Savings Banks. A lecture delivered . . . in the Cooper Institute February 17, 1872,* New York, 1872, 32 p.

3. *A Plain Exposition of the Theory and Practice of Life Assurance, with a Brief Sketch of its History,* New York, 1874, 61 p. The substance of this pamphlet was prepared as an article for Johnson's *New Universal Cycl.*

4. *An Historical Sketch of Columbia College in the City of New York 1754–1876,* New York, 1876, ii+243 p.

5. Edited *Elements of Geometry and Trigonometry from the Works of* A. M. Legendre *adapted to the course of mathematical instruction in the United States* by Charles Davies, 1882, 275+134+62 p.; 1885, 291+150+71 p.; 1890, 291+150+71 p.

6. C. Davies, *Elements of Surveying and Levelling,* rev. by J. H. Van Amringe, New York, Chicago, 1883, 374+29+161 p.

7. "The school of mines," *School of Mines Quart.*, v. 10, 1889, p. 338–350.

8. "History of Columbia University," *Universities and their Sons,* New York, v. 1, 1898, p. 571–731. He was also the author or ed. of the sketches of Columbia men in v. 2–5, 1899–1900.

9. Address to the Alumni, Commencement 1898, *Columbia U. Quart.*, v. 1, 1898, p. 21–24.

10. "What the college buildings should be," *Columbia U. Quart.*, v. 1, 1899, p. 272–273.

11. "Columbia University and the education of women," *Church Eclectic,* New York, v. 28, 1900, p. 33–37.

12. Letters of Van Am in *Class Books* of 1900, 1902, 1904, *Five Year Class Book* [of Class of 1899] 1904, 1905, 1906, 1907, 1908, 1909, 1910; and also in the junior class *Columbian,* 1909, 1910, 1911, 1912. Van Am's portrait appeared in several of the v.

13. "Ogden N. Rood," *Columbia U. Quart.*, v. 5, 1902, p. 47–62.

14. "Charles King LL.D.," *Columbia U. Quart.*, v. 6, 1904, p. 121–137+portrait frontispiece.

15. "King's College and Columbia College" in *A History of Columbia University 1754–1904,* New York, 1904, p. 1–195.

16. "Columbia men in the making of the nation," *Columbia Mo.*, v. 2, 1905, p. 97–98 [Extract from an address at the sesquicentennial dinner of the Alumni].

17. "A letter from the dean," *Columbia Mo.*, v. 2, 1905, p. 209–210.

18. "Some reflections on the growth of Columbia College," *Columbia U. Quart.*, v. 9, 1906, p. 34–36.

19. "Henry Yates Satterlee," *Columbia U. Quart.*, v. 10, 1908, p. 198–199.

20. "Edward Mitchell," *Columbia U. Quart.*, v. 11, 1909, p. 342–343.

21. "George Gosman DeWitt," *Columbia U. Quart.*, v. 14, 1912, p. 176–178.

2. John Emory McClintock

Curriculum Vitae.—B. Carlisle, Pa. 19 Sept. 1840; d. Bay Head, N.J. 10 July 1916. Student at Dickinson C., Carlisle (54–56), Yale U. (56–57), Columbia U. (57–59, A.B. 59; tutor math. 59–60; A.M. 62). Student chemistry at U. Paris and U. Göttingen (61–62). U.S. consular agent at Bradford, Eng. 63–66. Connected with a banking firm in Paris 66–67. Actuary Asbury Life Ins. Co. of N.Y. 67–71; and Northwestern Mutual Life Ins. Co. Milwaukee 71–89. Actuary Mutual Life Ins. Co. of N.Y. (89–11; vice-pres. and trustee 06–11; consulting actuary 11–16).

Honors.—Fellow Institute of Actuaries, London 74. Hon. Ph.D. U. Wisconsin 84. Hon. LL.D. Columbia U. 85. A founder and fellow ASA 89; mem. council 89–91. VP AMS 90. P AMS 91–94. VP ASA 91–95. Assoc. fellow AAcAS 92. Awarded second prize, for an essay (Bibl. no. 42), by the Institute of Actuaries, London 92. P ASA 95–97. Corresp. mem. Association des Actuaires Belges 96. VP for the U.S. of the Permanent Comm. of Intern. Congresses of Actuaries

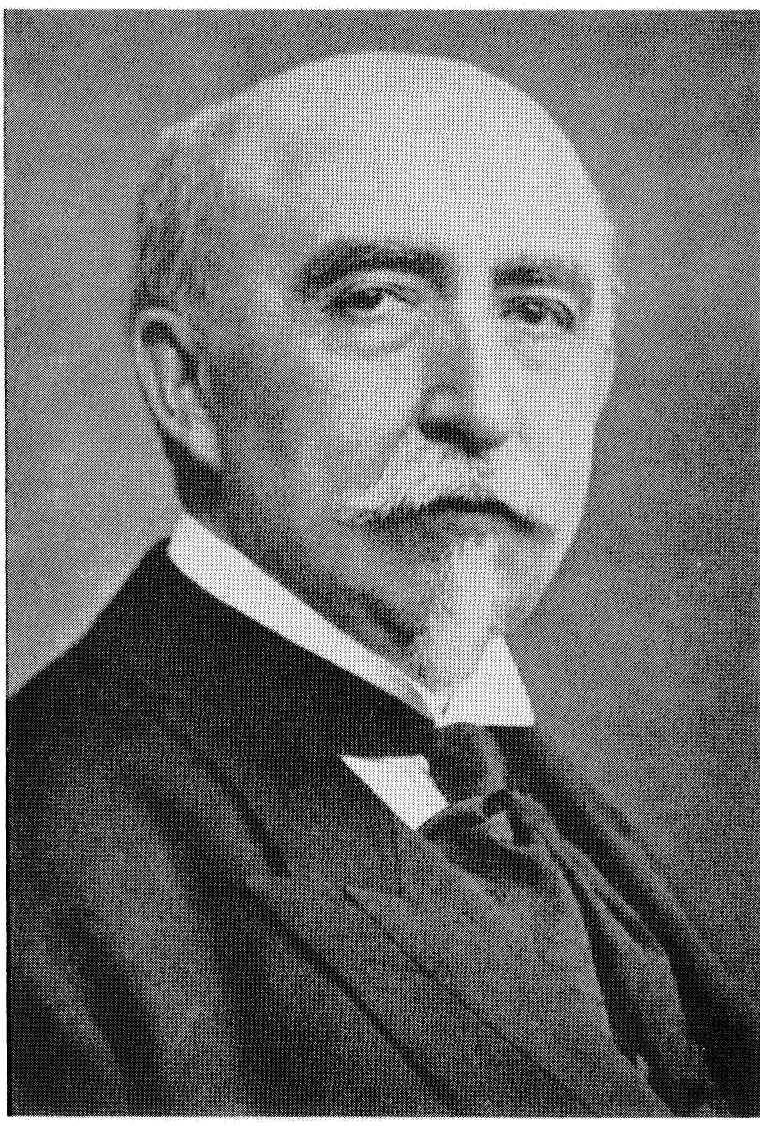
96–16. Corresp. mem. Institut des Actuaires Français 96. Hon. LL.D. Yale U. 99. Governor So. Colonial Wars in the State of N.J. 00–04. Starred *Amer. Men Sci.* 06.

BIOGRAPHICAL NOTES.—Dr. McClintock was a son of John M'Clintock (not McClintock) whose parents were both born in county Tyrone, Ireland, but moved to Pennsylvania. This John M'Clintock was prof. of math. Dickinson College, Carlisle, Pa. 1837–40 and prof. of classics there 1840–48; it was he who collaborated with J. Strong in editing the great *Cyclopaedia of Biblical, Theological, and Ecclesiastical Literature,* (New York, 12 v., 1857–87). On his mother's side Dr. McClintock was of puritan ancestry, being a descendant of John Wakeman (d. 1661) of Hartford, Conn., whose parents were natives of Bewdley, England. J. Emory received his degree A.B. at Columbia, *honoris causa,* when only eighteen years of age, and some time before the rest of his class, because the authorities wished to meet an emergency by at once appointing him a tutor. But he resigned in 1860 to go to Paris where his father during the Civil War was in charge of the American chapel and of signal service to the Union cause.

Although our list of McClintock's publications is probably incomplete, it is much more extensive than anything of the kind previously published. It will be observed that thirty articles dealing with various actuarial questions were published during the years 1868–77. His services to the Northwestern helped greatly in developing its policy and in building up that company, and he became one of the best informed life insurance men in the country. His remarkable abilities and long experience "gave him a unique position in the insurance world in the stormy days of the Armstrong Investigation in 1905. His testimony before that committee [no. 70] was the most complete and comprehensive statement of the phases through which American life insurance passed since its early days . . . and the opinions which he then expressed on various subjects formed the basis of much of the legislation which followed." (Hutcheson). After his appointment in 1906 as vice-president of the Mutual he went to Europe to direct changes in the company's European agencies, made necessary because of recent legislative investigation and enactments. His testimony at this time before a comm. appointed by the House of Lords to investigate the necessity of requiring foreign companies doing business in Great Britain to deposit funds for the security of British policy holders (no. 71) did much to influence this comm. to report against any such action. His influence in stabilizing, and inspiring confidence in life insurance at this time was great, but he broke under the strain, and had to limit his activities after 1906. Then, and for many years earlier, he was universally recognized as the foremost actuary America had produced, one who had made epoch-making contributions to the theory of life insurance, and one whose judgment on all questions pertaining to his profession was accorded a weight attached to the views of no other. As a business executive also his broad and comprehensive views seldom failed to carry conviction. It was during his presidency of the Actuarial So. of America that the examination system for admission to the Society was inaugurated, and its success was largely due to his inspiration and efforts.

Of McClintock's 22 strictly mathematical papers 15 were published in *AJM*, 5 in NY and AMS *Bull.*, one (no. 66) in *AM* on a simplified solution of the cubic, and one of particular importance (no. 67) in AMS *Trans.*, on the nature and use of the functions employed in the recognition of quadratic residues. Eight of the papers appearing in *AJM* before the Society was founded included the remarkable essay on the calculus of enlargement (no. 31; see "Sources" below, for comment on a paper about this memoir by W. S. Nichols) which was an effort to present the theory of finite differences and the differential calculus from a unified point of view. The paper may be regarded as a precursor of attempts to consider difference equations as differential equations of infinite order. His other more important papers were a series of researches on solvable quintic equations (nos. 36, 37, 61), indicating remarkable clarity of vision and power of manipulation, and the one on quadratic residues (no. 67) already noted. In 1909 he had hoped, with the assistance of Mr. S. A. Joffe, to bring out a v. of his collected papers, but this plan never materialized. McClintock was one of the creative mathematicians of high rank flourishing before the Society came into existence. In 1903 when 80 of the leading mathematicians of the country were selected, McClintock was rated seventeenth, next after Cole. McClintock is known to have expressed regret that he had not followed an academic career, which would have permitted him to give a large share of his time to research and to the enjoyment of those mutually inspiring relations, so often existing between a teacher and his students. In such a direction he would probably have gone far. Professor Fiske, a friend of many years, has written, "McClintock never failed to stimulate and inspire everyone of scientific aptitude or taste with whom he came in contact." Aside from his scholarship he possessed those traits which constitute a really great man. Quiet and unassuming, he was ever ready to extend a helping hand to those who sought his counsel. No subject was too insignificant for him to discuss with the young inquirer. He always gave the impression of being thankful for an opportunity to impart the results of his own thought and experience.

McClintock arrived in New York from Milwaukee in the autumn of 1889 and became a member of the New York Mathematical Society in December. He had that year already participated in the founding of the Actuarial So. of Amer. Almost at once he was elected a VP of NYMS and in the following year its P, the only president in the Society's history to serve for four years, four consecutive terms. Numerous very notable achievements of the Society in this administration are set forth in chapter I. He was a voracious, omnivorous reader, including volumes of his-



Emory McClintock

1904

tory and fiction. Genealogy greatly interested him, and he spent much time in tracing his ancestors in Great Britain and America. For many years his home was at Kemble Hill, near Morristown, N. J.; one of his publications (no. 49) deals with Washington's camp in this neighborhood during the revolution. By his first wife, a Yorkshire lady, he had one son, Major John McClintock, of the U. S. Army, for some time military attaché of the American legation at the court of Austria-Hungary.

SOURCES.—E. McClintock, Autobiographical sketch of extraordinary interest (Bibl. no. 76). *Appleton's Cycl. Amer. Biog.*, New York, v. 9, 1922, portrait. W. A. Hutcheson, T. B. Macaulay, W. S. Nichols, ASA *Trans.*, v. 17, 1916; it is hardly conceivable that Nichols was really informed on the subject (Bibl. no. 31) about which he was writing. T. S. Fiske, AMS *Bull.*, v. 23, 1917. *Intern. Ins. Encycl.*, v. 1, New York and London, 1910. H. F. Tyrrell, *Semi-centennial History of the Northwestern Mutual Life Insurance Co. of Milwaukee*, 1908, portrait. D. E. Smith, *DAB*, v. 11, 1933. *Amer. Men Sci.*, 2d ed., 1910 and 5th ed., 1933.

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4. "Annuitants' mortality," *Ins. Times*, v. 1, 1868, p. 450.

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6. "Improved accumulation formula," *Spectator*, v. 1, 1868, p. 274.

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8. "Surrender value," *Ins. Times*, v. 2, 1869, p. 125.

9. "The contribution plan. A theoretical limitation," *Ins. Times*, v. 2, 1869, p. 211; "The contribution plan again," p. 515.

10. "On the iniquity of net valuations," *Ins. Times*, v. 2, 1869, p. 719.

11. "The contribution plan: its merits and defects," *Spectator*, v. 3, 1869, p. 75.

12. "Actual vs. assumed premiums," *Ins. Times*, v. 3, 1870, p. 23.

13. "The proposed reform in state valuations," *Ins. Times*, v. 3, 1870, p. 805. The index states incorrectly that the art. "Relative merit" in this v. was also by McClintock.

14. "Cash surrender values. Elizur Wright's proposed bill," *Ins. Times*, v. 4, 1871, p. 339.

15. "On the comparative importance of policies," *Ins. Times*, v. 4, 1871, p. 570a–570b.

16. "On the comparative importance of life policies," *Ins. Times*, v. 4, 1871, p. 733.

17. "On the comparative importance of life insurance policies," *Ins. Times*, v. 4, 1871, p. 857, 859, 861, and v. 5, 1872, p. 274.

18. "Formulae for dividend calculations," *Ins. Times*, v. 4, 1871, p. 657.

19. "Valuation formulae," *Spectator*, v. 7, 1871, p. 446–447.

20. "Suggestions on the use of Elizur Wright's calculating machine," *Ins. Times*, v. 5, 1872, p. 743.

21. "Arousing the sleepers," *Ins. Times*, v. 6, 1873, p. 131.

22. "Assessing expenses," *Ins. Times*, v. 6, 1873, p. 656.

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3. George William Hill

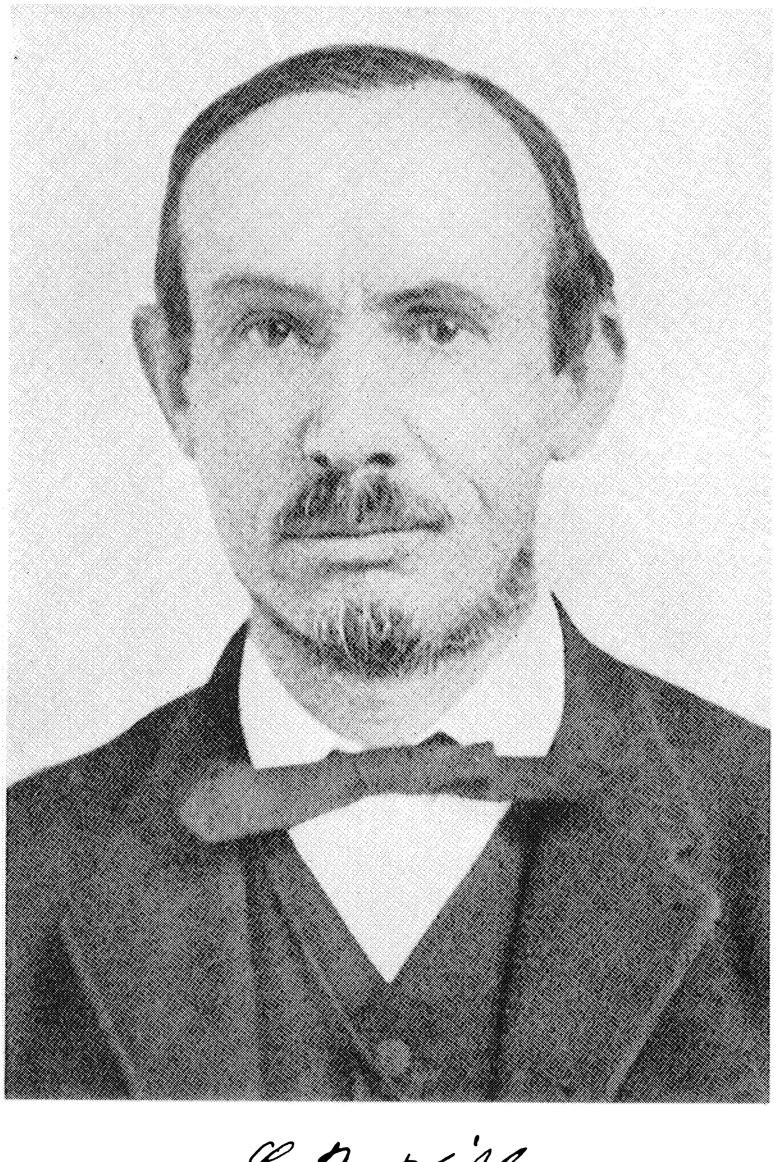
Curriculum Vitae.—B. New York City 3 Mar. 1838; d. West Nyack, N.Y. 16 Apr. 1914. After attending the local school he went to Rutgers C. (A.B. 59); joined the staff of the Nautical Almanac Office (61), but after a year or two in Cambridge he obtained permission to do his work at his home in West Nyack until he moved to Washington, D.C. in 82 and worked there until 92, when he resigned his position and returned to West Nyack, where he spent the rest of his life. He lectured on Celestial Mechanics at Columbia U. for four years 93–95, and 98–00 (see Hill's letter 8 July 1907 in Mittag-Leffler Library, Djursholm, Sweden, and *Columbia U. Bull.*, July 1894).

HONORS.—Hon. Ph.D. Rutgers C. 72. Assoc. fellow AAcAS 73. Mem. NAS 74. For. assoc. RAS 78. Gold Medal RAS, for his researches on the lunar theory (see presidential address by J. W. L. Glaisher, RAS *MN*, v. 47, p. 203–220) 87. Hon. mem. Cambridge Phil. So. 90, "on the ground of his investigations on the secular motion of the moon's perigee and other researches in the lunar theory;" elected at the same time as Brioschi, Gibbs, Kronecker, Lie, and Poincaré. Hon. Sc.D. U. Cambridge 92. Corresp. mem. Manchester Lit. and Hist. So. 92. Hon. LL.D. Columbia U. 94. P AMS 95–96. Hon. LL.D. Princeton U. 97. Corresp. mem. BAAS 97. Damoiseau triennial prize of 2000 francs of the Acad. des Sci., Institut de France 98, "pour l'ensemble de ses travaux mathématiques et astronomiques" (see report *CR* Paris, v. 127, 1898, p. 1080–1081). Hon. mem. N.Y. Acad. Sci. 98. For. mem. RS London 02. Mem. Amer. Phil. So. 03. Corresp. mem., sect. astr., Acad. des Sci., Institut de France 03. Schuberth Prize (900 roubles, about $461) by the Imperial Acad. Sci., St. Petersburg 05; this prize is the income of a foundation in honor of a former academician F. F. Schuberth, a general in the infantry. Hill's *Collected Mathematical Works*, 4v., published by the Carnegie Institution, Washington, D.C., 07–09. Hon. mem. LMS 07. Hon. fellow RS Edinburgh 08. Corresp. mem. Bavarian Acad. Sci. 08. Bruce Gold Medal, ASP 08; (eighth award, see presidential address by C. Burckhalter, ASP *Pub.*, v. 21, p. 51–60). Copley Medal RS London 09; the highest scientific honor in the gift of the British Empire. Assoc. mem. Acad. Royal des Sci. . . . de Belgique 09. For. mem. So. of Sci. in Christiania 10. Hon. mem. Calcutta Math. So. 10; at the same time as Osgood, Darboux and Picard. For. mem. Swedish Acad. Sci. 13. For. mem. Acad. Lincei 13. Centenary of Hill's birth to be celebrated by a special number of *AJM*, Oct. 38; the following are among announced contributors: Birkhoff, E. W. Brown, Levi-Civita, Morse and Hedlund, v. Neumann, Toeplitz, Whittaker, Wintner.

BIOGRAPHICAL NOTES.—G. W. Hill's grandfather John Hill (1770–1850), and father John William Hill (1812–79), were both born in England. The grandfather (see *DAB*) made his mark as an engraver in aquatint in London before emigrating to Philadelphia in 1816, and settling there. About 1846 he retired to a lonely upland farm near West Nyack. The father was a painter as well as an engraver and leader of the Pre-Raphaelite school in America. G. W. Hill's brother John H. Hill (1839–1922), carried on the family tradition as an artist into the twentieth century.

G. W. Hill was one of the small number of outstanding research mathematicians among the Society's presidents (Simon Newcomb is not counted among these), and none of them, except Birkhoff, has yet equalled Hill in the extensive international recognition of his eminence. In 1903 Newcomb wrote that Hill would "easily rank as the greatest master of mathematical astronomy during the last quarter of the nineteenth century." In 1903 mathematicians also voted that E. H. Moore was the leading mathematician of the United States and Hill next; by the astronomers Hill and Newcomb were bracketed as first, and equal, in their field (see *Amer. Men Sci.*, 5th ed., p. 1269, 1272).

Hill's first publication (Bibl. no. 1) appeared before he graduated from Rutgers, and less than twenty years elapsed when memoirs of epoch-making importance had appeared (nos. 31, 35). One of these, "Researches in the lunar theory", was in the opening number of the newly founded *AJM*. "In this paper he calculated the first step in a new method for treating



1890

the motion of the moon under the attractions of the earth and sun. What proved to be equally important in the paper was the initiation of the 'periodic orbit'—an idea which has had a profound effect on the later development of celestial mechanics. In the hands of H. Poincaré, G. H. Darwin, and many others, it has greatly changed the approach to the study of the motions of three mutually attracting bodies. Its publication gave new life to a subject which had seemed to be marking time in merely securing higher numerical accuracy for the various gravitational theories of the bodies in the solar system, and the impetus is not yet exhausted. Another useful idea, the surface of zero velocity, is also set forth in this paper." (E. W. Brown, 1932). It is a surface consisting of various ovals and folds, giving certain limitations on the path of the moon, and therefore carrying on the stability of its motion one important step. "This memoir of but fifty quarto pages has become fundamental for the development of celestial mechanics in three different directions. It would be difficult to say as much for any other publication of its length in the whole range of modern mathematics, pure or applied. Poincaré's remark that in it we may perceive the germ of all the progress which has been made in celestial mechanics since its publication is doubtless fully justified." (Brown, 1915).

Hill's second great memoir (no. 31) was first published privately in 1877, in the year before the one to which reference has just been made; it was entitled, "On the part of the motion of the lunar perigee which is a function of the mean motions of the sun and moon," and while not so far reaching as the memoir first discussed above, from the point of view of future developments, it is even more remarkable as an exhibition of Hill's extraordinary power of analysis. His discussion leads him to the differential equation

$$\frac{d^2p}{dt^2}+(\theta_0+\theta_1 \cos 2t+\theta_2 \cos 4t+ \cdots)p=0,$$

(θ_0, θ_1, θ_2 . . . being constants), now known as "Hill's equation." A recent work (in Russian) of G. V. Bondarenko is entitled *Uravnenie Khilla i ego Primenenie v Oblasti Tekhnicheskikh Kolebanii* [*Hill's Equation and its Application in the Domain of Technical Oscillations*] (Moscow and Leningrad, 1936, 51 p.). For Lord Rayleigh's use of the equation in the discussion of physical questions see *Phil. Mag.*, v. 24, 1887, p. 145 or Rayleigh, *Scientific Papers*, v. 3, p. 1f. See also A. N. Krylov's recent volume, supplementary to v. 5–6 of his collected works (Moscow-Leningrad, 1937), p. 152–248; and E. L. Ince, "On a general solution of Hill's equation," RAS *MN*, v. 75, 1915, p. 436–448. This equation is equivalent to an infinite number of algebraic linear equations. By a most elegant method Hill showed how to develop the infinite determinant corresponding to these equations. This determinant is set equal to zero and the unknown is calculated correct to fifteen places of decimals. Hill's work with the infinite determinant was wholly original; he knew nothing of Fürstenau's obscure publications of a few years earlier and if he had they would have aided him not at all in arriving at his results. Hill reduced his determinant to a convergent form, but the proof of the convergence was left to Poincaré (SMF *Bull.*, v. 14, 1886, p. 77). It is not a little interesting that J. C. Adams of Cambridge, England, the co-discoverer with Leverrier of the planet Neptune, had somewhat earlier than Hill constructed and evaluated the infinite determinant but he kept to the lunar problem while Hill extended the idea in a general manner (see RAS *MN*, v. 38, Nov. 1877, p. 43–49).

During his ten years in Washington, Hill worked constantly on the theories of Jupiter and Saturn, the most difficult parts of Newcomb's grandiose scheme involving all of the planets. The final result of Hill's achievement in this connection is one of the most important contributions to mathematical astronomy of the past century. Among his later papers is a noteworthy contribution (nos. 42 and 45) for calculating the effects of the planets on the motion of the moon. This is, in effect, a particular case of the problem of four bodies. (Brown). His biographies of Oliver and Hall (nos. 69, 97) are exceedingly interesting.

Among the unpublished manuscripts left behind by Hill, and now deposited in the library of Columbia University, are two of some interest. The earlier is a carefully written diary, illustrated with photographs, containing an account of the second expedition which he made to the northwest of Canada. The route followed took him, with a companion and guides, by rivers and lakes from Lake Superior to Hudson's Bay and back. It must have been sufficiently laborious, with the numerous portages of the canoes and supplies, but Hill apparently found enough spare energy to record everything of sufficient interest to appeal to him. The other manuscript, which must have cost him a great deal of labor, consists of the lectures delivered at Columbia University. They are a more or less complete, but very concise, account of the methods by which the motions of the moon and planets are computed.

Hill loved to roam through pathless woods, and the whole country in Virginia, for twenty miles about Washington, and for miles about West Nyack, was an open book to him. He knew all the trees and flowers, and in most cases their common and botanical names, genera, and species. He would walk twenty-five or thirty miles a day with little apparent exertion. Birds held not a little fascination for him. Nature's secrets, oddities, and beauties were objects of his constant search.

Hill never married. His chief characteristic was a single-minded devotion to the subject which he had made his own. A highly sensitive conscience was always apparent in his dealings with the world. "He never appeared to be melancholy or morose. To him the world was always bright. He could tell amusing stories of some hardships on his excursions, but not a word of complaint. He mingled with his fellow men wherever he went, and was always glad to see his friends, both abroad and at his home. He freely helped all who asked his aid." (Hedrick).

In April 1936 Prof. Frank Schlesinger, the director of the Yale Observatory, and one of Hill's students at Columbia U., placed a bronze tablet on the Hill homestead in West Nyack. It bears the following inscription: George William Hill | 1838–1914 | Astronomer Mathematician | lived in this house.

SOURCES.—E. W. Brown: (a) *DAB*, v. 9, 1932; (b) with H. B. Hedrick and others, NAS *Biog. Mem.*, v. 8, 1916; (c) RS London, *Proc.* v. 91 A, 1915, reprinted in AMS *Bull.*, v. 21, 1915. E. W. Brown, E. T. Whittaker and others in *Encyk. d. Math. Wiss.*, v. 6.2. A and B, 1912–26 (see numerous references in alphabetical index). J. J[erwood], RAS *MN*, v. 75, 1915. S. C[hapman], LMS *Proc.*, s. 2, v. 14, 1915. H. Poincaré, *Collected Mathematical Works of George William Hill*, v. 1, Washington, D.C., 1905. F. Schlesinger, "Recollections of George William Hill," ASP *Pub.*, v. 49, 1937. S. Newcomb, *Reminiscences of an Astronomer*, 1903. T. Muir, *Theory of Determinants in the Historical Order of Development*, London, v. 3, 1920. Thieme—Becker, *Lexikon der bildenden Künstler*, v. 17, Leipzig, 1924. F. Weitenkampf, *American Graphic Art*, New York, 1912.

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3. "On the conformation of the earth," *Runkle's Math. Mo.*, v. 3, 1861, p. 166–182.

4. "Ephemeris of the great comet of 1858," *AN*, v. 64, 1865, p. 181–190.

5. "On the reduction of the rectangular coordinates of the sun referred to the true equator and equinox of date to those referred to the mean equator and equinox of the beginning of the year," *AN*, v. 67, 1866, p. 141–142.

6. "Discussion of the observations of the great comet of 1858, with the object of determining the most probable orbit," AAcAS *Mem.*, v. 9, 1867, p. 67–100.

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62. "Discussion of the observations of Saturn with resulting values for the elements of the orbit and the masses of Jupiter and Uranus," *APAE*, v. 7, 1895, p. 147–167.

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*64. "Tables of Jupiter, constructed in accordance with the methods of Hansen," *APAE*, v. 7, 1895, pt. I, p. 1–144.

*65. "Tables of Saturn, constructed in accordance with the methods of Hansen," *APAE*, v. 7, 1895, pt. II, p. 145–285.

66. "On the convergence of the series used in the subject of perturbations," AMS *Bull.*, v. 2, 1896, p. 93–97.

67. "Remarks on the progress of celestial mechanics since the middle of the century," AMS *Bull.*, v. 2, 1896, p. 125–136, AMS P add. 27 Dec. 1895. Also in *Science*, n.s., v. 3, 1896, p 333–341.

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*69. "Memoir of James Edward Oliver 1829–1895," NAS *Biog. Mem.*, v. 4, 1896, p. 57–74.

70. "On the values of the eccentricities and longitudes of the perihelia of Jupiter and Saturn for distant epochs," *AJ*, v. 17, 1897, p. 81–87.

71. "On intermediary orbits in the lunar theory," *AJ*, v. 18, 1897, p. 81–87.

*72. "Observations on Professor Newcomb's determination of the principal element of precession," *AJ*, v. 18, 1898, p. 153–156; correction p. 168.

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74. "On the inequalities in the lunar theory strictly proportional to the solar eccentricity," *AJ*, v. 20, 1899, p. 115–124.

75. "On the extension of Delaunay's method in the lunar theory to the general problem of planetary motion," AMS *Trans.*, v. 1, 1900, p. 205–242, 508–509.

76. "Ptolemy's problem," *AJ*, v. 21, 1900, p. 33–35.

77. "Normal positions of Ceres," *AJ*, v. 21, 1900, p. 51–54.

78. "Secular perturbations of the planets," *AJM*, v. 23, 1901, p. 317–336.

79. "On the use of the sphero-conic in astronomy," *AJ*, v. 22, 1901, p. 53–56.

80. "Illustrations of periodic solutions in the problem of three bodies," *AJ*, v. 22, 1902, p. 93–97, 117–121.

81. "On the application of Delaunay transformations to the elaboration of the secular perturbations of the solar system," *AJ*, v. 22, 1902, p. 183–189.

82. "Examples of periplegmatic orbits," *AJ*, v. 24, 1904, p. 9–14.

83. "The theorems of Lagrange and Poisson on the invariability of the greater axes in an ordinary planetary system," *AJ*, v. 24, 1904, p. 27–29.

84. "Comparison of the new tables of Jupiter and Saturn with the Greenwich observations of 1889–1900," *AJ*, v. 24, 1904, p. 60–61.

85. "Development of functions in power series from special values," *AJ*, v. 24, 1904, p. 123–128.

86. "Deduction of the power series representing a function from special values of the latter," *AJM*, v. 27, 1905, p. 203–216.

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89. "Application of the Delaunay transformation in the planetary theories," CI *Pub.*, no. 9, v. 4, 1907, p. 345–391.

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91. "Development, in terms of the true anomaly, of odd negative powers of the distance between two planets moving in the same plane," CI *Pub.*, no. 9, v. 4, 1907, p. 398–407.

92. "On the construction of maps," CI *Pub.*, no. 9, v. 4, 1907, p. 408–418.

93. "Dynamic geodesy," CI *Pub.*, no. 9, v. 4, 1907, p. 419–452.

*94. "Attraction of the homogeneous spherical segment," *AJM*, v. 29, 1907, p. 345-362.

*95. "Subjective geometry," AMS *Bull.*, v. 14, 1908, p. 305–313.

*96. "The Jovian evection in the lunar theory," *AJ*, v. 25, 1908, p. 193–196.

*97. "Biographical memoir of Asaph Hall 1829–1907," NAS *Biog. Mem.*, v. 6, 1908, p. 241–309.

*98. "Motion of a system of material points under the action of gravitation," *AJ*, v. 27, 1913, p. 171–182.

*99. "The secular perturbations of the four outer planets," *AJ*, v. 28, 1913, p. 59–71.

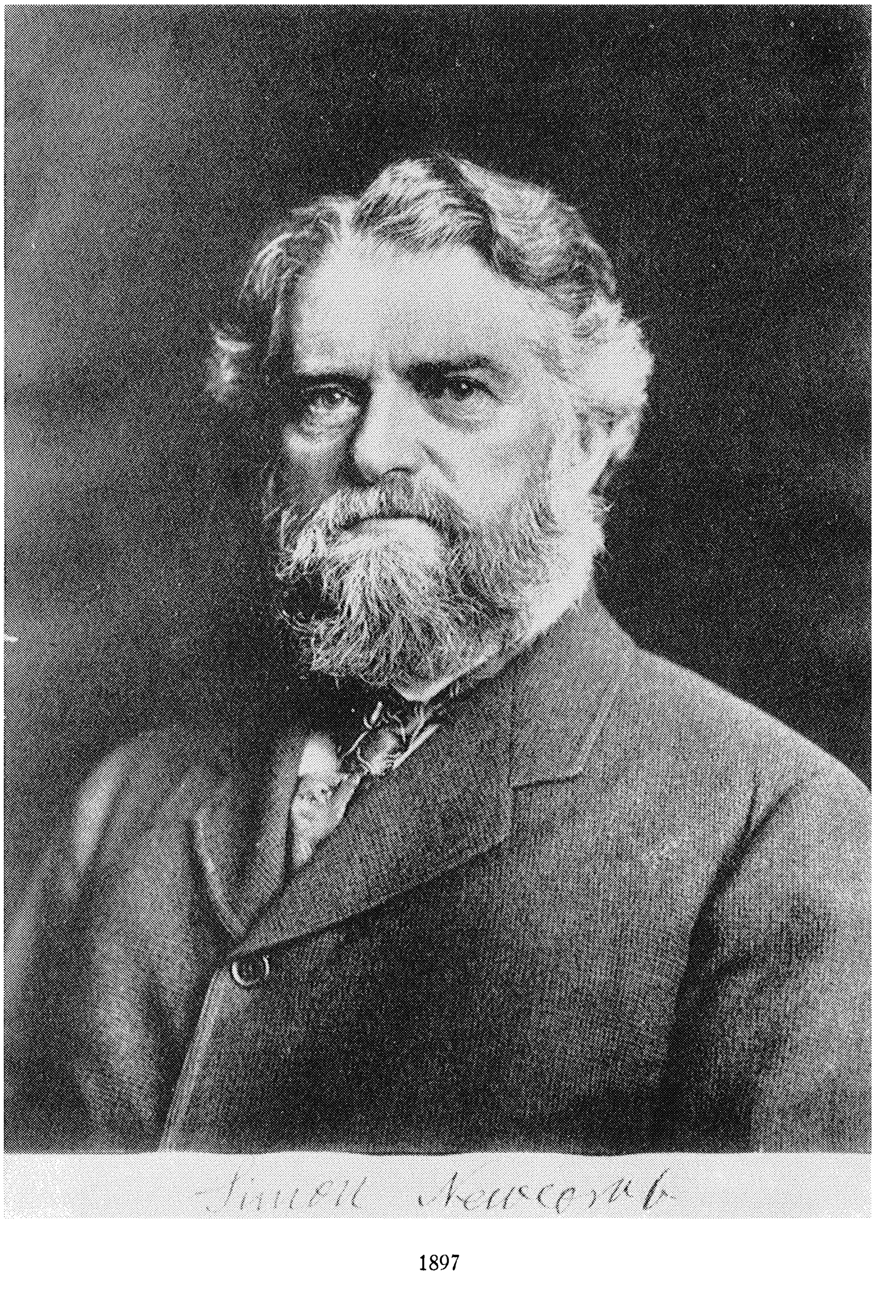
*100. "Hypergeometric series and Walker's table of the Leverrier coefficients," *AJ*, v. 28, 1914, p. 93–100.

*101. Reviews of books by J. N. Stockwell in *Analyst*, 1882; and by Gylden in *AJ*, 1894.

4. Simon Newcomb

Curriculum Vitae.—B. Wallace Bridge, Nova Scotia, Can. 12 Mar. 1835; d. Washington, D.C. 11 July 1909. Taught by his father. Came to U.S. in 53. Teacher in a country school at Massey's Cross Roads, Md. 54, and in the village school at Sudlersville, Md. 55. Computer in Nautical Almanac Office, Cambridge, Mass. (Jan. 57–Sept. 61; office moved to Washington in 66). Prof. math. U.S. Navy (Sept. 61-Sept. 77; senior prof. math. and supt. Naut. Alm. Office Sept. 77–Mar. 97). Lect. in Columbian, afterwards George Washington, U. (73–84; prof. astr. 84–86). Prof. math. and astr. JHU (Oct. 84–Dec. 93; 98-00; prof. math. emeritus 00–09). Lect. U. California summer 07. Became citizen of U.S. probably sometime 57–61.

Honors.—Expedition, directed by S. Newcomb and W. Ferrel, to observe total solar eclipse Lake Winnipeg, Can., July 60. Fellow AAcAS 60. Mem. NAS 69. In U.S. Govt. exped. solar eclipse to Des Moines, Ia. Aug. 69, to Gibraltar Dec. 70, to Separation, Wyo. July 78, and to Cape of Good Hope Dec. 82 (see Bibl. nos. 21, 26). Hon. LL.D. Columbian U. 74. Corresp. mem., sect. astr. Acad. des Sci., Institut de France 74. Awarded Gold Medal RAS for his "tables of Neptune and Uranus and other mathematical works" 74. Offered directorship Harvard Obs. 75. Hon. master of math. and Ph. Nat. D., U. Leyden 75; on the celebration of the 300th anniversary of its founding. Hon. LL.D. Yale U. 75. For. assoc. Royal Swedish Acad. Sci. 75. Corresp. mem. Imp. Acad. Sci., Leningrad 75. Corresp. mem. Royal Bavarian Acad. Sci. 76. P AAAS 76; ret.



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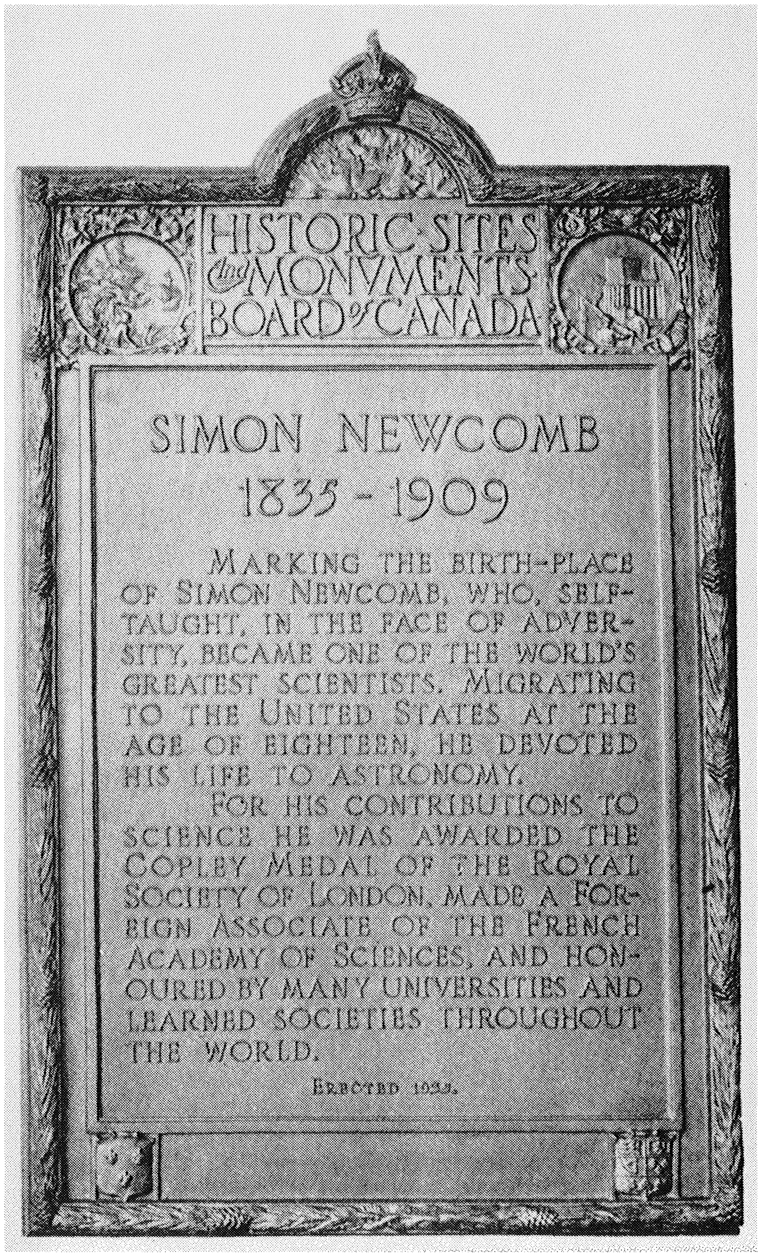

TABLET IN MONUMENT ERECTED BY THE CANADIAN GOVERNMENT add. "The course of nature" (no. 44). Assoc. Royal So. Sci., Upsala 77. For. mem. RS London 77. Mem. Amer. Phil. So. 78. For. mem. So. Dutch Sci., Haarlem, and awarded by this So. Huygens Medal 78; biennially "awarded to the individual who by his researches and discoveries or inventions during the previous twenty years had in the judgment of the Society distinguished himself in an exceptional manner in a particular branch of science." Hon. mem. Cambridge Phil. So. 78. P Phil. So. Wash. 79–80 and 08. Lect. (4 lects.) on political economy at Harvard U. 79–80. For. fellow RS Edinburgh 81. Chm. NAS advisory comm. on meteorology 81–84. One of three administrators for NAS of the Watson Fund providing means for supporting research and the award of the Watson Gold Medal 81–09; he was chm. board of trustees 87–09 (E. W. Brown received this medal in 37). Lowell Lect. (12 lects.) Boston 81–82; "History of astronomy." For. mem. Royal Physiographic So., Lund 81. Hon. mem. Royal Irish Acad. 82. VP NAS 83–89. Corresp. mem. Prussian Acad. Sci. 83. Hon. LL.D. Harvard U. 84. Corresp. mem. BAAS 84. Ed.-in-chief *AJM* 85–93, 99–00; assoc. ed. 78–79, 95–98, 01–08. P Amer. So. Psychical Research 85–86. Offered presidency U. California 85. Hon. Ph.D. U. Heidelberg, on the celebration of the 500th anniversary of its founding 86. Hon. mem. (at same time as Chrystal and Sylvester) of Assoc. for the Improvement of Geom. Teaching, afterward Math. Assoc., London 86. P Alumni Assoc., Lawrence Sci. School, Harvard U. 86. P Political Economy Club of Amer. 87. Russian emperor ordered portrait painted and placed in gallery of famous astronomers at the Pulkovo Obs. 87. Hon. LL.D. Columbia U. on the occasion of its centenary cel. 87. Hon. mem. Manchester Lit. and Phil. So. 87. Presented by U. Tokyo with pair bronze vases of exquisite workmanship 88. In recognition of his great services in securing for Pulkovo Obs. a large object glass, presented by the Czar of Russia with a rare vase of jasper 89. Awarded Copley Medal RS London, for contributions to the progress of gravitational astr. 89; the medal was accompanied by a check for £50. Hon. mem. N.Y. Acad. Sci. 91. One of 21 eminent scientific men elected Hon. mems. Royal Institution G.B., on the cel. of the Faraday centenary 91. Hon. mem. comm. organization Fifth Intern. Congress Geologists, Wash. 91. Hon. LL.D. U. Edinburgh 91. Hon. mem. Astr. and Phys. So. Toronto now RAS Can. 91. For. assoc. Royal Acad. Sci., Brussels 91. Hon. Sc.D. U. Dublin in cel. tercentenary of its founding 91. Hon. Ph. Nat. D. U. Padua in cel. tercentenary Galileo's appointment as prof. 92. Winner first prize $150, of two "citizenship prizes" offered by the Anthropological So. of Wash. for the best essay on an assigned topic, "The elements which make up the most useful citizens of the United States" 94. Math. ed. *Science* 95–03. Awarded *AJ* prize of $400 for the "most thorough discussion of the theory of the rotation of the earth with reference to the recently discovered variation of latitude" 95. Elected one of eight for. assoc. Acad. des Sci., Institut de France to succeed Helmholtz 95; first native Amer. since Franklin so honored. For. assoc. astr. sect. Acad. Lincei 95. Hon. mem. Imp. Acad. Sci., Leningrad 96. Officer Legion of Honor, France 96; authorized by Congress to receive this decoration (see *Congr. Records*, 3 Mar. 97) 96. Hon. LL.D. U. Glasgow 96. Hon. Sc.D. U. Cambridge 96. Hon. LL.D. Princeton U. 96. P AMS 97–98; ret. add. "The philosophy of hyperspace" (no. 112). Awarded the Schuberth Prize (about $460) by the Imp. Acad. Sci., Leningrad 97. Corresp. mem. Imp. Geographical So., Leningrad 97. At 21st anniversary cel. of founding JHU requested by faculty and friends to sit for portrait, painted by R. G. Hardie, to be given to the U.; reproduced in *AJM* 99. For. assoc. Italian So. Sci. (dei XL) 97. Hon. corresp. mem. Royal So. Arts 97. First recipient Bruce Gold Medal, from the ASP 97; the So. had to select recipient from nominees by directors of six observatories Berlin, Greenwich, Harvard, Lick, Paris, and Yerkes, but one name stood forward so prominently the So. could but set the seal of its approval upon the verdict of its peers. Cape Newcomb of the Hoyt Islands, Hubbard Bay, W. Greenland named after S. Newcomb (see *Nat. Geogr. Mag.*, v. 9, p. 3) 98. For. assoc. Royal Inst. Sci. Letters and Arts, Venice 98. Hon. mem. Colonial So. Mass. (one of nine) 98. Hon. mem. Royal Acad. Sci., Amsterdam, 98. Hon. D.C.L. Oxford U. 99. Assoc. corresp. mem. Royal Inst. of Sci. and Letters, Milan 99. For. corresp. Bureau of Longitudes, Paris 99. First P Astr. and Astrophys. So. (now Amer. Astr. So.) and reelected annually until he requested and insisted on relief from the duty 99–05. Hon. LL.D. U. Cracow, Austria on the cel. of the 500th anniversary of its foundation 00. One of two receiving first award of Sylvester Prize of JHU, a bronze medallion of J. J. Sylvester, framed in oak 01; the first impression of the tablet was presented to Lord Kelvin and the second "to Simon Newcomb, a distinguished astronomer, who has been a friend of the university from its inception, and who guided the affairs of the mathematical department." Hon. mem. Russian Astr. So. 01. Hon. mem. Royal So. New South Wales, Sydney 01. Hon. LL.D. JHU at the cel. of the 25th anniversary of its founding, "in recognition of his preeminent attainments and important discoveries in science," 02. Hon. mem. Astr. So. Mexico 02. Presented to King Vittorio Emanuele III of Italy 02. Hon. Math. D. U. Christiania in connection with the cel. of the centenary of the birth of Niels Henrik Abel 02; Newcomb went as delegate from NAS, and during the cel. was presented to King Oscar of Sweden and Norway. Appointed one of five mems. advisory comm. in astr. for the Carnegie Inst. 03; during 03–08 Newcomb received $28,000 in grants towards expenses of his investigations. For. Secy. NAS 03–09. Mem. comm. Amer. Phil. So. to organize bicentenary cel. of Franklin's birth 03. Presented to King Edward VII of England 03. P Intern. Congress of Arts and Sci., Louisiana Purchase Exposition, St. Louis Sept. 04; as P of the Congress he made a special trip to Europe to secure cooperation of leading European men of sci. VP BAAS 04. Corresp. mem. Royal Acad. Sci., Vienna 04. Hon. LL.D. U. Toronto 04. Corresp. mem. Royal Acad. Sci., Turin 05. Corresp. mem. Nat. Inst. of Geneva, Switzerland 05. Knight of the Order Pour le Mérite for Sci. and Arts, Prussia 05; bill granting Newcomb permission to accept this decoration became law Apr. 06. P Cosmos Club, Wash. 06–07. Mem. Board of Overseers Harvard U. 06–09; first election to this body of a grad. of Lawrence Sci. School not already a grad. of the C. Hon. mem. Royal Acad. Sci., Letters and Arts, Padua 06. Commissioned rear-admiral U.S. Navy 06. Commander of the Legion of Honor, France 07. Hon. fellow (one of twelve) Phys. So., London 07. For. mem. So. Sci., Christiania 07. For. mem. Royal So. Sci., Göttingen 07. A VP and invited speaker fourth Intern. Congress Mathems., Rome, Apr. 08. Received in audience by Emperor William II Germany, and lunched with his Majesty and the Empress Aug. 08. VP Amer. Phil. So. 09. Medallion of Newcomb in the sci. panel of one of two bronze doors, designed and modeled by Louis Amateis, for the U.S. Capitol 10. Cut-stone monument with inserted bronze tablet, erected by The Historic Sites and Monuments Board of Canada on the site of Newcomb's birthplace, Wallace Bridge, Nova Scotia, unveiled 30 Aug. 35; see photograph of monument, and add. of R. C. Archibald, *Scripta Mathem.* v. 4, 1936. Bronze bust by Frederick MacMonnies unveiled in the Hall of Fame, N.Y.U. 28 May 36; received 78 out of 100 votes in 35.

Biographical Notes.—Simon Newcomb's ancestry was chiefly English, and in minor degrees Scotch, French, German, and Irish. His ancestors in every line had crossed the Atlantic long before the American Revolution, and the American descent was almost entirely through New England families. Simon Newcomb's paternal grandfather removed to Nova Scotia in 1761. His father John Burton Newcomb was a school teacher, and his gifted mother Emily Prince bore two daughters and five sons, of whom Simon was the eldest.

Since no other American scientist has ever accumulated such an extraordinary collection of honors as those listed above (and the list might have been considerably extended) an attempt will be made to record some brief suggestions as to reasons for such acclaim. (I shall often closely follow E. W. Brown's sketch which is especially valuable.) First of all it should be borne in mind that more than forty years have passed since Newcomb became president of the Society, and that in the same year he retired from his position as Superintendent of the Amer. Ephemeris and Nautical Almanac. This was before the founding of the Amer. Astr. So. and before many later extraordinary astronomical developments in America. His connection with the Nautical Almanac Office was for yet another forty years earlier, namely 1857–97. Even during the first decade of this period, with the Civil War and consequent disorganization of Govt. work, Newcomb began an investigation on the asteroids which resulted in one of his most important papers (no. 8). This virtually disposed of the explosion theory of Olbers put forward to account for the existence of these minor planets. Already at this time he displayed a grasp of the general principles of celestial mechanics and the methods of dealing with observations, always such a marked feature of all his researches. In 1869 he completed a four-year program of star observations, planned with great care and resting on its own foundations. Discussion of the observations revealed, as he had expected, the presence of systematic errors in existing catalogues of star positions. As his knowledge extended from the fixed stars to the moon, he was becoming more and more impressed with the confusion assailing exact astronomy because of the different values of the constants used by different observers. Two gigantic plans gradually matured in his mind. The one was a determination of all the constants of astronomy and their reduction to a homogeneous system, which would involve extended work on the theories of the planets and satellites. The second was the resolution of the lunar motions and the test of the law of gravitation which a comparison of the lunar theory would involve. The first plan was achieved, and the immense mass of work summarized in a little volume of 1897, *Elements of the Four Inner Planets and the Fundamental Constants of Astronomy* (no. 106). This gathers together his life work and constitutes his most enduring memorial. Leading up to results here won, are his publications, nos. 16, 27, 75, 98, 100, 104, 105, 111, 113, and 114. The theory was not the heaviest part of the work. All known observations had to be collected and compared. It was here that Newcomb's particular genius for the organization of huge masses of material, and his firm grasp of the facts which could be deduced from them, was given free play. The mutual perturbations of Jupiter and Saturn are so large that the problem of unravelling their motions is a much more difficult application of planetary theory than the other six large planets require. For the successful completion of Newcomb's scheme within his life time it was necessary that these two planets should be treated by another hand, and he enlisted the services of G. W. Hill who spent ten years on the work. Newcomb's determination of the solar parallax in 1862 (no. 18) as 8″.848, he corrected to 8″.790 in 1897. In order to fix the constant of aberration, a fresh determination of the velocity of light was carried through with Michelson (no. 82). Greatly increased facilities for observation were made possible in 1873 when he had secured a large refracting telescope for the Naval Obs. His founding of the remarkable series, *Astr. Papers prepared for the Use of the Amer. Ephemeris and Naut. Alm.* (*APAE*) made the results of latest research generally available.

As early as 1859 Newcomb compared observed places of the moon with those given in the Ephemerides, and his last, but one of his best, paper (no. 149) dealt with the motions of the moon and was finished only a month before his death. Other publications in this connection were nos. 19, 20, 23, 25, 39, 99, 145, and 146. In these his personal contributions were numerous and interesting, especially no. 39 in which he added observations carrying back the period dealt with by Hansen for at least 75 years. He had always hoped to prepare a new set of tables of the moon's motion but this was to be finely achieved by E. W. Brown at a later day.

One of Newcomb's rare excursions into pure theory is contained in "The general integrals of planetary motion" (no. 32) and it consists of an attempt to show how the coordinates of a planet, under the attraction of any finite number of planets, may be represented by trigonometric series. Poincaré has used this paper as a text for his investigations into the possibility of such developments (see Poincaré, *Les Méthodes Nouvelles de la Mécanique Céleste*, v. 2, 1893). Another very interesting and little known excursion into non-euclidean geometry (no. 36) was founded on the ideas of Riemann's celebrated doctoral dissertation, and is quoted extensively in Sir Robert Ball's article on measurement in the *Encycl. Brit.*, 9th ed. In the very first paper in *AJM* Newcomb proved (no. 42) a theorem, concerning geometry in fourth dimension, which is often quoted (see chap. I). Turning to Newcomb's other mathematical work, Cayley characterized the memoir on the perturbations of the moon (no. 25) as follows: "from the boldness of the conception and beauty of the result a very remarkable one, and constitutes an important addition to theoretical dynamics." Newcomb was the author of a series of school and college mathematical text-books (nos. 60, 61, 66, 67, 68, 77, 78, 91) which did not have a large sale, except in the case of the mathematical tables (no. 66) which went through many editions. He was, naturally, much interested in questions in the theory of probabilities and least squares (nos. 6, 7, 9, 10, 11, 28, 59, 86, 142). In an address before NYMS in 1893, on modern mathematical thought (no. 101), he began with a disclaimer of any right to be considered a mathematician in the modern sense of the word, but from the remarks which follow it is evident that he had not only read but had devoted much thought to modern ideas on hyperspace, group theory, projective geometry and the like. His presidential add. was on the philosophy of hyperspace (no. 112). We have noted above that he was editor-in-chief of *AJM* for a number of years and prof. of math. and astr. at JHU, where he was one of the first to receive appointment as lecturer on its opening in 1876. In many of the early years he served as examiner in math. and economics. Further indication of Newcomb's interest in the teaching of mathematics (see no. 95, 139) is furnished by the fact that he was chm. of the comm. of ten on math. in secondary education appointed in 1892 by the comm. of the National Education Assoc. of the U. S. The report adopted had a large influence on the teaching of mathematics; the chairman's part in its preparation was considerable.

Among Newcomb's astronomical works reference may be made only to his remarkable *Popular Astronomy* (no. 40) which went through many editions and was translated into Norwegian, Russian and German; to his *Astronomy for Everybody* (no. 125) translated into Russian, German, Swedish, and Bohemian and still annually selling by the thousand in American department stores; to his *Compendium of Spherical Astronomy* (no. 137), still the best of its kind. In the field of Political Economy Newcomb published in 1865 at his own expense, *A Critical Examination of our Financial Policy during the Southern Rebellion* (no. 15) and during the next forty years he wrote many articles, and three other v., including a large work on *Principles of Political Economy* (nos. 33, 84, 85) which was several times reprinted. Newcomb was ranked high as an economist by Irving Fisher and President Hadley of Yale U. and there is little doubt that if he had chosen economics as the chief field of his endeavors he would have been among the foremost of modern economists. He was P Political Economy Club of America in 1887.

He discussed in print various questions connected with meteorology, aerial flight, occultism, life insurance, and a host of other topics. Stories (nos. 107, 130) and even a novel (no. 121) also flowed from his pen. In the novel, airships of the Zeppelin type are successfully employed. Newcomb was sceptical of the possibility of airplanes, since he failed to conceive of motors such as were developed soon after his death. Some samples of his collections of encyclopedia articles are indicated below (nos. 96, 122, 123, 131, 148).

He was indefatigable in his attendance at congresses, scientific meetings and academic functions. At many gatherings of this kind he was a singularly effective presiding officer, and entered upon such duties with pleasure. He rendered exceedingly valuable service in connection with several of the world's great telescopes, and his other contributions to the work of many observatories were great.

"Newcomb's work, driven by untiring energy and guided by philosophic intelligence for more than half a century, placed him at the head of his profession in America, and gave him membership in a small class of the most productive astronomers of all countries and all centuries. His influence upon the development of the science was exerted by speech and by letter as well as by published paper and volume. It was potent with beginners and assistants as well as with veterans and directors. It was applied with singleness of purpose, and solely in the interest of the science. Those who discussed astronomy with Newcomb had the impression of obtaining astronomy in the abstract, impersonal and disembodied, and on that account his scientific associates often failed to understand his personality. A survey of Newcomb's activities leads to the view that he was intellectually a giant." (Campbell).

His favorite motto was, "Whatsoever thy hand findeth to do, do it with all thy might." That, irrespective of his surroundings, he could with all his might concentrate on any subject, explains, in part, the extraordinary extent of his achievements. In the honors showered upon him as a result of these, Newcomb always took a naive pleasure. He spoke French and German fluently and knew sufficient of the languages of Italy and Sweden to be able to travel in these countries with comfort. Accustomed from childhood to long walks he continued this form of exercise throughout life, walking daily several miles between the close of office hours and dinner. On Sundays the walks were much longer. Nothing delighted him more than his walking trips in Switzerland while he was abroad. Even when he was seventy years old he climbed to the chalet high up the side of the Matterhorn, a feat almost unprecedented for a man of his age. He was a lover of travel. Only intimates would know that he was full of fun and loved to romp with his children, when they were young. He read history and other literature extensively and could recite page after page of poetry. He delighted in art and never went abroad without spending many hours in famous galleries and enjoying paintings. Of music he knew nothing. In fact, he used to say that he did know enough to distinguish between Old Hundred and Yankee Doodle because the former was slow and the latter quick. He never went to the theater nor learned to play the usual card games, but he was an expert chess player and during an ocean voyage is known to have carried on four games simultaneously without reference to any chess boards. His wide and varied reading, combined with accurate memory and universal interest, made his conversation virile and enlightening. His wife was a granddaughter of F. R. Hassler, the first superintendent of the U. S. Coast Survey. One of Newcomb's grandsons is Hassler Whitney, professor of math. at Harvard U. and one of America's most gifted younger men (see *Scripta Mathem.*, v. 4, p. 284).

SOURCES.—E. W. Brown, AMS *Bull.*, v. 16. G. W. Hill, *Science*, n.s., v. 30. R. C. Archibald: (a) "Bibliography of his life and work," NAS *Mem.*, v. 17, 1924; (b) *Science*, n.s., v. 44, 1916, p. 871–878, list of honors, etc. A. Cayley, RAS *MN*, v. 34, 1874, p. 224–233. I. Fisher, *Econ. Journ.*, v. 19, 1909. M. Loewy, *Nature*, v. 60, 1899. W. W. Campbell, NAS *Mem.*, v. 17. H. H. Turner, RAS *MN*, v. 70. S. Newcomb, *Reminiscences of an Astronomer* (no. 128). B. M. Newcomb, *Andrew Newcomb 1618–1686 and his Descendants*, New Haven, Conn., 1923. Mrs. S. N. Merrick (S. Newcomb's sister), *McClure's Mag.*, v. 35, 1910, with many illustrs. Carnegie Inst., *Year Books*, nos. 1–8, 1902–09. Information from Dr. Anita McGee, daughter of S. Newcomb.

BIBLIOGRAPHY

I have elsewhere given Newcomb's Bibliography in great detail, 542 items: 319 under the general heading of "astronomy," 35 under "mathematics," 42 under "economics," 146 under "miscellaneous." Some of these items, apart from his 35 books, are quite extensive, for example the 73 cyclopedia articles in no. 96 below. Others are very brief like his first publication (no. 1), a letter to a newspaper, and an anonymous note on B. Peirce (no. 31). In the present Bibliography nearly 400 items have been omitted, but an attempt has been made to preserve sufficient to suggest everything which is of outstanding significance, or which is of special interest from a mathematical point of view, and to illustrate the extraordinary diversity of Newcomb's interests and activities. The first three items (nos. 1–3) are given simply because they are the first three, although the first had interesting repercussions (see no. 94). All of his books and all foreign translations of items have been listed. Samples of his anonymous reviews and editorial notes have also been included; of the latter in the *Nation*, authorship was determined from the editorial file in New York City nearly thirty years ago. All items are here arranged chronologically regardless of topics.

1. "Velocity of meteors. Motion of bodies impelled by a single center of force," *National Intelligencer*, Wash., May 26, 1855, col. 2.

2. "Elements and ephemeris of the fifty-fourth asteroid" (with T. H. Safford), *AJ*, v. 5, 1858, p. 162.

3. "Elliptic elements of comet, 1858, V," *AJ*, v. 5, 1858, p. 178.

4. "On a method in dynamics," *AJ*, v. 5, 1858, p. 121–127.

5. "Note on differentiation," *Runkle's Math. Mo.*, v. 1, 1859, p. 396–397.

6. "Notes on the theory of probabilities," *Runkle's Math. Mo.*, v. 1, 1859, p. 136–139, 233–235, 331–335, 349–350; v. 2, 1860, p. 134–140, 272–275; v. 3, 1861, p. 68, 119–125, 341–349.

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5. Robert Simpson Woodward

Curriculum Vitae.—B. Rochester, Mich. 21 July 1849; d. Washington, D. C. 29 June 1924. Received preparatory educ. at the acad. in his native town before entering U. Michigan (68–72; C. E. 72). Assist. engineer U. S. Lake Survey 72–82; assist. astronomer U. S. Venus commission 82–84; astronomer, geographer, and chief geographer U. S. Geol. Survey 84–90; assist. U. S. Coast and Geodetic Survey 90–93. Prof. mechanics Columbia U. (93–99; dean of school of pure science 95–04; prof. mechanics and math. phys. 99–04). P Carnegie Institution of Washington 13 Dec. 1904–1 Jan. 1921.

Honors.—Assoc. ed. *AM* June 88–June 99. VP AAAS and chm. Sect. A, math. and astr. 89 Hon. Ph.D. U. Michigan 92. Assoc. ed. *Science* 94–24. Treas. AAAS 95–24. Treas. AMS 95–96. Mem. NAS 96. Assoc. fellow AAcAS 96. VP AMS 97–98; P 99–00. P AAAS 01. P N. Y. Acad. Sci. 01. Mem. Amer. Phil. So. 02. Hon. LL.D. U. Wisconsin 04. Hon. Sc.D. Columbia U. 05. Hon. Sc.D. U. Pennsylvania 05. Starred *Amer. Men Sci.* 06. P Phil. So. Wash. 10. Hon. LL.D. U. Michigan 12. P Lit. So. Wash. 13–14. Hon. LL.D. JHU 15. P Wash. Acad. Sci. 15. Mem. Naval Consulting Board 15–24. Chm. Sect. on astr., meteorology, seismology, Second Pan-Amer. Scientific Congress, Washington, D. C. 16.

Biographical Notes.—Dr. Woodward was a son of Lysander and Peninah A. (Simpson) Woodward. His father, who was of New England ancestry, settled in Michigan about 1835. He was one of the most progressive farmers of the state, sought to apply scientific principles to the operation of his farm, and took a keen interest in public affairs. His mother belonged to a family prominent in the annals of Connecticut. Already in his primary triangulation work on the Great Lakes Dr. Woodward acquired what turned out to be a life-long interest in the earth as a whole—its shape, its tides, its atmosphere, and a host of geophysical problems, many of which still await solution. The service on the Venus Commission was under Asaph Hall, the discoverer of the satellites of Mars. Thus twelve years after graduation were spent in geodetic and astronomical work of the highest precision. It was during the next six years that Woodward wrote his most important scientific papers (e.g. nos. 19, 26, 27, 28). These contributions were geophysical, having in part to do with the deformation of the earth's surface as the result of the removal or addition of load over a large area, and in part with the secular cooling of the earth. He also studied the field methods for topographical mapping and for primary and secondary triangulation and put them on a practical engineering basis. During his years with the Coast and Geodetic Survey he worked on the problem of base-line measurement in primary triangulation, and he developed the iced-bar apparatus for measuring base-lines and calibrating steel tapes and was the first to prove that base-lines could be measured with sufficient accuracy by means of long steel tapes. This work was of fundamental importance to geodesy and resulted in the saving of much expense and time in field work; also it placed the primary triangulation work of the Coast and Geodetic Survey on a higher plane than had been previously possible.

During the twelve years at Columbia he was remarkably successful both as teacher and as administrator. He had a most attractive, genial, and lovable personality, and his advice was being so constantly sought by students and members of the faculty, that he found it very difficult to pursue the mathematical work to which he had looked forward. He was a member of the Society from May 1891 and became successively its treasurer, vice-president and president. His *Higher Mathematics* (no. 43) edited in collaboration with Mansfield Merriman (1848–1925), in different forms attained to some popularity, and his own part has been translated into French since his death. More than one of his publications display power in applying mathematics to practical problems. Among the 80 mathematicians and 150 physicists arranged according to their rating by colleagues in 1903 Woodward was twenty-first in the first group and eleventh in the second (*Amer. Men Sci.*, 5th ed.).

Andrew Carnegie gave bonds valued at more than ten million dollars to establish at Washington an Institution to promote study and research. Daniel C. Gilman, president emeritus of the JHU, was its first president, but he undertook the task only temporarily until the best man for the position could be selected. When Dr. Woodward became president, the Institution was only two years old and had still to determine the best policies to follow. At this critical period, his mature judgment and experience, his clarity of vision, common sense, enthusiasm, and geniality, led, after much travail, to the establishment on a firm foundation of an Institution which has very notably promoted learning in this country. On looking back over his years of activity, he states in his last report as president that "probably no other organization in the evolution of learning has been so beset by what Dr. Johnson called the anfractuosities of the human mind as the Carnegie Institution of Washington." Prof. J. M. Cattell reports that the late physicist, Prof. O. N. Rood, once said that "he liked to go to faculty meeting in order that he might sit and look at Woodward" (*Columbia U. Quart.*, v. 7).

Karl W. Woodward, professor of forestry at the U. New Hampshire is one of three sons of Dr. Woodward.

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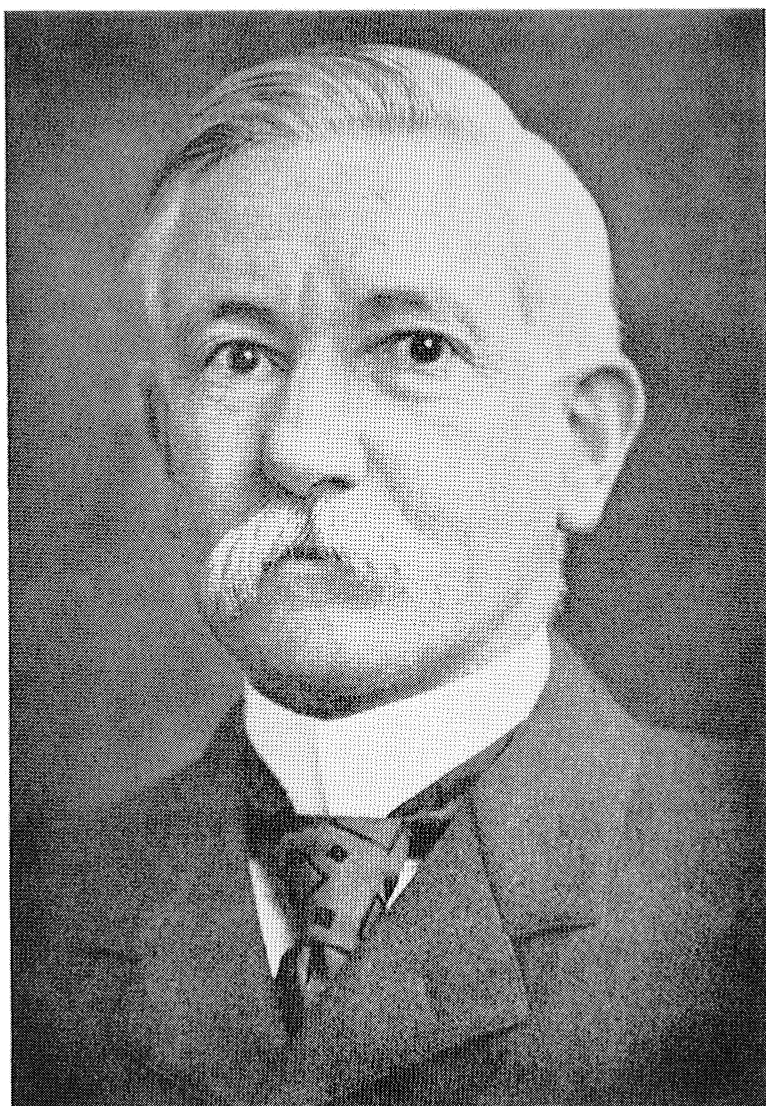

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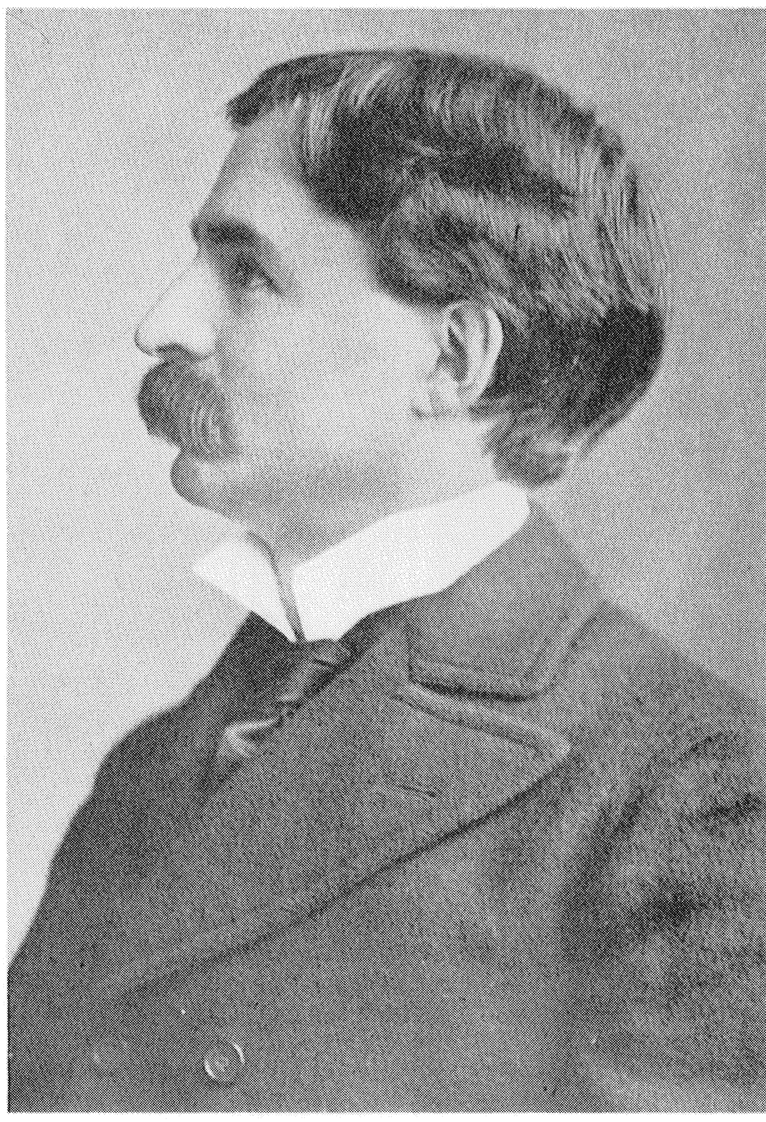
6. Eliakim Hastings Moore

Curriculum Vitae.—B. Marietta, O. 26 Jan. 1862; d. Chicago, Ill., 30 Dec. 1932. At Woodward high school in Cincinnati prepared (76–79) for Yale U. (79–85; A.B. 83; Ph.D. 85). At U. Berlin (85–86). Instr. at acad., Northwestern U. (86–87). Tutor math. Yale U. (87–89). Assist. prof. Northwestern U. (89–91; assoc. prof. 91–92). Prof. math. U. Chicago (92–32; head of dept. 96–31).

Honors.—VP Intern. Math. Congress Chicago 93; ed. (with Bolza, Maschke and H. S. White) of *Mathematical Papers read at the . . . Congress*, pub. by AMS 96. VP AMS 98–00. Hon. Ph.D. U. Göttingen 99. Ed. AMS *Trans.* 99–07. Mem. NAS 01. Assoc. fellow AAcAS 01. P AMS 01–02. Chm. comm. advising Carnegie Inst. in relation to original research math. 02. Hon. LL.D. U. Wisconsin 04. Chm. algebra and analysis sect. Congress of Arts and Sci., Universal Exposition, St. Louis 04; G. A. Bliss was secy. of this sect. Mem. Amer. Phil. So. 05. Starred *Amer. Men Sci.* 06. Colloq. lect. AMS, New Haven 06; "Introduction to a form of general analysis" (Bibl. no. 47). Mem. ed. comm. CMP *Rend.* 09–14. Lect. Clark U. on 20th anniversary of founding, "The rôle of postulational methods in mathematics" Sept. 09; hon. Math. D. conferred. Hon. Sc.D. Yale U. 09. VP AAAS and chm. Sect. A 11; ret. add. "On the foundations of the theory of linear integral equations" (no. 49). VP Fifth Intern. Congress Mathems., Cambridge, Eng., 12. Hon. corresp. mem. BAAS 12. Chm. board eds. U. Chicago Sci. Series 14–29. Mem. ed. board NAS *Proc.* 15–20. Mem. Nat. Comm. on Math. Requirements, MAA, J. W. Young chm. 18–23. Hon. Sc.D. U. Toronto 21. P AAAS 21; ret. add. "What is a number system," unpub. Eliakim Hastings Moore Fund of AMS established 22; on the occasion of the 25th anniversary meeting of the Chicago group. Hon. Sc.D. Northwestern U. 27. Eliakim Hastings Moore Distinguished Service Professorship established at U. Chicago 29; L. E. Dickson first incumbent. Portrait painted by Ralph Clarkson presented to U. Chicago by Prof. Moore's former students and placed in Eckhart Hall 30.

Biographical Notes.—Prof. Moore's grandfather Eliakim Hastings Moore, a banker and treasurer of Ohio U. at Athens, O., was a county officer and collector of internal revenue, and a congressman. Eliakim Hastings the younger served as messenger in Congress during one summer vacation while his grandfather was there. His father was a Methodist minister, David Hastings Moore, and his mother was Julia Carpenter Moore of Athens. The family moved from place to place while E. H. Moore was young, but a considerable part of his childhood was spent in Athens, where one of his playmates was Martha Morris Young, sister of the lamented Prof. J. W. Young of Dartmouth C., who was afterwards to become his wife. His father D. H. Moore, besides being a preacher, was successively a captain, major, and lieutenant colonel in the Civil War; president of Cincinnati Wesleyan C.; an organizer and first Chancel-



1902

lor of the U. Denver; and bishop of the Methodist Episcopal Church in Shanghai with jurisdiction in China, Japan and Korea. (This paragraph and much of what follows is taken from sketches written by G. A. Bliss.)

While E. H. Moore was still in high school, Ormond Stone, then director of the Cincinnati Observatory, and later founder of the *AM*, secured him as an emergency assistant. Stone had a high appreciation of mathematics and inspired his young assistant with a first interest in that science. One of Moore's friends at this time was Carl Barus (1856–1935), afterwards to become the distinguished physicist, but then variously employed, in particular as organ pumper for his father. In his reminiscences he tells of initiating Moore "into the art of the organ pumper. Strange as it may seem, in after life we often met at scientific gatherings and we received the honorary doctorate on the same day at Clark U. Who knows what my instruction in organ pumping may have done for Professor Moore?" At Yale H. A. Newton (1830–96), prof. of math. and scientist of distinction, first inspired in him the spirit of research, and was so deeply impressed with the young mathematician's ability he made it possible for him to spend a year in Germany where he studied most of the time at U. Berlin. Here Weierstrass (then 70 years old) and Kronecker were lecturing. The latter especially made a deep impression on Moore as he did on Fine a little earlier, and later.

President Harper had a remarkable capacity for picking young men of genius for the U. Chicago which first opened in the autumn of 1892. Moore was appointed professor and acting head (permanent head four years later) of the department of mathematics. He persuaded the President to associate with him from the very first two unusually fine scholars Oskar Bolza (1857–) and Heinrich Maschke (1853–1908), both former students at U. Berlin and doctors from U. Göttingen. Bolza made it a condition of his acceptance of a call to U. Chicago, that Maschke should receive an appointment at the same time. These three men supplemented one another remarkably. Moore was a fiery enthusiast, brilliant, and keenly interested in the popular mathematical research movements of his day; Bolza, a product of the meticulous German school of analysis led by Weierstrass, was an able, and widely read research scholar; Maschke was more deliberate than the other two, sagacious, brilliant in research, and a most delightful lecturer on geometry. During the period 1892–1908 the U. Chicago was unsurpassed in America as an institution for the study of higher mathematics. At this time such men as Birkhoff and Veblen carried on advanced work at Chicago. "In the lecture room Professor Moore's methods defied most established rules of pedagogy. Such rules, indeed, meant nothing to him in the conduct of his advanced courses. He was absorbed in the mathematics under discussion to the exclusion of everything else, and neither clock time nor meal time brought the discussion to a close. His discourse ended when some instinct told him that his topic for the day was exhausted." For the *élites* he was enormously inspiring, and among the ablest mathematicians of our country at the present time those who drew their chief inspiration from Prof. Moore are numerous.

The following list of those (31) whose thesis work for the doctorate was done under his direction, 1896–1929, is a very distinguished one: L. E. Dickson, H. E. Slaught, D. N. Lehmer, W. Findlay, O. Veblen, T. E. McKinney, G. D. Birkhoff, N. J. Lennes, F. W. Owens, H. F. MacNeish, R. P. Baker, T. H. Hildebrandt, Anna J. Pell (Mrs. A. L. Wheeler), A. D. Pitcher, R. E. Root, E. W. Chittenden, W. L. Hart (under Moore and F. R. Moulton), M. G. Gaba, C. R. Dines, Mary E. Wells, E. J. Moulton, A. R. Schweitzer, V. D. Gokhale, E. B. Zeisler, J. P. Ballantine, C. E. Van Horn, R. E. Wilson, M. H. Ingraham, R. W. Barnard, H. L. Smith, F. D. Perez.

In chapters VII and V are to be found details concerning the AMS Chicago Section in which Moore figured so prominently, being chairman from its organization in 1897 through 1902; and concerning his remarkable services as editor-in-chief of the *Transactions* during the first seven years of its publication, two of them while P of the Society. He was a prominent organizer of the scientific congress at the World's Columbian Exposition, 1893. At the Universal Exposition of 1904 in St. Louis he was chm. of one of the sections in mathematics. In 1916 by his advice and encouragement he gave great assistance to H. E. Slaught, who was mainly responsible for the founding of the MAA. Besides being long chm. of the board of eds. of U. Chicago Science Series, he was also joint ed. of the U. Chicago Mathematical Series, consisting of secondary school texts. His attempt to help even lower grades is illustrated by his *Grammar School Arithmetic by Grades*, 1897 (no. 19). In his ret. add. as P AMS in 1902 (no. 38) Moore devoted the first part to an illuminating description of his conception of the logical structure of pure and applied mathematics, but the latter part was a discussion of the pedagogical methods, in primary and secondary schools, colleges, and universities, by which one might hope to establish such concepts in the minds of students. The address was prepared at a time when repercussions of the Perry movement in England had started nation-wide discussion of mathematical teaching in this country, and Moore was greatly interested in a laboratory method of instruction for college students.

Turning now to his mathematical research publications, we find that they fall roughly into the following four groups: Geometry (nos. 1–4, 25, 34, 36, 40, 63, 69), 1885–1913; Groups, numbers, algebra (nos. 6, 7, 10, 11, 13, 14, 15, 16, 17, 20, 21, 22, 23, 24, 26, 29, 35, 39, 41, 44, 50, 57, 58, 59, 73, 74, 75, 78), 1892–1922; Theory of functions (nos. 5, 8, 9, 12, 18, 27, 28, 31, 32, 33, 43, 54, 60, 61, 62, 67, 72, 77), 1890–1926; Integral Equations (nos. 46, 47, 49, 51, 52, 53, 56, 64, 65, 68, 70, 71), 1906–1935. This indicates the sequence of his major interests. His studies in algebra and the theory of groups fell in the period of his greatest activity as a writer, while integral equations and general analysis were his absorbing interest during the latter part of his life when he published least. For general analysis he never lost his enthusiasm.

In geometry, the papers dealt with questions in algebraic geometry, Moore's first mathematical interest, and postulational foundations. It is of special interest that at this time he freely used the theory of linear systems of curves, then of fundamental value, and displayed both skill and power in manipulation of such systems, and discovered elegant results. Hilbert's book of 1899 on the foundations of geometry, and earlier work of Pasch and Peano, as well as of Hilbert, inspired Moore and his disciples to important activity. Moore deftly dealt with independence questions in Hilbert's axioms and gave a new formulation of a system of axioms for n-dimensional geometry, using points only as undefined elements instead of the points, lines, and planes of Hilbert in the three-dimensional case (nos. 34, 36). In algebra Moore's paper at the Chicago Congress of 1893 (no. 14) contained a generalization of the modular group, a statement and proof for the first time of the interesting and important theorem which says that every finite field is a Galois field, and a characterization of a doubly-infinite system of so-called simple groups, only a few of which had been known before. Moore's power in analysis was first displayed in his paper on transcendentally transcendental functions (no. 18), which is a model of clarity and elegance and gives evidence of his increasing interest and ingenuity in mathematical generalizations. The subject of space-filling curves of Peano and Hilbert (*MA*, v. 36, 38) was delightfully illuminated in the first number of AMS *Trans.* by an often quoted paper "On certain crinkly curves" (no. 27). His papers on improper definite integrals (31, 32, 33) were important and timely contributions in the period before that of the later and more effective integration theories of Borel and Lebesgue. But the theories of integral equations and general analysis were the subjects which most captivated Moore's exploratory interests. In the years following 1900 the fundamental papers of Fredholm and Hilbert attracted wide attention. Moore saw that the equations which they studied, as well as corresponding and more elementary ones well known in algebra, must be special instances of a much more general linear equation, and he set about the construction of a general theory which should include them all. His guiding principle, as often stated, was that "the existence of analogies between central features of various theories implies the existence of a general abstract theory which includes the particular theories and unifies them with respect to these central features." This principle was the dominant note of his colloq. lectures (no. 47; reviewed by G. D. Birkhoff, with a list of corrections, AMS *Bull.*, v. 17, p. 414–423); these lectures of 1906 were not published until after a related paper (no. 46). In these publications and two later ones (nos. 49, 51) Moore gave in essential outline his first theory of general analysis and his generalization of preceding theories of linear equations. [An admirable summing up of this theory was given by Bolza in his "Einführung in E. H. Moore's 'General Analysis' und deren Anwendung auf die Verallgemeinerung der Theorie der linearen Integralgleichungen," DMV, *Jahr.*, v. 23, 1914, p. 248–303.] His attack was highly postulational and original, especially in the fact that the postulates applied to classes of functions rather than to individual ones. He was able to secure for his general theory most of the results which are of interest in the more special cases, but some of them eluded him. The attempts which he made in order to complete the theory in these respects led to such complexities that finally, about 1915, he turned from his first method to a second more constructive theory of similar character, but with a much simpler basis. The results which he attained are to be found partly in his memoirs, and partly in mss. With Prof. R. W. Barnard's able cooperation a definitive edition is soon to be available (no. 56) to the scholar desiring to familiarize himself with an extraordinary conception. The ideas here set forth do not, on the whole, seem to have won as general acceptance as the widely differing methods of Banach and his school.

Prof. Moore was an extraordinary genius, "vivid, imaginative, sympathetic," foremost leader in freeing American mathematicians from dependence on foreign universities, and in building up a vigorous American School, drawing unto itself workers from all parts of the world.

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5. "Note concerning a fundamental theorem of elliptic functions, as treated in Halphen's *Traité*, vol. 1, pages 39–41," CMP *Rend.*, v. 4, 1890, p. 186–194.

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9. "On a theorem concerning p-rowed characteristics with denominator 2," AMS *Bull.*, v. 1, 1895, p. 252–255.

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11. "Concerning Jordan's linear groups," AMS *Bull.*, v. 2, 1895, p. 33–43.

12. "A note on mean values," *AMM*, v. 2, 1895, p. 303–304.

13. "On an interesting system of quadratic equations" (with E. C. Ackermann), *AMM*, v. 3, 1896, p. 38–41.

14. "A doubly-infinite system of simple groups," *Intern. Congress Mathems.*, Chicago, 1896, p. 208–242; abstract, NYMS *Bull.*, v. 3, 1893, p. 73–78.

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18. "Concerning transcendentally transcendental functions," *MA*, v. 48, 1897, p. 49–74.

19. *Grammar School Arithmetic, by Grades*, ed. by E. H. Moore, New York, etc., 1897, 344+xvi p.

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22. "An universal invariant for finite groups of linear substitutions: with application in the theory of the canonical form of a linear substitution of finite period," *MA*, v. 50, 1898, p. 213–219.

23. "Concerning Abelian-regular transitive triple systems," *MA*, v. 50, 1898, p. 225–240.

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33. "Concerning Du Bois-Reymond's two relative integrability theorems," *AM*, s. 2, v. 2, 1901, p. 153–158.

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36. "The betweenness assumptions," *AMM*, v. 9, 1902, p. 152–153.

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See also:

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7. Thomas Scott Fiske

Curriculum Vitae.—B. New York City 12 May 1865. Early educ. at the Old Trinity Church School, N.Y., and in Pingry School, Elizabeth, N.J., before entering Columbia U. (82–88, except 87; A.B. 85; A.M. 86; Ph.D. 88); assist. in math. 85–88, spending six months of 87 at U. Cambridge, England. Tutor in math. Columbia U. (88–91; instr. 91–94; adjunct prof. 94–97; prof. 97–36; executive officer of the dept. 15–28; prof. emeritus 36–). In charge of math. at Barnard C. (89–95; acting dean 99). Secy. College Entrance Exam. Board (01–36).

Honors.—FOUNDER AMS 88. Secy. AMS 88–95. Treas. AMS 90–91. Ed.-in-chief AMS *Bull.* Oct. 91–Jan. 99. VP AMS 98–01. Joint ed. AMS *Trans.* 99–05. P AMS 03–04. P Assoc. Teachers Math., Middle States and Md. 05–06. Starred *Amer. Men. Sci.* 06. First chm. Council of Amer. Federation of Teachers of Math. and Nat. Sci. 06–07. Examiner N.Y. State Educ. Dept. 09–11. Chm. AMS Semi-centennial Comm. 28–38.

Biographical Notes.—Prof. Fiske is a son of Thomas Scott and Clara (Pittman) Fiske. His father, whose business career was mainly in New York City, was a member of an old New Hampshire family which originated in this country with William Fiske from Suffolk county, England, who settled in Wenham, Mass. in 1637. Prof. Fiske's mother was also of English descent. The first secretary of the College Entrance Exam. Board, organized in 1900, was Prof. N. M. Butler, and when he resigned in 1901 (he became president at Columbia U. in 1902) he was anxious that Prof. Fiske should take over the work and regard this as an appreciable portion of his duties as a professor promoting the cause of education. Prof. Fiske continued this service until his retirement as Executive Secretary and Treasurer on 28 Oct. 1936. Under his guidance the Board grew from a small organization examining in one year 973 candidates prepared at 249 schools for admission to 21 colleges, to the present world organization which in a single year at its maximum examined 23,478 candidates prepared at 1,959 schools seeking admission to 206 colleges. During his long, devoted and very notable service the usefulness of the Board steadily increased.

Elsewhere in this volume an attempt has been made to suggest the enormous debt which the Society owes to its able Founder, whose enthusiastic activities on her behalf during the first fifteen years of her existence, were so unremitting and so wise.

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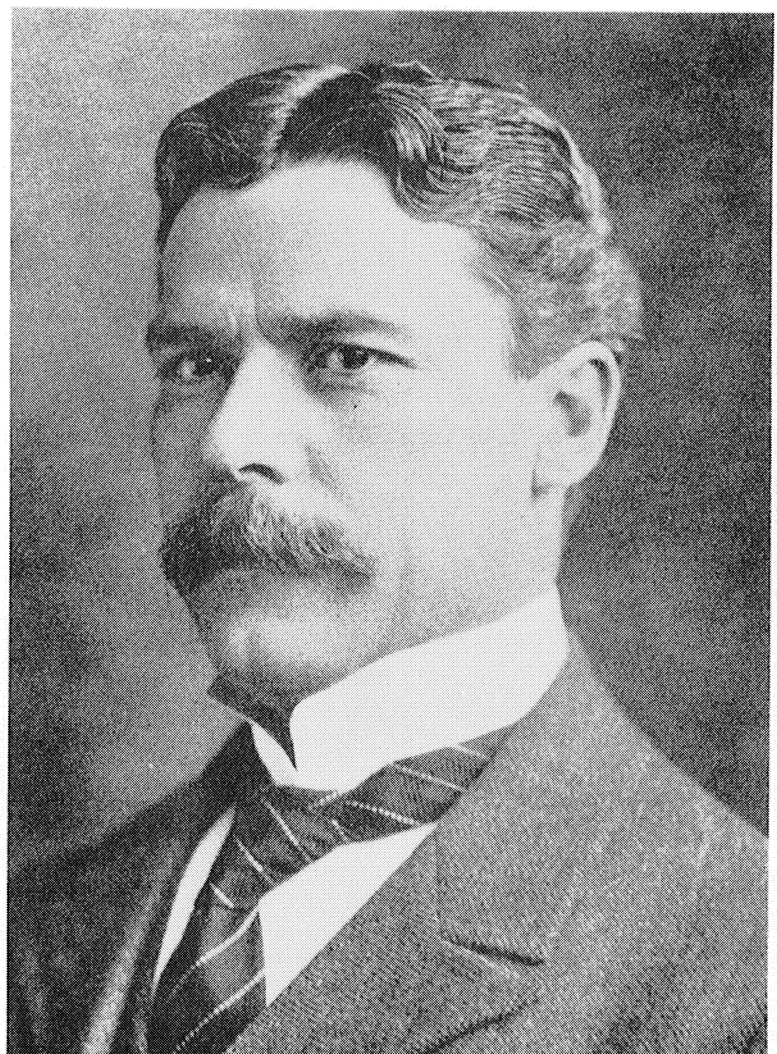

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Halphen in *School of Mines Quart.*, 1889; by Cajori in *Ed. Rev.*, 1891; by Edwards, Van Velzer, Shutts, Beman and Smith, and Forsyth in *Science*, 1896–1901.

8. William Fogg Osgood

Curriculum Vitae.—B. Boston, Mass. 10 Mar. 1864. Graduated at the Boston Latin School (82) and at Harvard U. (A.B. 86, *summa cum laude* and second in a class of 286; A.M. 87); Harris and Parker fellow from Harvard at U. Göttingen (87–89) and at U. Erlangen (89–90; Ph.D. 90). Instr. math. Harvard U. (90–93; assist. prof. 93–03; prof. 03–33; emeritus 33–). Prof. math. National U. Peking (34–36).

Honors.—Colloq. lect. AMS 98. Mem. AAcAS 99 (resigned 02). Ed. *AM* 99–02. Contributor to *Encyk. d. Math. Wiss.* 01; "Allgemeine Theorie der analytischen Funktionen" (see Bibl. no. 26). VP AMS 03. Mem. NAS 04. P AMS 05–06. Corresp. mem. Kharkov Math. So. 08. Mem. Amer. Sect. Intern. Comm. Teaching Math. 08–20. Hon. LL.D. Clark U. 09. Mem. comm. eds. CMP *Rend.* 09–17. Hon. mem. Calcutta Math. So. 10. Ed. AMS *Trans.* 10. Colloq. lect. AMS 13. Mem. Amer. Phil. So. 15. Acting dean graduate school of arts and sci. Harvard U. 22 (Feb.–July). Corresp. mem. So. Sci. Göttingen 22. Chm. Comm. of the College Entrance Exam. Board, on college entrance requirements in math. 22–23. For. mem. Leop.-Carol. deutsche Akad. Naturf. in Halle 24.

Biographical Notes.—Prof. Osgood is a son of William and Mary Rogers (Gannett) Osgood and a descendant of John Osgood of the county of Hampshire, England, who came to Ipswich, Mass. in 1638. His mother was of English ancestry. His return from Germany was at the time of a great revival in American mathematical study, with emphasis on rigorous discussion of many concepts. During the next dozen years especially were his contributions (including more than a score of publications) of a very notable character. In 1903 when mathematicians chose 80 leaders in research the first three were, in order, E. H. Moore, Hill, Osgood (*Amer. Men Sci.*, 5th ed., p. 1269). Then, and for many years later, his influence was exerted not only through publications but also through his students whose interests he ever whole-heartedly promoted in painstaking fashion. His teaching of the second course in Differential and Integral Calculus was such as soon to quadruple the number in regular attendance. Textbooks (Bibl. nos. 36, 59 and part of 64) resulted from experience thus gained; so also his works, analytic geometry (no. 58) and mechanics (no. 74), were developed through experience in the classroom. The following four students were prepared for their doctorate under his direction, 1901–13: C. W. McG. Black, L. D. Ames, E. H. Taylor, and G. R. Clements (under Bouton and Osgood).

Prof. Osgood's first important paper was the one on non-uniform convergence and the integration of series term by term (nos. 8, 11). The result was general and altogether new; and the ideas were akin to those which later led to Borel's definition of measure. Schoenflies reports at length on this paper, in his Bericht (DMV *Jahr.*, v. 8, 1900, p. 225–233). In paper no. 21 the last word was spoken on the conformal map of the interior of a simply connected plane region on a circle; the most general case of boundary points was discussed later (no. 43). Whether a simple plane Jordan curve can be included in a region of arbitrarily small area, appears not to have been settled before Osgood's example answered the question in the negative (no. 29). The notes in no. 18 were novel and led to extensive and important applications by Hartogs; in practice the theorems have important practical applications. In the calculus of variations the converse theorem, formulated and proved in no. 24, was novel and has been taken seriously by later writers; compare, e.g., Hadamard, *Calcul des Variations*, p. 281 f. Whether the three equations

$$w = f_1(u,v), \qquad z = f_2(u,v), \qquad t = f_3(u,v)$$

where f_1, f_2, f_3 are analytic at (u_0, v_0) define a locus that can also be represented in the form $F(w, z, t) = 0$, when F is analytic at (w_0, z_0, t_0) was raised, and answered for the first time, in the negative, in no. 48. The question of the dimensionality of a locus represented analytically by several simultaneous analytic equations in the complex domain is one to which the answer is not immediately obvious. The result is needed in the simplified proof of the Riemann-Weierstrass theta theorem and was given in no. 69.

Quite different from such studies is that of the motion of the gyroscope: Let a rigid body have dynamical symmetry about an axis; let one point of the axis be fixed in space; and let the angular velocity of the body about the axis be constant. What couple will be required to make the axis describe a given cone at a given rate? What cone will the axis describe, if the couple is given? A direct answer to these questions is given by a certain pair of equations in no. 61.

When the *Funktionentheorie* (no. 35) was begun, in 1901, there was no comprehensive treatment of the field, in which all the tools of ordinary modern analysis were rigorously used. Such a general treatment necessarily had to overlap parts of a number of excellent treatments of special topics. But it was necessary to organize the material as a whole, and to fill many gaps, some small, some large. Most of these gaps in the literature were not pointed out as such, nor published in special monographs. But it is significant that Weierstrass's second implicit function theorem (v. 2_1, second ed., p. 131) can be proved in a single page of text, after the general theory of implicit functions has been systematically developed up to a certain natural conclusion, including the systematic development of the idea of the irreducibility of an analytic function *im Kleinen*, independent of any particular choice of coordinate axes. Again, the theorems about functions which behave meromorphically at every point of a complex n-dimensional space, closed by a suitable infinite region, are new. The second part of v. 2 had for its object a simple and rigorous treatment of the algebraic functions and their integrals. Weierstrass had used uniformization *im Kleinen:* $w = f(t)$, $z = \phi(t)$, and Klein and Poincaré had pointed out that the automorphic functions yield a uniformization *im Grossen* (the proofs were first given by Koebe), but a systematic use of

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a class of automorphic functions for treating questions *im Grossen* had not as yet been given. As a result a simplified statement and proof of the theorem of correspondence of Cayley and Noether came out. These threads were finally woven together into a proof of the theta theorem, in which there is a minimum of the formalism of the thetas with p arguments. The work, as a whole, is one of America's greatest contributions to the development of mathematics.

Professor Osgood's favorite recreation is touring in his motor car.

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9. Henry Seely White

Curriculum Vitae.—B. Cazenovia, N.Y. 20 May 1861. Prepared at Cazenovia Seminary (where his father was later teacher) for entrance to Wesleyan U. (A.B. 82; assist. in the astr.obs. 82–83; tutor in math. and registrar 84–87); teacher math. and chemistry in the Centenary Collegiate Institute, Hackettstown, N.J. (83-84); student U. Göttingen (87–90; Ph.D. 91); assist. in math. Clark U. (90–92); assoc. prof. pure math. Northwestern U. (92–94; prof. 94–05); prof. math. Vassar C. (05–36; lect. and prof. emeritus 36–). Visiting prof. Chicago U. 08, and Columbia U. 10, and 11. Assoc. physicist, U.S. Bureau of Standards summers 18, 19.

Honors.—AMS Colloquium Founder 96. Assoc. ed. *AM* 99–05. VP AMS 01. Colloq. lect. AMS 03. Chm. math. sect. St. Louis Congress of Arts and Sci. 04. Starred *Amer. Men Sci.* 06. Ed. AMS *Trans.*, 07–14. P AMS 07–08. VP AAAS and chm. Sect. A 14. Mem. NAS 15. Hon. LL.D. Northwestern U. 15. AMS nominee mem. Div. Phys. Sci. NRC 18–21. Hon. Sc.D. Wesleyan U. 32.

Biographical Notes.—Prof. White was a son of Aaron White, who was a teacher of elementary mathematics and surveying in the Cazenovia Seminary, and Isadore Maria Haight. His first American ancestor, John White, came from Essex county, England, to Cambridge, Mass. in 1632, and subsequently became one of the original settlers of Hartford, Conn. As an editor and member of many important committees and officer of the Society, Prof. White's counsel was ever in the direction of maintenance of the highest ideals and standards. Elsewhere we have given details of his part in the founding (1896) of the AMS Colloquium Lectures. He has been a very regular attendant at meetings and many a mathematician will recall how such men as he, and Professors Morley and Pierpont, were interested in seeking him out as a young member, in making him feel very much at home, and in showing appreciation of his scientific achievements. In 1903 mathematicians rated according to merit the leaders in mathematical research. Nine of the first ten have been presidents of the AMS; Prof. White was eighth in this list. His research has been in the fields of theory of invariants, geometry of curves and surfaces, special types of (3, 3) correspondences, algebraic plane curves and twisted curves of low orders, homeomorphic sets of lines in a plane, relativity in mechanics. In his paper on semi-combinants as concomitants of affiliants (no. 6) there are novel definitions and developments of importance. Von Staudt had formulated the beautiful result that if two tetrahedrons have eight points of a twisted cubic for vertices, their eight faces osculate a second cubic curve. Somewhat resembling and underlying this is the following very elegant theorem of Prof. White (no. 32): If seven points on a twisted cubic be joined, two and two, by twenty-one lines, then any seven planes that

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contain these 21 lines will osculate a second cubic curve. This theorem is more strictly fundamental than von Staudt's in that it concerns only seven points, six of which can be arbitrary (random) points of space; whereas von Staudt's relates to eight, two more than those sufficing for definition of the curve. In this respect the seven-point theorem is analogous to Pascal's on the plane six-point on a conic. But while Pascal's conclusion terminates with a lower figure, a line, this on seven-points concludes on the same higher level, namely a third order class-curve. It is thus doubtful which theorem is more justly to be rated as the analogue of Pascal's. At least von Staudt's can be deduced from White's but perhaps not conversely. Nos. 6 and 32 may claim basic originality to a higher degree than other items in the Bibliography.Compare A. B. Coble's Bibliography "A proof of White's porism" (no. 18), where it is remarked that White's theorem "furnishes perhaps the only important generalization of the Poncelet polygons."

In his treatise on *Plane Curves of the Third Order* (no. 42) the author confines himself almost entirely to the projective properties of non-singular cubics, and his presentation is clear, readable, and rigorous. His selection from a wealth of available material is judicious, and the whole constitutes "a stepping stone to many extensive and beautiful treatises on special themes." In reviewing the book Hilton referred to the "novelty of the elegant but highly condensed, symbolic notation." The aesthetic element, and happy choice of words, is noticeable in many of Prof. White's writings (e.g., no. 46).

He delights in music. Mrs. White was the composer Mary Gleason, and F. G. Gleason, 1848–1903, the composer, musician, and music-critic, was her brother. All friends recognize the aptness of the following characterization of Prof. White: "Wise, kind, the soul of courtesy."

SOURCES.—*Nat. Cycl. Amer. Biog.*, v. 14, 1917. A. C. White, *1632–1892. Memorials of Roderick White and his wife Lucy Blakeslee of Paris Hill, N. Y. . . .* , Ithaca, N. Y., 1892. This work is supplementary to A. S. Kellogg, *Memorials of Elder John White*, Hartford, Conn., 1860. J. B. White, *Geneal. of Descendants of Thos. Gleason of Watertown, Mass.*, Haverhill, Mass., 1909. *N. E. Geneal. and Hist. So. Reg.*, v. 55, 1901. *Alumni Record of Wesleyan U.*, 5th ed., 1921. Diss. "Lebenslauf" (Bibl. no. 2). *Who's Who in Amer.*, v. 19. *Leaders in Educ.*, 1932. Personal information.

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6. "Semi-combinants as concomitants of affiliants," *AJM*, v. 17, 1895, p. 235–265.

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8. "Numerically regular reticulations upon surfaces of deficiency higher than 1," AMS *Bull.*, v. 3, 1896, p. 116–121.

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10. "Collineations in a plane with invariant quadric or cubic curves," AMS *Bull.*, v. 4, 1897, p. 17–23.

11. "Inflexional lines, triplets, and triangles associated with the plane cubic curve," AMS *Bull.*, v. 4, 1898, p. 258–260.

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42. *Plane Curves of the Third Order*, Cambridge, Mass., 1925, xii+168 p.

43. "The Amherst colloquium," AMS *Bull.*, v. 35, 1929, p. 16–18.

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10. Maxime Bôcher

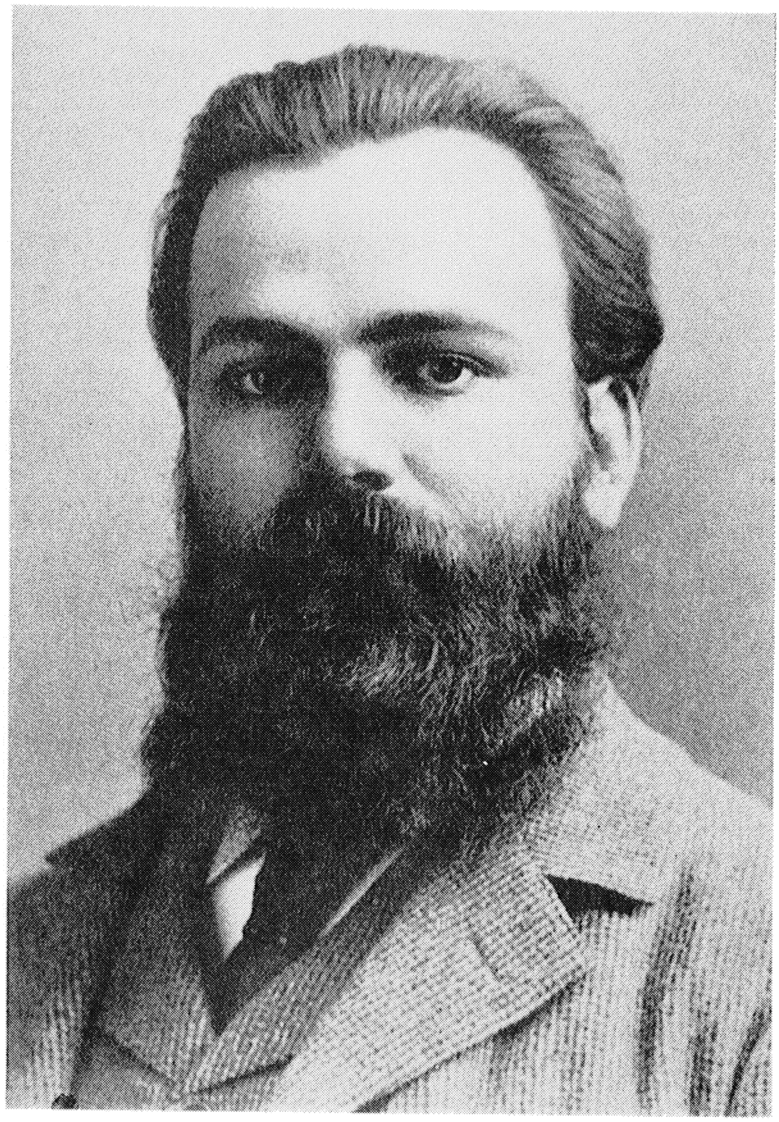
Curriculum Vitae.—B. Boston, Mass. 28 Aug. 1867; d. Cambridge, Mass. 12 Sept. 1918. Graduating at the Cambridge (Mass.) Latin School he entered Harvard U. (83–88; A.B., *summa cum laude*, 88). Student as Harvard, Harris, and Parker fellow U. Göttingen (88–91; Ph.D. 91). Instr. math. Harvard U. (91–94; assist. prof. 94–04; prof. 04–18).

Honors.—Full prize awarded by faculty U. Göttingen for essay and diss. (Bibl. no. 2) 91. One of first two Colloq. Lects. AMS 96; 6 lects. on "Linear differential equations and their applications", partly printed nos. 19, 24. Assoc. ed. *AM* 96–00; joint ed. 01–07, Sept. 11–June 14. Fellow AAcAS 99. Contributor to *Encyk. d. Math. Wiss.* 00; "Randwertaufgaben bei gewöhnlichen Differentialgleichungen" (no. 33). VP AMS 02. Invited speaker Congress Arts and Sci. St. Louis 04; "The fundamental conceptions and methods of mathematics" (no. 48). Starred *Amer. Men Sci.* 06. Ed.-in-chief AMS *Trans.* 08–09, 11–13. Mem. NAS 09. P AMS 09–10. Invited lect. Intern. Congress Mathems., Cambridge, Eng. 12; "Boundary problems in one dimension" (no. 68). Harvard exchange prof. U. Paris 13–14; for lects. see no. 79. Mem. Amer. Phil. So. 16.

Biographical Notes.—Prof. Bôcher was a son of Ferdinand and Caroline (Little) Bôcher, and grandson of Ferdinand Jules of Caen, Normandy, France, who came frequently to America on business and died in St. Louis, Mo., but was never settled in this country although his son Ferdinand (1832–1902) happened to be born in New York. This son was for many years Prof. of modern languages at Harvard U., a man of all-round culture, and a great collector of books in the field of French literature, art, and history. Maxime's mother belonged to one of the oldest New England families, tracing her ancestry back to Thomas Little who joined the Plymouth Colony in its early days and in 1633 married Anne

Warren, daughter of Richard Warren, who came in the Mayflower company.

It was to the influence of his parents that the awakening of Bôcher's interest in science was due. He spent five years in the U. and his course was a broad one. Outside of mathematical work, especially under Byerly, B. O. Peirce, J. M. Peirce, and F. N. Cole, he took courses in Latin, chemistry, philosophy, zoology, physical geography and meteorology, Roman and mediaeval art, and music. In his senior year he won a second Bowdoin prize for an essay on "The meteorological labors of Dove, Redfield, and Espy" (no. 1). During six semesters as Harvard fellow at Göttingen he attended lectures by Klein, Schoenflies, Schur, Schwarz and Voigt, and he found of special interest the lectures on Lamé's functions which Klein delivered in 1889–90. This was suggestive in connection with his thesis, on developments of the potential function into series (no. 2), which won a prize from the U. Göttingen and was afterwards elaborated into a book (no. 13) containing important new original work. It was an able treatment calling for extensive knowledge of the theory of potential, of Dupin's cyclides and their generalization by Laguerre, Moutard and Darboux, of the use of elementary divisors, and dealing with important questions in Lamé's polynomials, Lamé's products, and boundary value problems of partial differential equations of physics. Thus at the very beginning Bôcher got into vital touch with the chief branches of mathematics. He was interested in all phases of the theory of ordinary linear differential equations with real independent variable. His surveys of work on boundary problems up to 1912 were well covered in his *Encyk.* article (no. 33) and Congress paper (no. 68) but in this field he wrote many other papers of which the most important appeared in the first two v. of AMS *Trans.* (nos. 31, 39, 42) where he greatly improved on methods of Sturm and attained to a maximum of generality. A survey of Bôcher's boundary problems for differential equations was made by R. G. D. Richardson (AMS *Bull.*, v. 26, p. 108–124) in his review of Bôcher's lectures at the Sorbonne (no. 79). In this v. is given the first complete discussion of the convergence of the series used in the method of successive approximations. In the field of fundamental existence theorems for linear differential equations (nos. 24, 26, 42, 43) he introduced new results, and the extended Green's functions in no. 35 turned out to be of great importance (see also no. 62). In his expository article on Fourier series (no. 53) he called attention to the remarkable phenomena exhibited by a Fourier's series near a point of discontinuity, previously noted by Gibbs, and called "Gibbs' phenomena" by Bôcher who gave the first adequate treatment. His contributions to the theory of the harmonic function in two dimensions are elegant and distinctly important (nos. 14, 25, 45, 54, 58). All of Bôcher's papers excel in simplicity and elegance and nearly all of them treat subjects of great importance to marked advantage. He never occupied himself



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with an unimportant problem. How extensive and how useful his work was in one field, will be suggested by looking up the references under Bôcher's name in the index to Osgood's *Funktionentheorie*, v. 1. See also the references to Bôcher in indices of *Encyk. d. Math. Wiss.*, v. II.3.2 and III.2.2. In 1903 when the leading 80 mathematicians were listed the first four were Moore, Hill, Osgood, and Bôcher.

Bôcher's *Introduction to Higher Algebra* (no. 56), translated into German and Russian, was a remarkable pioneer work in English, which was long of great service to students (see reviews by A. Ranum, AMS *Bull.*, v.16; J. Tannery, *DB*, s. 2, v. 32). Yet another exceptional service was rendered by his *Introduction to the Study of Integral Equations* (no. 59; reviewed by G. A. Bliss, AMS *Bull.*, v. 16), the emphasis placed on the historical development of the subject being an interesting feature of the tract. Special attention should be drawn also to his little known pamphlet on regular points of linear differential equations of the second order (no. 19) used for a number of years in connection with one of his courses of lectures. Because of the clarity and care with which his elementary texts on analytic geometry and trigonometry were written they are still in demand (nos. 44, 75, 76).

Osgood has well written that "the standards of clearness, both in thought and expression, which characterize French men of letters and science, Bôcher made his own, not by a conscious effort but through an inner driving force which made it a part of his very nature to find suitable expression for his ideas." His lectures were so lucid, the difficulties of subjects were not perhaps as effectively assimilated by students as they would have been under a poorer teacher. He was by nature very reserved and he never gave way to enthusiasm. He was a puritan, and with the virtues he had also the faults of the puritan. There was no place in his world for human weakness; he respected only results. These same stern standards he applied equally to himself. For guiding students working on doctoral dissertations he was remarkably well equipped; the following 17 men did their theses under him, 1895–1919: J. W. Glover, M. B. Porter, F. H. Safford, D. F. Campbell, O. Dunkel, D. R. Curtiss, W. B. Ford, W. H. Roever, W. C. Brenke, F. Irwin, C. N. Moore, G. C. Evans, T. Fort, L. R. Ford, M. T. Hu, L. Brand, C. N. Reynolds (under Bôcher and Birkhoff).

Elsewhere in this v. we have told of Bôcher's connection with the founding of the *Transactions*, of which he was for five years a remarkably effective editor-in-chief. He was a fine critic, ever free with constructive suggestions. For many years he served as an assoc. ed. of *AM*. He was never very strong, and long he had to combat ill health. Finally he was cut off, almost in his prime.

Birkhoff has summed up: "In amount and quality his production exceeds that of any American mathematician of earlier date in the field of pure mathematics. Because of this fact and the weight he has added to our mathematical traditions in other ways, Maxime Bôcher will ever remain a memorable personality in American mathematics."

SOURCES.—G. D. Birkhoff, "The scientific work of Maxime Bôcher," and W. F. Osgood, "The life and services of Maxime Bôcher," AMS *Bull.*, v. 25. Harvard, *Class of 1888 Report*, v. 6, 1909, v. 7, 1913 (with portraits in 1888 and 1913), and v. 8, 1920, with biog. notes by A. G. Webster. D. E. Smith, *DAB*, v. 2, 1929. W. F. Osgood, "Professor Bôcher's scientific start in life," *AMM*, v. 26, p. 262–263. *Who's Who in Amer.*, v. 10. *Nat. Cycl. Amer. Biog.*, v. 18, 1922. *Science*, n.s. v. 48, 1918, p. 534; minute, faculty Harvard U. Doctoral diss. "Lebenslauf" (no. 2).

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11. Henry Burchard Fine

Curriculum Vitae.—B. Chambersburg, Pa. 14 Sept. 1858; d. Princeton, N.J. 22 Dec. 1928. Student at C. of New Jersey later Princeton U. (76–84; A.B. 80; fellow in experimental sci. 80–81; tutor in math. 81–84; A.M. 83; assist. prof. 85–89; prof. 89–28; dean faculty 03–12; dean dept. sci. 11–28). Student at U. Leipzig (84–85; Ph.D. May 85); at U. Berlin (summer 85). Acting director Princeton U. Obs. 08–12.

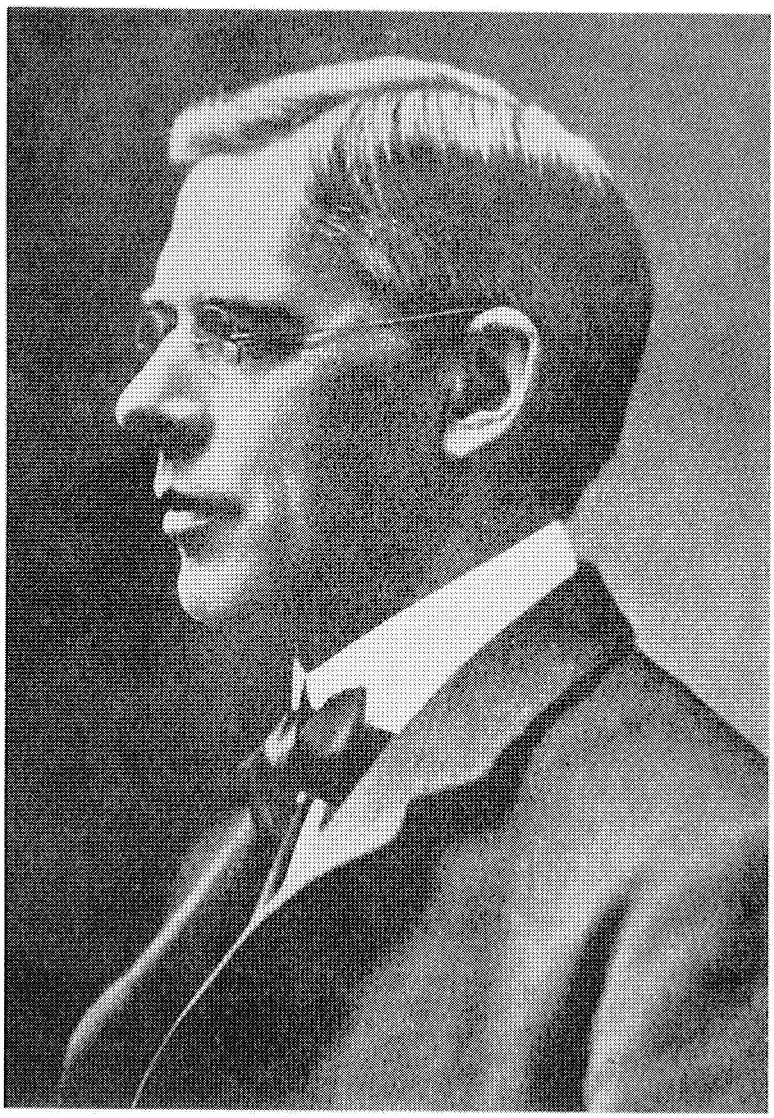
Honors.—VP AMS 92–93. Mem. Amer. Phil. So. 97. Starred *Amer. Men Sci.* 06. Hon. LL.D. Williams C. 09. Practically acting P Princeton U. under the nominal presidency of the senior member of the Board of Trustees from the time of Wilson's resignation in 10 to the appointment of President Hibben in 12. P AMS 11–12. By President Wilson offered appointment as U. S. Ambassador to Germany 13; Wilson also offered him a place on the Federal Reserve Board and recommended him as P JHU (see R. S. Baker, in "Sources" below); he was repeatedly invited to be P Mass. Inst. Tech. P Assoc. Math. Teachers of New Jersey 15–16. Henry Burchard Fine Research Professorship in Math. established by an endowment of $200,000 from T. D. Jones 25; Prof. Veblen was the first incumbent, and on resigning from the U. in 33 he was succeeded by Prof. Lefschetz. Dedication in 31 of Henry Burchard Fine Memorial Hall for math., given to Princeton U., furnished and endowed by T. D. Jones and his niece Miss Gwethalyn Jones, including a portrait of Dean Fine by E. L. Ibsen.

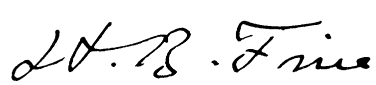
Biographical Notes.—Dean Fine was a son of Lambert Suydam and Mary Ely (Burchard) Fine, and a great-great-grandson of Hendrick and Elizabeth (Lefferts) Fine who came to this country from Holland. His father (d. 1869) was a Presbyterian minister, and his mother in 1875 finally settled in Princeton, where by private study her son finished his preparation for the College, where he led his class each year. He specialized in classics which he later on expected to teach; he also began the study of Sanskrit and he was one of the small group who discussed philosophy with Dr. McCosh and enjoyed the impulse of his invigorating mind. His adoption of mathematics as a career was largely due to George Bruce Halsted (1853–1922), that extraordinary enthusiast for non-euclidean geometry. Halsted had graduated in Princeton in 1875 and after studying under Sylvester at The JHU spent the years 1878–81 in Princeton as "instructor in post-graduate mathematics." On graduation Fine was appointed a fellow in experimental science, did a certain amount of experimental work and even published a paper (Bibl. no. 1) in collaboration with W. F. Magie, subsequently professor of physics at Princeton and Fine's biographer (see "Sources"). But Fine was never really interested in experimental work and gladly changed to service as tutor in mathematics during the next three years. In March 1884 he and Magie sailed for Germany, and he went to Leipzig where he attended lectures and seminars of Klein, C. G. A. Mayer, C. G. Neumann (physics), F. H. Schur, and Wilhelm Wundt (philosophy). In a little more than a year he obtained his doctorate with a thesis (no. 4) on a topic approved by Klein but suggested by Study, later one of Fine's closest friends. Fine spent the following summer in Berlin, where he listened to Kronecker's lectures on the theory of elimination and was profoundly influenced by them (see nos. 15, 22); he had another period of study with Kronecker in the summer of 1891.

After taking up his life work at Princeton, Fine published a few research papers (nos. 4-diss., 6, 10, 12), and another of some importance (no. 23) as late as 1916. But his time was mainly devoted to teaching, administration, and the logical exposition of elementary mathematics. His *Number System of Algebra treated Theoretically and Historically* (no. 14) which is devoted to an exposition of the logical foundations of analysis is still a very useful reference book on this subject, and has recently been reprinted. There followed three text-books for undergraduates, *A College Algebra*, 1905 (no. 17), *Coordinate Geometry*, 1909 (no. 21, with H. D. Thompson), and *Calculus*, 1927 (no. 27). In point of view of accuracy of statement and adequacy with which they present the subject the first and last are unexcelled. This was partly due to the fact that they had been printed or mimeographed in a preliminary form and used with classes for many years, and modified before publication as the result of such experience.

Fine became a member of the AMS in 1891 and was VP for the next two years; then at three different periods he served as member of the Council for eight years before he became P in 1911. During almost the whole period of his presidency of the Society he was also in reality acting President of Princeton U. As dean of the faculty during President Wilson's administration he contributed largely to the raising of academic standards. In the controversies which raged during this period on various questions of academic policy, he supported the President. These two men had been members of the editorial board of the *Princetonian* in their student days and from that time dated a life-long friendship based upon the respect which each had for the qualities of intellect and character of the other. When the preceptorial system of instruction was introduced at Princeton in 1905 Fine seized the opportunity of laying the foundations of a department of mathematics of first rank and this standing has been maintained ever since. But he had an important part in the choice of men in the other fields of science. In 1911 he became in letter what he was in fact—the dean of the departments of science. When it was decided in 1925 to organize a campaign for funds for the further development of research in the sciences, his was the guiding hand and he was chairman of the committee for this purpose. Largely because of the confidence which he inspired, the General Education Board offered Princeton U. a million dollars for research in pure science on condition that the U. raise two additional millions for the same purpose. The fund was completed in 1928, chiefly by the contributions of Mr. T. D. Jones, a life-long friend of Fine.

In early days Fine played the flute in the college orchestra and he was later active in bringing good concerts to Princeton. His knowledge of music was extensive, and during the year of his death he was commissioned to engage an organist and choirmaster for the new university chapel. He took keen interest in games and in the daily life of the undergraduates. For nearly the whole of his professional career he served on the





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university committee of athletics. Death was the result of an accident. In the uncertain evening light he was riding his bicycle on a road in the outskirts of Princeton and was struck from behind by an automobile, the driver of which failed to see that he was starting to make a left turn. He died early the next morning without having recovered consciousness.

Fine Hall today, the headquarters also of the School of Mathematics in the Institute for Advanced Study, is the greatest center of mathematical activity in this country, a magnificent memorial to one who was an exemplar of the highest type of scholar and teacher, and to a man, singularly genial and winning in personal intercourse, of serene strength, poise, and wisdom.

SOURCES.—W. F. Magie, (a) *DAB*, v. 6, 1931; (b) *Science*, n.s., v. 69, 1929. O. Veblen, (a) AMS *Bull.*, v. 35, 1929; (b) *Princeton Alumni Weekly*, 30 Oct. 1931. L. P. Eisenhart, "Henry Burchard Fine Memorial Hall," *Scientific Mo.*, v. 33, 1931; picture of Hall and portrait of Fine. R. S. Baker, *Woodrow Wilson Life and Letters*, v. 2–4, 1927–32. H. B. Fine, "Autobiographical sketch" in doctoral diss. (Bibl. no. 4). *Pr. Al. Wkly.*, 11 Jan. 1929, portrait, communications by J. G. Hibben, R. S. Baker, and others. G. D. Birkhoff, *Pr. Al. Wkly.*, 6 May 1927. *Who's Who in Amer.*, v. 15, 1928. *Nat. Cycl. Amer. Biog.*, v. 14, 1917.

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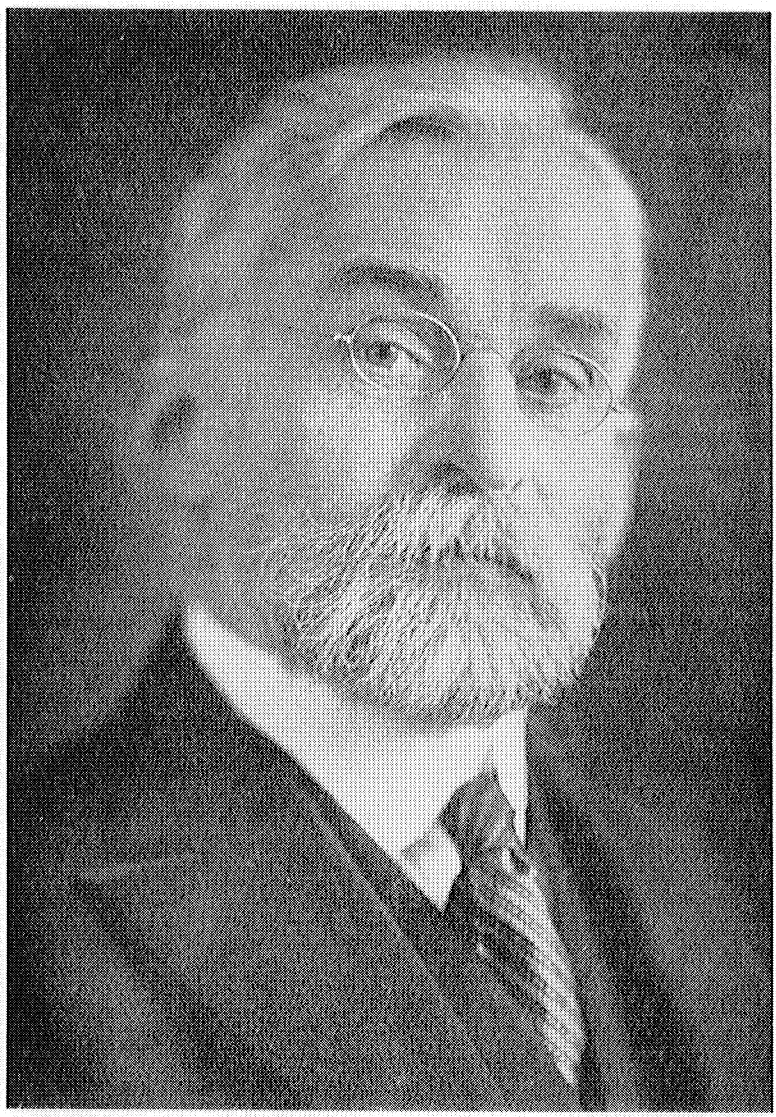
12. Edward Burr Van Vleck

Curriculum Vitae.—B. Middletown, Conn. 7 June 1863. Prepared at high school of Middletown, Conn., and Wilbraham Acad. to enter Wesleyan U. (80–84; A.B. 84; assist. in phys. lab. 84–85; A.M. 87; tutor math. 87–90; assoc. prof. 95–98; prof. 98–06). Graduate student JHU (85–87); at U. Göttingen (90–93; Ph.D. 93). Instr. U. Wisconsin (93–95; prof. 06–29; prof. emeritus 29–). Lect. in math. at Harvard U. second sem. 19–20.

Honors.—AMS delegate Abel centenary celebration Oslo 02. Colloq. lect. AMS 03. Ed. AMS *Trans.* 05–10. Starred *Amer. Men Sci.* 06. Chm. Chicago Sect. AMS 07. VP AMS 09. Hon. LL.D. Clark U. 09; Osgood and E. H. Moore became doctors at the same time, in connection with the celebration of the 20th anniversary of the founding of Clark. Mem. NAS 11. VP AAAS and chm. Sect. A 12. P AMS 13–14. Hon. D. math. and phys. U. Groningen 14; on 300th anniversary of its founding. Hon. Sc.D. U. Chicago 16; on the quarter-centennial celebration of the founding of the U. Secy. local military Draft Board 17–18. Decorated by the French Govt. "Officier de l'instruction publique," in recognition of his services as teacher and investigator and for his work during the war 20. AMS nominee mem. Div. Phys. Sci. NRC 21–Dec. 23. Hon. LL.D. Wesleyan U. 25.

Biographical Notes.—Prof. Van Vleck is a son of the late John Monroe and Ellen Maria (Burr) Van Vleck, and a descendant of Tielman Van Vleeck of Amsterdam and Bremen who migrated to New Amsterdam in 1658, and was the founder of the first organized govt. at Bergen, afterwards a part of Jersey City. His father (1833–1912) taught mathematics and astronomy at Wesleyan U. for over fifty years, and during three different periods he was acting president of the U.; he was a vice-president of the AMS (1904), and the fine Van Vleck Observatory at Wesleyan U., erected in his memory by his brother, was dedicated in 1916 (see *Pop. Astr.*,



Edward B. Van Vleck

1912

v. 24, p. 407–418; and Bibl. no. 25 below). Two years of graduate study (the second as fellow in physics) at JHU, in the fields of mathematics, physics, and astronomy, under Craig, Newcomb, Rowland, and Story, led E. B. Van Vleck to the choice of the pursuit of mathematics rather than physics as a profession. As a result of five semesters at the U. Göttingen, under Burkhardt, Fricke, Schur, Schwarz, Voigt, Weber, and that "marvelous teacher Felix Klein," his scientific knowledge was notably enriched. There were three events which had a marked influence on Van Vleck's educational development. The first was a fourteen months' trip in Europe in 1877–78 which roused a cultural interest in history, literature, but especially art. The second was the year at Wilbraham Academy where the exceptionally fine teaching in Greek, Latin, and mathematics stirred his enthusiasm and interest. The third was the period of his study under Klein. Thus broad and solid foundations were laid for later scientific and academic activities. Practically all of his publications have been in the fields of theory of functions and differential equations. Among the 80 leading mathematicians of the U. S. in 1903, Prof. Van Vleck was listed as no. 11.

At the fourth colloquium of the Society in 1903, he and two other students of his father (H. S. White and F. S. Woods) were the three lecturers, and their lectures form the first v. in this series. Prof. Van Vleck gave six lectures on topics of divergent series and continued fractions (no. 14) and thus rendered a notable service to young mathematicians, not only in setting forth the substantial foundation for a theory of the subjects, which had been laid by such men as Poincaré, Stieltjes, and Borel, but also by supplying a very complete bibliography of algebraic continued fractions, which was especially helpful to students of that time. His address on "The influence of Fourier's series upon the development of mathematics," as retiring chm. of Sect. A of AAAS (no. 21) was also delivered, in 1914, in French translation at the École Normale Supérieure, Paris, and again in Rome where it was translated into Italian and published. The study of certain functional equations for the θ-functions (no. 23) was in collaboration with the gifted student F. T. H'Doubler, and counted as the latter's doctor's thesis. H'Doubler was the first of four young men to receive their doctorate at Wisconsin under Prof. Van Vleck's direction; the other three were T. M. Simpson, H. T. Davis, H. S. Wall. But more than one who got his degree at another institution, received valuable initial training under Professor Van Vleck. Elsewhere in this v. we have had occasion to comment on his service in contributing to the harmonious development of the AMS, at a critical period.

Traveling, and collecting Japanese prints, are his chief hobbies. His collection of these prints, numbering thousands of items, is very remarkable, and one of the major private collections. It is especially valuable for the study of Japanese art of all periods, from the end of the sixteenth century to the present day. His only child, John Hasbrouck Van Vleck (see *America's Young Men . . . 1936–37*) is prof. of mathematical physics at Harvard U., and also a member of the NAS.

SOURCES.—*Who's Who in Amer.*, v. 19, 1936. "Vita" in doctoral diss. (Bibl. no 1). *Alumni Record of Wesleyan U.*, 4th ed., 1911. *Nat. Cycl. Amer. Biog.*, v. A, 1930, portrait. *Amer. Men Sci.*, 5th ed., 1933. Personal information.

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13. Ernest William Brown

Curriculum Vitae.—B. Hull, Eng. 29 Nov. 1866; d. New Haven, Conn. 22 July, 1938. Educ. at Hull and East Riding C., in preparation for Christ's C., Cambridge (84-87; A.B. 87, sixth wrangler in math.; fellow 89-95); U. Cambridge (A.M. 91; Sc.D. 97). Instr. math. Haverford C. (91-93; prof. applied math. 93-00; prof. math. 00-07). Prof. math. Yale U. (07-21; Sterling prof. math. 21-31; first Josiah Willard Gibbs prof. 31-32; Josiah Willard Gibbs prof. math. emeritus 32-38). Naturalized as citizen of U.S. 30 Jan. 22.

Honors.—Fellow RS London 98; as British subjects, Brown and Morley were the only ex-presidents eligible to become fellows. Mem. Amer. Phil. So. 98. Joint ed. AMS *Trans.* 99-06. VP AMS 05. Starred *Amer. Men Sci.* 06. Mem council Amer. Phil. So. 06-08, 10-12, 14-16, 18-21. Seventh astronomer to be awarded gold medal of RAS for researches in the lunar theory (see presidential add. RAS *MN*, v. 67, p. 300-313) 07; the sixth astronomer to receive a similar award, in 87, was G. W. Hill. Hon. A.M. Yale U. 07. Eleventh recipient U. Cambridge Adams prize (80 pounds) "for an essay on some subject of pure mathematics, astronomy or other branch of Natural Philosophy" 07; essay, "The inequalities in the motion of the moon due to the direct action of the planets" (Bibl. no. 49); J. C. Maxwell (in 57) and J. J. Thomson (83) were second and sixth recipients. G. de Pontécoulant prize of 700 francs awarded by the Acad. des Sci., Institut de France, for advancing lunar knowledge (see report *CR* Paris, v. 149, p. 1200) 09. VP AAAS and chm. Sect. A 10; ret. add. "The relations between Jupiter and the asteroids" (no. 64). Joint ed. AMS *Bull.* 10-13. Hon. fellow Christ's C., Cambridge 11. Fellow AAcAS 12. Assoc. ed. *AJ*, Albany, N. Y. 12-38. Hon. Sc.D. U. Adelaide 14; when guest there at a meeting of BAAS. Gold medal (with a silver copy) by RS London in recognition of his investigations in math astr. 14. Contributor to *Encyk. d. Math. Wiss.* 15; "Theorie des Erdmondes" (no. 83). P AMS 15-16; ret. add. "The relation of mathematics to the natural sciences" (no. 90). AMS nominee mem. Div. Phys. Sci. NRC July-Dec. 19. Fifteenth recipient of Bruce Gold Medal (see report ret. P ASP, ASP *Pub.*, v. 32, p. 85-92), choice based upon nominations of six observatories, Harvard, Yerkes, Lick, Greenwich, Paris, Cordova, 20; previous recipients were 1. S. Newcomb, 8. G. W. Hill, 9. J. H. Poincaré; Brown's add. following the presentation was "The problem of the moon's motion" (no. 95). VP Amer. Alpine Club 20-22. Chm. NRC comm. on celestial mechanics (other mems. G. D. Birkhoff, A. O. Leuschner, H. N. Russell) 20 (see report in no. 98). Correspondent astr. sect., Acad. des Sci., Institut de France 21. Mem. NAS 23. VP Amer. Astr. So. 23–25. Corresp. mem. Royal Belgian Acad. Sci. Letters and Fine Arts 26. AMS Josiah Willard Gibbs Lect. 27. P Amer. Astr. So. 28–31. Hon. Sc.D. Yale U. 33; "in grateful and affectionate acknowledgment of the luster shed upon her by your brilliant scientific achievements during a long and distinguished service on her faculty" (Angell). Hon. Sc.D. Columbia U. 34. P Amer. Assoc. Variable Star Observers 34–36. Grants from Amer. Phil. So. of $2000 to E. W. Brown for completing work on the motions of the moon, 35, and $500 to E. W. Brown and W. J. Eckert for the verification of the polar coordinates which are used to predict the moon's place 38. Hon. LL.D. McGill U. 36. James Craig Watson Medal awarded by NAS (see report A. O. Leuschner, *Science*, n.s., v. 85, p. 433) 37.

Biographical Notes.—Prof. Brown, only son of William and Emma (Martin) Brown, was a rather delicate youth carrying on his studies with his father's hearty encouragement and support, but he emerged at college into sturdy manhood with strength for hard study and such vigorous exercise as rowing in college boats at races (see nos. 3, 24). His high standing as wrangler just as he became of age suggested talents of high order, later to mature and lead to most notable intellectual achievements. During a year of post-graduate work at Cambridge, his chief adviser, Prof. G. H. Darwin, recommended him to study G. W. Hill's classic paper, "Researches in the lunar theory" (see Hill's Bibl. no. 35), and thus he started in a field of research which was to occupy him for more than forty-five years. This first acquaintance with American mathematics was shortly before he came to America. Within a year of his advent his first scientific paper, "On the part of the parallactic inequalities in the moon's motion which is a function of the mean motions of the sun and moon," (no. 4) appeared in *AJM;* this was fourteen years after Hill's paper had been published in the same place. The extraordinary merit of Brown's rapid sequence of publications including a *Treatise on the Lunar Theory* (no. 11) is suggested by the fact that within seven years from his first paper he was elected a fellow of the RS London. Beginning with an extension of Hill's work, he was led gradually to a complete development of a lunar theory that includes the gravitational action of every particle of matter which can have a sensible effect on the moon's motion, so that any differences which appear between theory and observation may not be set down to want of accuracy in the completeness with which the theory is carried out. Every known force capable of calculation is included. Such was the stage that he had reached in 1907 (see the great memoirs of 1897–1908 listed in no. 18), when the RAS awarded him its gold medal, and he terminated his stay at Haverford, where he had been able to carry on his work under favorable conditions. But the Yale authorities recognized the importance of his work by arranging special facilities for its continuance, and undertook to provide the funds required for both the preparation and the publication of lunar tables, which appeared twelve years later (no. 94, review by J. Jackson, *Observatory*, v. 43), with a supplement in 1926.

Ernest W. Brown

1910

The first tables of the moon strictly so-called were those of Clairaut published in 1752. Successive efforts of the ablest mathematicians to explain the observed positions of our satellite culminated in Hansen's *Tables de la Lune* (1867). These tables long held the field unchallenged, practically, although since 1880 the need for something better than Hansen's theory in the nautical almanacs was strongly felt. Before Brown's theory could replace that of Hansen it was necessary for him to make his theory accessible in the form of tables. Hansen's approximate theory included 500 terms as against Brown's 1500 terms. Brown's Tables have been uniformly used in nautical almanacs of the world since 1923, and predicted the 1923 eclipse with surprising accuracy. The aim of the Tables was to get every coefficient in latitude and longitude, in connection with the rectangular coordinates of the moon, to 0.″01. No error has since been found. One incidental fact proved in Brown's theory was that Newton's law of gravitation is accurate, so far as the moon is concerned, to one part in 25,000,000.

The third stage of his lunar theory, on which Brown was engaged when he died, had as its main objective the explanation of the minor discrepancies which have revealed themselves between the tabulated and the actual motion of the moon. Leuschner has summed up some of the outstanding results of his genius. "In 1907 he had produced the most accurate value of the secular term in the moon's mean motion, but there remained unexplained well-marked deviations in the longitude of a fairly systematic character. There were also unexplained departures in the motion of the perigee and of the node of the moon's orbit amounting to the really small trifles of 17″ and −12″, respectively, per century. These he has practically wiped out by the inclusion of still further significant terms in his expansions. This last achievement was an unexpected by-product of a remarkable investigation on the stellar problem of three bodies," only completed in 1937 (no. 180). "In 1924 he hit upon the real character of the occasional deviations in the longitude of the moon by correlating them with those of the sun and thereby was able to eliminate a gravitational cause external to the earth for the deviation of this type of the moon, sun, Mercury and Venus. This led to the discovery of the variability of the rotation of the earth and to the establishment of the moon as a more perfect time-piece than the earth. Of greatest importance are his demonstrations of the effect of the moon on the rate of the almost perfect Shortt clocks" (no. 157). His theory of the Trojan group of asteroids (no. 104) "is outstanding as regards originality and elegance of treatment and represents the observed motions of the planets of the group more perfectly than any other."

His contributions in the more general field of celestial mechanics have been very numerous. "Resonance in the solar system" was the title of his Gibbs lecture before the Society (no. 135) and he was successful in applying a general theory of resonance to explain the gaps in the distribution of the mean motions of minor planets (nos. 105, 164). His work on Fourier series (nos. 128, 149), on the development of the perturbative functions (no. 166), his special forms of separate differential equations, which made it possible to integrate the equations for the stellar problem of three bodies (no. 179), and other contributions, mark a new epoch in the general theory of perturbations. His latest and very notable book, *Planetary Theory*, 1933 (no. 172), develops the methods for the calculation of the general orbit of a planet, with many novel, practical, and interesting procedures. And finally, we may refer to his conclusion arrived at after highly ingenious and strictly mathematical discussion, that the discovery of the planet Pluto was not based on theoretical predictions (nos. 150, 158). In 1903 mathematicians of the U. S. rated him as seventh among the first eighty.

In addition to achieving a monumental body of research Prof. Brown gave courses of lectures at Yale for many years, and the following 8 men wrote their doctoral dissertations under his direction, 1912–31: W. H. Willard, A. L. Daniels, T. H. Brown, H. B. Hedrick, W. L. Crum, P. Slavenas, D. B. Ames, W. J. Eckert. Dr. Hedrick was associated with him for many years in the preparation of the lunar tables. Dr. Eckert is a member of the faculty of Columbia U. and secy.-treas. of the remarkable astronomical Computing Bureau there, directed by an advisory council of the Amer. Astr. So. Prof. Brown was chm. of the board of managers of this Bureau to the close of 1937; see "The astronomical Hollerith-computing bureau," ASP *Pub.*, v. 49, 1937, p. 249 f.

Prof. Brown was generous in giving up time to writing popular articles (e.g., nos. 22, 29, 44, 45, 47, 106), to the writing of many reviews (no. 181), and to editorial work which included years of valued services in connection with both the Society's *Bulletin* and *Transactions*. We have more specifically referred to his service on the *Transactions* in chapter V.

Like Newcomb, Brown formerly delighted in high climbing on Swiss mountains. He also found recreation in music—we have listed his settings of Haverford songs (no. 34A). He used to sing in choruses and choirs and was at one time president of the Oratorio So. in New Haven. When he was being presented for his Yale doctorate W. L. Phelps spoke in part as follows: "His publications on lunar theory and celestial mechanics have given him an international reputation and have added glory to Yale. His Tables of the motion of the moon is a monumental work and has brought him a blizzard of degrees, medals, prizes and honors. He is an excellent chess player and an amateur humorist of high reputation. In his youth he expected to be a concert pianist, but later took up the music of the spheres. His versatility is additionally shown in that, although a specialist on the moon, in the year 1925 in the city of New Haven he arranged a personally conducted total eclipse of the sun."

To one surveying the Society's history a feeling of great pride must be engendered by the fact that among her presidents have been three great men who worked on a common problem: Newcomb, that mighty watcher of the skies; Hill and Brown, the leaders among all mathematical astronomers who have achieved their careers in this country. Incidentally it may be remarked that the two latter, like the greatest mathematical astronomer of all time, were wedded to their intellectual interests alone. The same might be said of A. S. Eddington and Josiah Willard Gibbs.

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14. Leonard Eugene Dickson

Curriculum Vitae.—B. Independence, Ia. 22 Jan. 1874. Attended U. Texas while serving as chemist on the Geol. Survey of the state and graduated as valedictorian (Sc. B. 93, A.M. 94); continued post graduate study in math. at U. Chicago where he was one of the first two mathematicians to get the doctorate (Ph.D. 96), and at U. Paris and Leipzig (96–97). Instr. math. U. California (97–99; assist. prof. 99); assoc. prof. U. Texas 99–00; assist. prof. U. Chicago (00–07); assoc. prof. 07–10; prof. 10–). Visiting prof. U. California 14, 18, 22.

Honors.—VP AMS 10. Joint ed. AMS *Trans.* Oct. 10–Dec. 16. Mem. NAS 13; resigned 37. Colloq. lect. AMS 13. Assoc. Fellow AAcAS 15. P AMS 17–18. AMS nominee mem. Div. Phys. Sci. NRC 19–22. Corresp. mem. sect. geom. Acad. des Sci., Institut de France 20 (see *AMM*, v. 27, 1920, p. 384). Hon. P. Intern. Math. Union 20. Mem. Div. For. Relations NRC as chm. Amer. Sect. Intern. Math. Union 20–24. VP, and one of the four general lects., Intern. Congress Mathems. Strasbourg 20; topic, "Some relations between the theory of numbers and other branches of mathematics" (Bibl. no. 209). Mem. Amer. Phil. So. 20; resigned, 25. Chm. Comm. on Algebraic Numbers, Div. Phys. Sci. NRC 20– . Hon. mem. Czechoslovakian Union of Math. and Phys. 23. First award of $1000 prize, offered by a member of the AAAS for the most notable contribution to the advancement of science, reported at its Cincinnati meeting, 24; the award was made for the book *Algebras and their Arithmetics* (Bibl., no. 229) together with two papers presented by Dickson at Cincinnati, namely, "The theory of numbers and generalized quaternions" (no. 235) and "Quadratic fields in which factorization is always unique" (no. 234). VP Intern. Congress Mathems. Toronto 24. Awarded AMS Frank Nelson Cole Prize of $200 for his book, *Algebren und ihre Zahlentheorie* (no. 253) 28. Mem. comm. eds. CMP *Rend.* 28–35. One of four mathems. (chosen because they were regarded as the leading research men in America, England, France and Italy), lects. at Harvard Tercentenary Celebration 36. Hon. Sc.D. Harvard Terc. Celeb. 36.

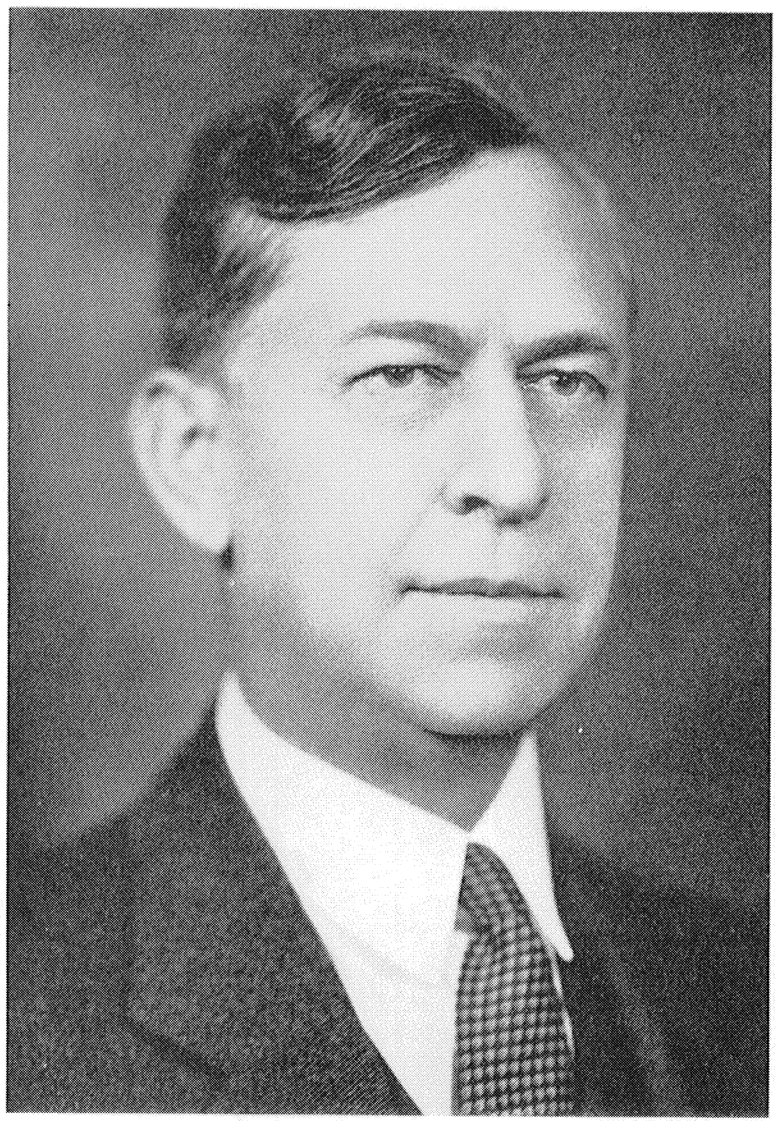
Biographical Notes.—Prof. Dickson's father was a merchant and banker of Texas, and a descendant of William Dickson, a native of Londonderry, Ireland, who came to America in the early part of the eighteenth century and settled at Londonderry, N. H. Prof. Dickson is one of the greatest research mathematicians that America has produced, and his research output has been enormous. In addition to more than 280 papers he has published eighteen books, two of which have been translated into German; one has appeared only in German. Fifteen of these books present material of high importance and include his monumental *History of the Theory of Numbers* in three volumes (no. 204; reviewed in AMS *Bull.*, v. 26, 30, and *AMM*, v. 26, 28, 30). In the preface to the second v. Dickson takes us into his confidence. "Conventional histories take for granted that each fact has been discovered by a natural series of deductions from earlier facts and devote considerable space in the attempt to trace the sequence. But men experienced in research know that at least the germs of many important results are discovered by a sudden and mysterious intuition, perhaps the result of subconscious mental effort, even though such intuitions have to be subjected later to the sorting process of the critical faculties. What is generally wanted is a full and correct statement of the facts, not an historian's personal explanation of those facts. The more completely the historian remains in the background or the less conscious the reader is of the historian's personality, the better the history. . . . With such a view of the ideal self-effacement of the historian, what induced the authoı to interrupt his own investigations for the greater part of the past nine years to write this history? Because it fitted in with his convictions that every person should aim to perform at some time in his life some serious, useful work for which it is highly improbable that there will be any reward whatever other than his satisfaction therefrom." Here as in all of his writing Dickson's extraordinary gift of clear, compact, exact expression and compression is everywhere in evidence.

In Dickson's *Algebren und ihre Zahlentheorie*, which won the prize noted above, a new theory was devised to determine what should be the subject-matter of arithmetics and algebras, after which it was found possible to construct a highly developed science of arithmetics. The result is a rich array of fundamental results which mark great steps forward in the classical theory of algebraic numbers and in the generalization of Hurwitz's integral quaternions. Dickson was able to unify and greatly enlarge the whole subject of the theories of algebras (see *Science*, n.s., v. 59, 1934, p. 77). E. T. Bell wrote of the English form of this work that it "bids fair to be epoch-making." See Hasse's detailed review in DMV *Jahr*. v. 37, 1928.

Dickson discovered the fundamental cyclic algebras, essential in the theory of "Division algebras" (nos. 121, 122 and chap. 5 in no. 229). It has been called a "Dickson algebra" by Wedderburn (AMS *Trans.*, v. 22, p. 129). He was the founder of the theory of modular invariants (compare no. 183). He exploded a fallacy which had persisted in connection with certain Diophantine equations from the time of Gauss to the present day (nos. 212, 213, 241). His solution of Waring's problem (no. 290) is outstanding and the results in such papers as no. 104 and 116 are of special interest.

Even back in 1903, when Dickson had been an assistant professor at the U. Chicago for only three years, mathematicians of the U. S. ranked him as ninth (*Amer. Men Sci.*, 5th ed., p. 1269); the first eight then were, Moore, Hill, Osgood, Bôcher, Bolza (Newcomb), Morley, Brown, and White. He was an assoc. ed. of the AMS *Trans.* 1911–16; managing ed. of the *AMM*, 1902–06, and assoc. ed. 1906–08.

Prof. Dickson's ideas and publications have been developed by many



Leonard E. Dickson.

1932

others and in particular by the following 64 persons who prepared their theses for the doctorate under his direction at the U. of Chicago, 1901–37: T. M. Putnam, W. H. Bussey, H. E. Jordan, A. Ranum, R. L. Börger, A. H. Wilson, W. C. Krathwohl, Mildred L. Sanderson, F. B. Wiley, Olive C. Hazlett, A. Henderson, J. E. McAtee, G. H. Cresse, W. L. G. Williams, Mayme I. Logsdon, C. C. MacDuffee, H. S. Everett, J. S. Turner, Mrs. Constance R. Ballantine, M. M. Feldstein, G. E. F. Sherwood, B. F. Yanney, Marguerite D. Darkow, C. Gouwens, Mildred Hunt, C. G. Latimer, F. S. Nowlan, Echo D. Pepper, A. E. Cooper, R. J. Garver, J. S. Georges, R. G. Archibald, Lois W. Griffiths, J. Williamson, A. A. Albert, B. W. Jones, D. C. Morrow, E. L. Thompson, K. C. Yang, O. E. Brown, R. H. Marquis, G. Pall, S. Silberfarb, A. Oppenheim, R. S. Underwood, Mina S. Rees, Emily M. Chandler, A. E. Ross, F. W. Sparks, Ruth G. Mason, R. D. James, R. Hull, R. E. Huston, Frances E. Baker, R. C. Shook, G. C. Webber, Marie Litzinger, K. S. Ghent, Mable G. Humphreys, J. C. Brixey, Mae R. Anderson, Dora McFarland, S. B. Townes, H. Chatland.

Bridge, tennis, and billiards have long been Professor Dickson's chief recreations.

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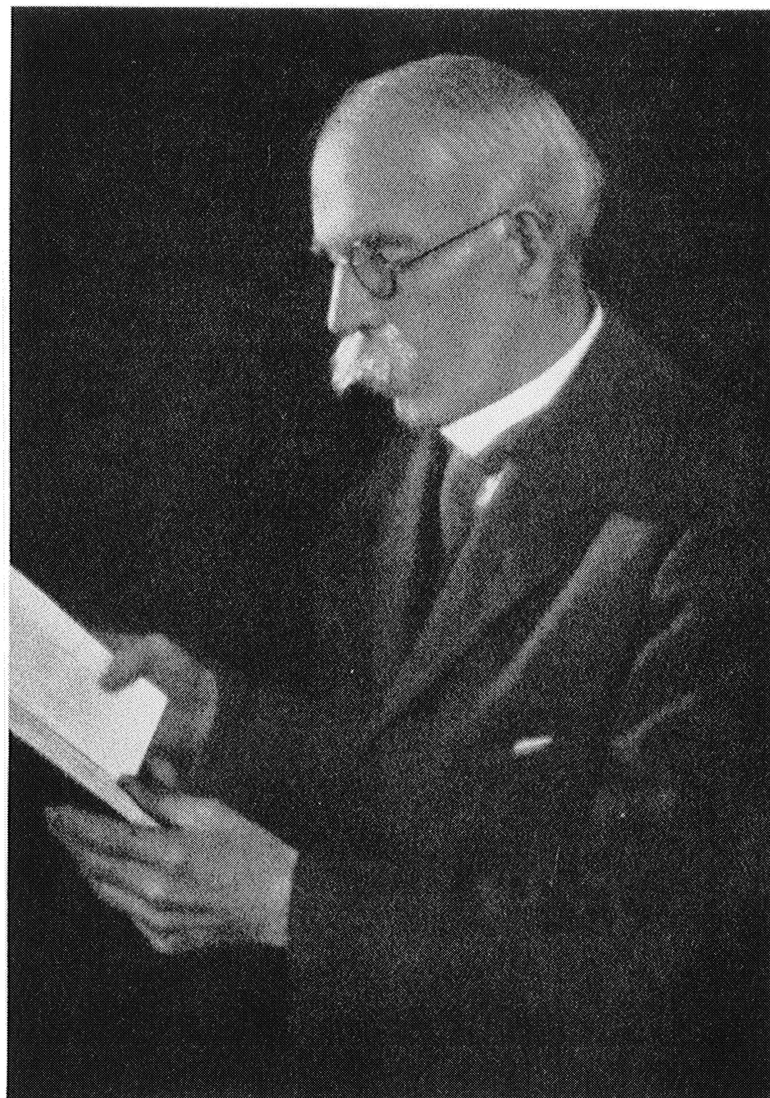
15. Frank Morley

Curriculum Vitae.—B. Woodbridge, Suffolk, Eng. 9 Sept. 1860; d. Baltimore, Md. 17 Oct. 1937. At King's C., Cambridge (79–84; A.B. 84, A.M. 87). Math. master Bath C. (84–87). Instr. Haverford C., Pa. (87-88; prof. 88–00, leave of absence during 97–98, spent in England at Cambridge U. (Sc.D. 98); prof. JHU (00–28; prof. emeritus 28–37).

Honors.—Ed. AMS *Bull.*, 95–98, Oct. 99-02. Mem. Amer. Phil. So. 97. Cooperating ed. *AJM*, July 99-00, Apr. 30–36; ed. 01–21; joint ed. 22-Jan. 30. VP AMS 02. Mem. Advisory Comm. on Math. to Carnegie Institution (with E. H. Moore chm.; and O. Stone) 02. Starred *Amer. Men Sci.* 06. Research assist., or Assoc., Carnegie Institution 09-36; except for a few years. Fellow AAcAS 17. P AMS 19-20. Portrait painted by T. C. Corner of Baltimore, presented to JHU and placed in the Library 26; reproduction in *JH Alumni Mag.*, v. 14, 1926, opp. p. 513, and in *AJM*, v. 60, frontispiece, 1938.

Biographical Notes.—Prof. Morley was a son of Quaker parents Joseph R. and Elizabeth (Muskett) Morley of Suffolk, Eng. Having won an open scholarship and prize he went into residence at King's C., Cambridge, in 1879, but his university career was sorely hampered by illness. He did not graduate until a year later than the normal date, eighth in the list when G. B. Mathews was senior wrangler and A. N. Whitehead fourth. "Ill health beyond all doubt had prevented him from doing himself justice, but the disappointment was keen. In middle life he was loth to speak of his student days, yet the friendships then formed with Lowes Dickinson and others were lasting." (Richmond). After settling in the U. S., hardships of his earlier years were behind him, his health was no longer a cause for anxiety, and since he had an assured position he married an English lady of Sussex. The twelve years at the Quaker college in Haverford were years of great happiness during which his powers and reputation steadily increased. More than a score of papers, and two books date from this period. His closest mathematical associations were with two Cambridge professors at the neighbouring college of Bryn Mawr, Charlotte Scott of Girton C., one of the foremost of the younger geometers, and James



Frank Morley

1916

Harkness[1] of Trinity C., who collaborated with him in his first book, *A Treatise on the Theory of Functions* (no. 15), reissued six years later in a shorter and much improved form as an *Introduction to the Theory of Analytic Functions* (no. 27); even today this work is a classic.

Of these treatises there were admirable reviews by Maschke (NYMS *Bull.*, v. 3), and Bolza (AMS *Bull.*, v. 6). Maschke wrote of the first that it "rendered the theory of functions accessible to everyone who wishes to acquire a thorough knowledge of the subject" and that "the great merits of this valuable work will secure it a high rank in modern mathematical literature." Of the *Introduction* Bolza pointed out that the title conveys an inadequate idea of its scope and object; it may be shortly described as a very complete treatise on Weierstrass's general theory of functions with applications to elliptic and algebraic functions, preceded by an introduction devoted to the number concept and the geometric interpretation of complex quantities, and followed by a short account of some of the leading ideas of Riemann and Cauchy. Bolza closes his review as follows: "Thus the authors have succeeded in producing not only a work of high scientific and pedagogical value but at the same time of a singular beauty and elegance. But there are numerous beauties of detail as well, for which, however, the reader must be referred to the book itself. A certain freshness and originality pervade the whole, even in places where the authors follow along beaten tracks, and give at every turn evidence of the complete mastery of the subject with which the book is written."

For comments on some of his papers we follow Prof. Coble. He tells us that Prof. White thought most highly of the one on geometry whose element is the 3-point of a plane (no. 40) but that his own favorite was the brief article on the Lüroth quartic curve (no. 50), a penetrating geometric analysis of kaleidoscopic character which eventually yields an algebraic result quite unattainable by conventional methods. His chief contribution to algebra was in the discussion of the eliminant of a net of curves (nos. 58, 62). The delightful retiring presidential address on "Pleasant questions and wonderful effects" (no. 52) reflected the invigorating spirit of a great man and a great teacher. He went to the JHU when graduate work in mathematics so brilliantly initiated by Sylvester had commenced to decline, and soon made it an inspiring intellectual center, which drew many students. He lectured several times a week to all students in the department, stimulating the entire group by his unusual gift in the application of advanced ideas to elementary topics by striking translation of the abstract into the concrete, the whole pervaded with refreshing humor.

[1] In his reminiscences Morley wrote of Harkness as follows: "A man of wide accurate and available information, remarkable in any case and astonishing in an Englishman of that time. Knew not only the pure mathematics as it then stood but much history and much worthwhile pure literature. And he brought out quotations apt to the occasion, usually with a chuckle. The élite of the men of Bryn Mawr ran to his rooms in cottage no. 2, at the hour of afternoon tea, Tom Morgan leading. Henry Crew and I at Haverford College a mile away joined up."

Many of Prof. Morley's ideas were also developed during 1900–31 by the following 49 students who carried on their work for the doctor's degree, at Haverford C. and JHU under his direction: F. H. Loud (at Haverford), I. E. Rabinovitch (name later changed to Marshall), A. B. Coble, H. A. Converse, C. E. Brooks, W. B. Carver, J. G. Hun, C. C. Grove, H. B. Phillips, R. P. Stephens, J. F. Messick, C. S. Atchison, A. E. Landry, E. C. F. Phillips, J. R. Conner, D. D. Leib, H. I. Thomsen, J. E. Hodgson, J. E. Rowe, T. B. Ashcraft, M. Clara L. Bacon, J. I. Tracey, R. M. Winger, H. Bateman, Florence P. Lewis, L. E. Wear, J. W. Gain, H. C. Gossard, Mabel M. Young, C. H. Rawlins, Jr., A. W. Hobbs, Teresa Cohen, Flora D. Sutton, G. H. Collignon, F. J. Gerst, Anna M. Whelan, J. B. Linker, L. T. Moore, B. C. Patterson, Martha H. Barton, P. S. Wagner, L. M. Blumenthal, A. S. Winsor, J. W. Peters, A. W. Richeson, Mildred W. Dean, W. K. Morrill, C. A. Spicer, H. A. Robinson. Coble tells us that with Morley "it was a cardinal point to have on hand a sufficient variety of thesis problems to accommodate particular tastes and capacities. Many promising ideas which occured to him were laid aside for student use. He followed the development of each one of his students with great solicitude and felt fully rewarded when some evidence of independent thinking appeared."

Many of Prof. Morley's discoveries are also contained in more than three scores of problems proposed for solution in the *Ed. Times* (Bibl. no. 1) from the time that he was an undergraduate on for nearly fifty years. Most of the problems are geometrical; three of them are as follows:
8340: Show that on a chess-board the number of squares visible is 204, and the number of rectangles (including squares) visible is 1296; and that, on a similar board with n squares in each side, the number of squares is the sum of the first n square numbers, and the number of rectangles (including squares) is the sum of the first n cube numbers.
10034: Prove that, of the four focal circles of a circular cubic or bicircular quartic, any two are orthogonal, and the radii are connected by the relation $\sum(\mu-2)=0$.
10562: Let there be three parallel rectilinear vortices in an infinite mass of fluid. Let a cross section meet the vortices at ABC. Prove that (1) the motion of any vortex A is at right angles to AK, where K is the symmedian point; and (2) the particles at foci of the maximum ellipse inscribed in ABC are instantaneously at rest.

By about 1900 the following result due to Prof. Morley was well known to Cambridge mathematicians and others: "If the angles of any triangle be trisected, the triangle, formed by the meets of pairs of trisectors, each pair being adjacent to the same side, is equilateral." The first published reference to it as "Morley's theorem,"[1] a term now in general use,

[1] See also *P. Mat.*, s. 4, v. 1, 1921, p. 240–290. *L'Enseignement Mathém.*, v. 22, 1922, p. 344. *Math. Gazette*, v. 11, 1922, p. 85, 164, 171, 310; v. 12, 1925, p. 391; v. 17, 1933, p. 126–268, and v. 22, 1938, p. 50–57, an art. entitled "Morley's triangle." LMS *Proc.*, s. 2, v. 31, 1930, p. 364. *DB*, v. 72, 1937, p. 360.

seems to have been in a paper by F. G. Taylor and W. L. Marr (EMS *Proc.*, v. 32, 1914, p. 119). This was followed by papers of Taylor, "The relation of Morley's theorem to the Hessian axis and circumcentre" (p. 132–135); and Marr, "Morley's trisection theorem: an extension and its relation to the circles of Apollonius" (p. 136–150). Morley's first personal published reference to the theorem was ten years later (no. 56), when he told the manner of its discovery. He found that if a variable cardioid touch the sides of a triangle the locus of its center, that is, the center of the circle on which the equal circles roll, is a set of 9 lines which are three by three parallel, the directions being those of the sides of an equilateral triangle. The meets of these lines correspond to double tangents; they are also the meets of certain pairs of trisectors of the angles, internal and external, of the first triangle. See also *Inversive Geometry* (no. 72, p. 242–244; rev. by Snyder in AMS *Bull.*, v. 40), a work which represents the development and refinement of many of his own articles and those of his students during a number of years. A quotation from the preface is illuminating: "We believe that the tradition that simple geometrical and mechanical questions are to be handled only as Euclid or Descartes may have handled them is very hampering; that the ideas of Riemann, Poincaré, Klein and others have pleasant reverberations in the investigation of elementary questions by students of proper maturity and leisure."

For many years, even after his retirement from the university, Professor Morley participated in research programs of the Carnegie Institution assisted by various associates including A. B. Coble, H. Bateman and J. R. Conner. When in 1903 mathematicians of America rated in order their 80 leading men of research, Morley was put seventh. In the recently published (1934) index of *Encyk. d. Math. Wiss.*, v. 3, there are 30 references to work of Morley; see in particular "Die Potentialkurven und die Morleyschen Enveloppen," part 2, p. 609–610, with references to his papers on metric geometry of the plane n-line and on projective coordinates (nos. 32, 39).

He enjoyed music and was for a number of years a member of the Baltimore Choral So. As a boy and young man he had shown exceptional promise as a chess player; "throughout life he could grasp the possibilities of a position at chess or of a hand at cards with astonishing ease and certainty. He had something of the same power in discussing a geometrical configuration, for he proved, not once but many times, that he could penetrate more deeply into its inner significance than the rest of us." (Richmond). He was on the Cambridge U. chess team 1880–84 and had the distinction of having once beaten Dr. Lasker, when Lasker was the champion of the world.

"He was a striking figure in any group. Deliberate in manner and speech, there was a suggestion of shyness about him. He was generally very well informed and interested in a strikingly wide range of subjects.

He was of an artistic temperament. While many of his papers and lectures seemed involved to the uninitiated, they all possessed a characteristic artistic charm." (Cohen). In the mass of his manuscripts left behind are many charming and characteristic items. An examination set his students in 1904 was prefaced with the remark: "In this examination, if an exact answer does not suggest itself, an inspired guess will be of value." In a seminary paper, when a new dormitory was being built, was the remark that what the University needed was not a dormitory but a cogitatory. His contributions to family newspapers of his children and grandchildren would probably interest a wide circle. "Those who were privileged to know him well will never forget the kindly aspects of his daily life nor the devotion with which he pursued the high cultural and scientific ideals which he had set. His personal achievements and his stimulating influence on the mathematics of his time assure him a permanent place in the history of the science." (Coble).

All three of Prof. Morley's sons were Rhodes scholars and have attained to distinction in various fields. Christopher, contributing ed. of *Saturday Rev. of Lit.*, is the author of scores of popular books; Felix is the ed. of the *Washington Post;* Frank V., after getting his Ph.D. in mathematics at Oxford, became director of the publishing firm Faber and Faber, Ltd., London. Since they were all born in this country they are citizens of the U. S.; but their father always remained a British subject.

SOURCES.—H. W. Richmond, (1) *Nature*, v. 40, 1937, p. 880; (2) LMS *Journ.*, v. 13, 1938. A.B. Coble, AMS *Bull.*, v. 44, 1938. A. Cohen, *Science*, n.s., v. 86, 1937, p. 461. *Who's Who in Amer.*, v. 19. *The Times*, London, 19 Oct. 1937. *Nat. Cycl. Amer. Biog.*, v. 15, 1916. *Amer. Men Sci.*, 5th ed., 1933. Carnegie Inst. *Year Book*, 1909–36.

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16. Gilbert Ames Bliss

Curriculum Vitae.—B. Chicago, Ill. 9 May 1876. Educ. U. Chicago (93–00; B.S. 97; M.S. 98; Ph.D. 00); instr. math. U. Minnesota (00–02); student U. Göttingen 02–03; assoc. U. Chicago (03–04); assist. prof. U. Missouri (04–05); preceptor Princeton U. (05–08); assoc. prof. U. Chicago (08–13; prof. 13– ; chm. dept. since 27). Martin A. Ryerson distinguished service prof. U. Chicago since 33. Lect. U. Wisconsin summer 07, Harvard U. first sem. 11–12.

Honors.—Colloq. Lect. AMS 09. Starred *Amer. Men Sci.* 10. VP AMS 11. Mem. NAS 16. Scientific expert, Range Firing Sect., Aberdeen Proving Ground, Oct.-Dec. 18. P AMS 21–22. Mem. NRC Fellowship Board 24–36. AMS trustee 24. First award of Chauvenet (quinquennial) Prize of $100 by MAA 25; for a mathematical article of expository excellence, "Algebraic functions and their divisors," see Bibl. no. 43. Mem. Amer. Phil. So. 26. Mem. AMS Comm. on Colloquia 26–28. Chm. editorial comm. Science Series, U. Chicago 29– . VP AAAS and chm. Sect A 30; ret. add. see Bibl. no. 57. Fellow AAcAS 35. Hon. Sc.D. U. Wisconsin 35.

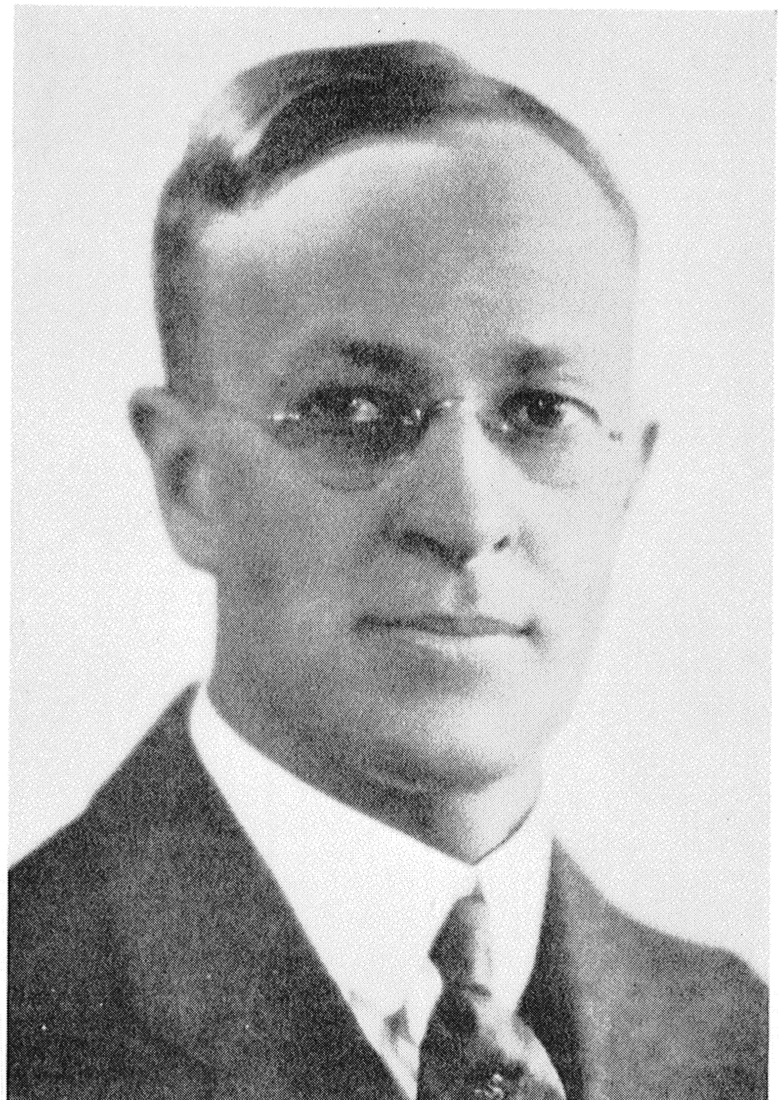
Biographical Notes.—Prof. Bliss is a son of George Harrison Bliss, an electrical expert who superintended the installation of one of the first incandescent lighting plants in a theater in Chicago. He is a descendant of Thomas Bliss who came from Belstone, Eng. to Boston, Mass. in 1636 and settled in Rehoboth, Mass. On his mother's side he is a grandson of Orrin P. Gilbert of Colchester, Conn., afterwards, instructor in modern languages in Worcester Academy.

In the graduate school at U. Chicago Bliss's work was at first mostly in mathematical astronomy under F. R. Moulton, an inspiring teacher who encouraged him in writing his first published paper (Bibl. no. 1). His principal interest was in mathematics, however, and in 1898 he became a candidate for the doctor's degree in that field. Through the acquisition of a copy of the famous course of lectures in the calculus of variations which Weierstrass gave in 1879, and through Bolza's fascinating lectures, this subject became Bliss's dominant interest. During the year at Göttingen, Klein, Hilbert and Minkowski were the leaders, and among the younger men were Zermelo, E. Schmidt, Abraham, Féjer, Carathéodory, Kellogg, and Max Mason. After only a year spent as assist. prof. math. under Prof. Hedrick at U. Missouri (where W. A. Hurwitz was an extraordinarily able and precocious student in one of his classes), he accepted a call to Princeton U. in connection with the initiation of President Wilson's preceptorial scheme, when Dean Fine commenced to lay the basis for the development of a great department. Eisenhart, Veblen, J. W. Young, and R. L. Moore were the associates with whom discussions were constantly stimulating. Maschke died in 1908, and Bliss was appointed to his place at the U. Chicago.

While the Bibliography below testifies to Prof. Bliss's activity in research and his special gift for lucid and interesting exposition, he has ever been generous in giving up time to much less congenial editorial tasks, as follows: assoc. ed. *AM* 06–08, assoc. ed. AMS *Trans.* 09–16, mem. editorial comm. Carus Monographs, 24–. But further, apart from directing the AMS at a critical period, and the affairs of his department for more than a decade he has long had many students working for their doctorate under his direction. The complete list of such students (46) is an interesting one, namely: E. J. Miles, Marion B. White, L. L. Dines, C. A. Fischer, W. V. Lovitt, Gillie A. Larew, A. S. Merrill, D. S. Smith, K. W. Lamson, F. E. LeStourgeon, W. P. Ott, I. A. Barnett, E. H. Clarke, J. D. Eshleman, L. M. Graves, Jewel W. Hughes, J. H. Taylor, H. A. Simmons, I. R. Pounder, Marion E. Stark, F. H. Bamforth, T. F. Cope, D. R. Davis, E. L. Mackie, A. O. Hickson, Rosa L. Jackson, Marie M. Johnson, L. La Paz, M. G. Boyce, W. L. Duren, Jr., Aline Huke, E. J. McShane (under Bliss and Graves), F. L. Wren, M. Coral, R. G. Sanger, M. R. Hestenes, K.-S. Hu (under Bliss and Graves), A. W. Raab (under Bliss and Graves), Julia W. Bower, B. Crosby II, R. H. Bardell, Evelyn P. Wiggin (under Bliss and Reid), C. H. Denbow (under Bliss, Graves and Reid), A. S. Householder, N. A. Moscovitch, F. A. Valentine (under Bliss and Graves).

After the U. S. joined in the World War, navigation was taught at U. Chicago in the summer of 1918, and Bliss had a section with about 100 students. At this time Oswald Veblen was a major in charge of the Range Firing Sect. of the Aberdeen Proving Ground, and induced Bliss to go there as scientific expert. His particular problem was to deal with "differential corrections" of trajectories for the effects of wind, variations from normal in the density of the air and weights of the projectile and powder charge, and in the case of long ranges, for the rotation of the earth. Application of the theories of calculus of variations was highly effective and in many cases reduced by three-fourths the time previously necessary for range corrections.

Of special significance in Bliss's research are the generalization of algebraic elimination theory (no. 21), the theory of the singularities of real transformations of the plane in the Colloquium Lectures (no. 22, of which there was a 2d ed.), and the theory of "differential corrections" (nos. 36, 37, 39, 40), applicable elsewhere than in ballistics, which may be the basis of future results of significance. Studies of the simplification of algebraic curves by birational transformations (nos. 41, 42, 43, 60) led to another volume in the *Colloq. Pub.* series. But by far the most extensive part of Bliss's research has been in the calculus of variations and culminated in the lectures on *The Problem of Bolza* (no. 68). Two earlier papers "Jacobi's condition for problems of the calculus of variations in parametric form" (no. 31), and "The transformation of Clebsch" (no. 49) are especially notable since they are the bases for quite remarkable improvements in the theory of the second variation in the calculus of variations, and have had



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much influence on the literature. As a result of them the elaborate transformation theories of Clebsch, von Escherich, and others, and of Weierstrass for parametric problems, can be replaced by relatively very simple arguments.

As an undergraduate Prof. Bliss was in the Glee Club and its president for a year. In order to earn money necessary for his college expenses he became a member of a student professional mandolin quartet. He has always been interested in sport and beginning with bicycle racing in student days he has successively taken up tennis, racquets, and golf. In 1910 Waseda U. of Tokyo invited U. Chicago to send its baseball team to Japan for a series of games with the teams of Waseda U. and Keio U. (near Tokyo). The Chicago team was the first one so invited and Prof. Bliss was asked to go with the team as faculty representative. He arranged not only for seven months' leave of absence, but also joined with the captain of the team on a trip around the world when the games were over. After the team left Hong Kong for the U. S., Bliss visited Canton, Singapore, Burma, India, and Egypt.

As an administrator, as a teacher, and as a man, Prof. Bliss's influence on American mathematicians has been most notable. We refer in chapter III to his services while he was P of the Society.

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17. Oswald Veblen

Curriculum Vitae.—B. Decorah, Ia. 24 June 1880. Prepared at public schools Iowa City, Ia., as student U. Iowa (94–98; A.B. 98; lab. assist. phys. 98–99); at Harvard U. (99-00; A.B. 00); at U. Chicago (00–03; Ph.D. 03; assoc. 03–05). Preceptor Princeton U. (05–10; prof. 10–26; Henry Burchard Fine prof. 26–32). Prof. in School of Math., Inst. for Adv. Study (32–). Capt. and major, U. S. Ordnance Dept., Aberdeen, Md., 17–19. Deputy for the Savilian prof. math. (exchange with G. H. Hardy), U. Oxford first sem. 28–29. Walker Ames prof. U. Washington first term of summer 37.

Honors.—Starred *Amer. Men Sci.* 10. Joint ed. *AM* Sept. 11–July 25; cooperating ed. Oct. 26–Sept. 31. Mem. Amer. Phil. So. 12. VP AMS 15. Colloq. Lect. AMS 16; "Analysis situs" (Bibl. no. 30). VP MAA 17; trustee 16, 20–22, 26–31. Mem. NAS 19. AMS nominee mem. NRC Div. Phys. Sci. Jan. 20–July 23; also mem. exec. comm. of Div. 20–23, and vice-chm. 22-23. VP AAAS and chm. Sect. A 21; add. "Geometry and physics" (no 35). Fellow Amer. Phys. So. 21. Fellow AAcAS 23. P AMS 23–24; ret. P add. "Remarks on the foundations of geometry" (no. 40). Trustee AMS 24, 27-30. Mem. NRC Fellowship Board for phys., chem., and math. 25–36. Mem. board of trustees of Nat. Research Endowment of NAS 26; see *Science*, n.s., v. 63, p. 158. Chm. AMS comm. on Colloquia and *Colloq. Pubs.* 26–28, Dec. 33–36. Mem. council NAS 26–29; 37– . Mem. AAAS comm. on grants 26. Mem. Council LMS 28. Hon. Sc.D. U. Oxford 29. Hon. Ph.D. U. Oslo 29; on the occasion of the Abel centenary celebration. Corresp. mem. Göttingen So. Sci. 29. William Lowell Putnam Lect. Harvard U., "Five-dimensional relativity," 30. Lect. U. Göttingen 32. Delegate U. S. Govt., Intern. Congress Mathems., Zürich 32. Delegate AAAS to BAAS 32. Hon. Ph.D. U. Hamburg 32. Assoc. ed. *Com. Mathem.* 34–. Invited speaker Intern. Congress Mathems., Oslo 36; "Spinors and projective geometry" (no. 67). Delegate U. S. Govt., and AAAS to Intern. Congress Mathems. Oslo 36. Joint ed. *Zentralblatt f. Math.* 36–.

Biographical Notes.—Prof. Veblen is a grandson of Thomas Anderson and Kari T. (Bunde) Veblen, who in 1847 emigrated from Valdris, Norway, and settled in Ozaukee County, Wis. In 1865 they moved to a prairie farm in Rice County, Minn. where their family of twelve children was reared under the harsh conditions of early settlement in the Northwest. One of this family was Thorstein Bunde Veblen (1857–1929) the distinguished economist and social theorist (see *DAB*, v. 19, 1936; *Cycl. Amer. Biog.*, v. 21, 1931). His brother Andrew Anderson (1848–1932) who became prof. of physics at U. Iowa (see *Amer. Men Sci.*, 4th ed.) and m. Kirsti Hougen, was Prof. Veblen's father. With such an inheritance it is not strange that Prof. Veblen's favorite recreation is working out of doors.

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He received the major part of his mathematical training at the U. Chicago from that inspiring trio Bolza, Maschke, and Moore. Under their direction he laid the basis for the important work he was later to achieve in the fields of foundations of geometry, projective geometry, analysis situs, differential invariants, and spinors. His often quoted dissertation (no. 5), under E. H. Moore, on a system of axioms of Euclidean geometry, followed the trend of development of Pasch (1882) and Peano (1889, 1894) rather than that of Hilbert (1899) and Pieri (1899). In this system "point" and "order" are the only undefined elements, and the number of axioms is reduced to twelve, which were proved to be independent (the first set of axioms for geometry of which this is true). His next paper, on analysis situs, appeared just before leaving for Princeton, which under his leadership during the next thirty years was to become one of the great centers of the world for topological studies. His lectures in this field at Princeton U., and such notable publications as nos. 25 and 26 naturally paved the way for his Colloquium Lectures on Analysis Situs in 1916 (no. 30; see reviews by S. Lefschetz, *DB*, v. 57, and AMS *Bull.*, v. 30). This book was for several years the source from which mathematicians in all parts of the world learned Topology and it is still a useful adjunct to the more modern and extensive work on Topology by Lefschetz, also in the AMS Colloquium series.

Veblen's diss. (no. 5) led naturally to questions treated in papers on projective geometry (nos. 11, 12, 13, 18) and to the very notable and scholarly treatise on the subject (no. 19), in two v., the first in collaboration with J. W. Young (see reviews by J. L. Coolidge AMS *Bull.*, v. 18, and R. L. Moore, *idem.* v. 26). This book has had a considerable influence on students of abstract algebra as well as of abstract geometry. As to the point of view in the joint v. the authors write: "Even the limited space devoted in this v. to the foundations may seem a drawback from the pedagogical point of view of some mathematicians. To this we can only reply that, in our opinion, an adequate knowledge of geometry cannot be obtained without attention to the foundations. We believe, moreover, that the abstract treatment is peculiarly desirable in projective geometry, because it is through the latter that the other geometric disciplines are most readily coördinated. Since it is more natural to derive the geometrical disciplines associated with the names of Euclid, Descartes, Lobatchewsky, etc., from projective geometry than it is to derive projective geometry from one of them, it is natural to take the foundations of projective geometry as the foundations of all geometry." The first v. made extensive use of spaces with a finite number of parts as illustrative of the generality of the theory. Linear order and continuity, and hence the discussion of the metric geometries characterized by certain subgroups of the general projective group, are topics of the second v. In this there are two principles for the classification of any theorem of geometry: (i) the axiomatic basis, or bases, from which it can be derived, or in other words, the class of spaces in which it can be valid: and (ii) the group to which it belongs in a given space.

Veblen's interest in the foundations of mathematics led to his collaboration with N. J. Lennes, then an instr. in a Chicago high school, in the preparation of another book, *Introduction to Infinitesimal Analysis, Functions of One Real Variable* (no. 15). Only fifteen years before, the first treatise in the English language on the theory of functions of a complex variable had been published. During that period the sister theory came into prominence in American university lecturing. In admirable fashion his work brought home to many American students of 1907 what was necessary for rigorous logical discussion of fundamental theorems of infinitesimal calculus. Such things as the systematic use of the Heine-Borel theorem, methodical use of the upper and lower bounds of a function for simplifying proofs, and the treatment of integration, were then novelties here. That the work is in demand, even at the present time, is indicated by its recent reprint.

Some of Veblen's important contributions after the world war were summed up in two of the *Cambridge Tracts* (nos. 43, 55) and in a monograph of the *Ergebnisse* series (no. 56). The first, *Invariants of Quadratic Differential Forms* (no. 43; reviewed by M. H. A. Newman in *Math. Gazette*, v. 14) took account of many new discoveries made after the advent of relativity, and sets forth those parts of the subject of primary value for applications to electromagnetic theory, dynamics, and quantum theory. The second tract on *The Foundations of Differential Geometry* (no. 55), written in collaboration with a former student, is a companion to the first and contains a critical study of the foundations of all mathematical systems which have been called geometries. A rigid definition of geometry is not attempted on the ground that any objective definition of geometry would include the whole of mathematics. "Any mathematical science is a body of theorems deduced from a set of axioms. A geometry is a mathematical science. The question arises why the name geometry is given to some mathematical sciences and not to others. It is likely that there is no definite answer to this question, but that a branch of mathematics is called a geometry because the name seems good, on emotional and traditional grounds, to a sufficient number of competent people." The third tract, *Projektive Relativitätstheorie* (no. 56; reviewed by D. J. Struik AMS *Bull.*, v. 40) is a result of a series of lectures at U. Göttingen and dealt with what was then a new aspect of the theory of relativity. It allows a unified theory of the gravitational and the electromagnetic field, and, with his later papers (nos. 57, 58), of the modern wave mechanics. It may be regarded as a generalization of classical non-euclidean geometry. The projective relativity theory is one of a series of investigations in which attempts, begun by Weyl in 1918, were made to define a space-time structure depending not only on gravitational but also on electromagnetic potentials. Projective relativity seems to offer a simple and attractive solution. It has subsequently been recast and extended by various other mathematicians and physicists, as for example by Schouten and Van Dantzig in *Zeitsch. f. Physik*, and *AM* (v. 34). The recently published index (1934) to *Encyk. d. Math. Wiss.*, v. 3, gives more than a score of references to Veblen's publications.

With the founding of the Institute for Advanced Study in 1930, and the starting in 1932 of its School of Mathematics, a new stimulant of extraordinary potency was provided in Princeton for the development of mathematical research in the U. S. It was Veblen who was chiefly responsible for choosing the brilliant group of professors (Alexander, Einstein, Morse, von Neumann, Weyl) who constitute the nucleus of this School. At present he annually conducts seminars on topics such as: Modern differential geometry; Differential geometry and quantum theory; Geometry of complex domains (see no. 66); and in 1937–38, Quantum mechanics of composite systems, the last three with J. von Neumann.

Veblen made a great contribution to mathematical research in this country in yet another direction. It was largely through his influence that mathematicians since 1924 have been the recipients of National Research Council Fellowships. In chapter III an attempt is made to indicate the extraordinary indebtedness of the Society to him, at a critical time, for constructive service which he alone was qualified to render.

At U. Chicago and Princeton U. the doctoral dissertations of the following fifteen individuals were done under Veblen's direction, 1905–36: R. L. Moore (at Chicago), G. MacF. Conwell, U. G. Mitchell, H. H. Mitchell, A. A. Bennett, H. R. Brahana, P. Franklin, T. Y. Thomas, A. Church, M. S. Knebelman, J. H. C. Whitehead, A. L. Foster, B. Hoffmann, J. L. Vanderslice, J. W. Givens.

During the World War Major Veblen's remarkable powers of organization were capitalized by the Govt. which put him in charge of range firing and ballistic work at Aberdeen, Md. His work was largely experimental (see no. 28) and administrative. In addition to the routine computations, a considerable number of mathematical investigations were carried out in 1918 by the following mathematicians in this organization: H. F. Blichfeldt, G. A. Bliss, T. H. Gronwall, C. R. Dines, P. Franklin, W. C. Graustein, C. N. Haskins, H. H. Mitchell, and W. H. Roever.

It can be the privilege of but few to have done as much as Prof. Veblen to promote mathematical research in the United States.

Mrs. Veblen's brother O. W. Richardson, formerly a professor at Princeton U., is the distinguished research prof. of the RS and director of research in physics at King's C., London.

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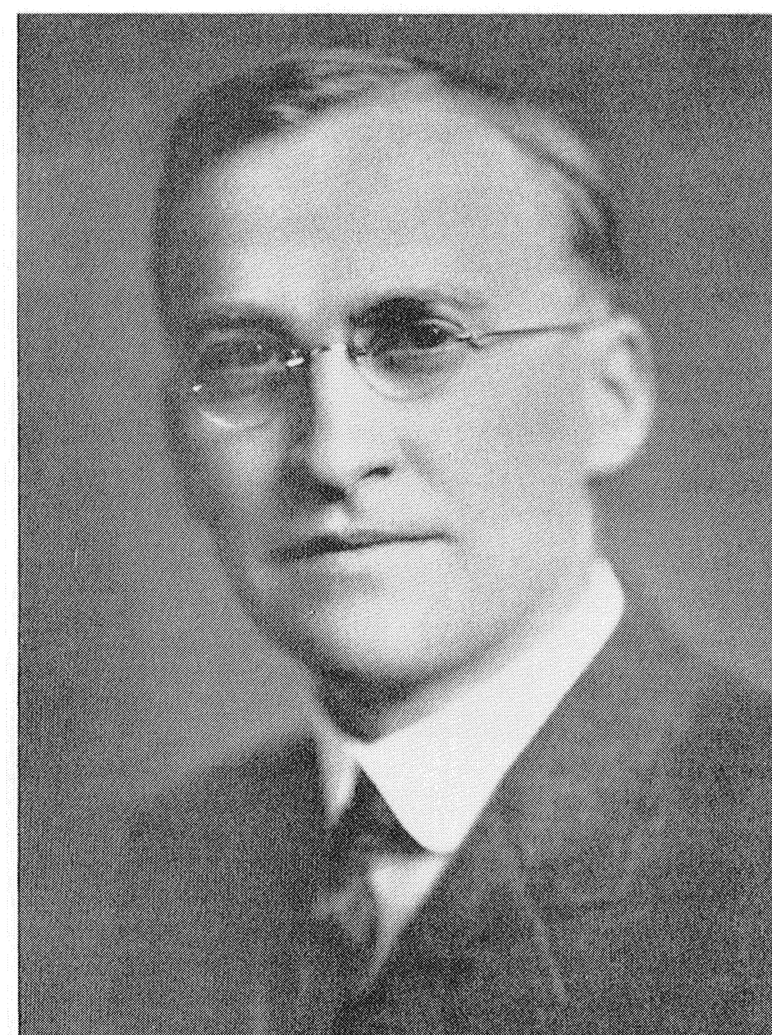
18. George David Birkhoff

Curriculum Vitae.—B. Overisel, Mich. 21 Mar. 1884. He was a student at the Lewis Inst., Chicago (96–02), U. Chicago (02–03; 05–07; Ph.D. 07), Harvard U. (03–05, A.B. 05; A.M. 06). Inst. U. Wisconsin (07–09); preceptor Princeton U. (09–11); prof. (11–12); assist. prof. Harvard U. (12–19; prof. 19– ; acting dean faculty arts and sci. 35–36; dean Sept. 36–). Visiting prof. U. Chicago summer 17; U. California summers 22 and 24; Columbia U. summer 29.

Honors.—Starred *Amer. Men Sci.* 10. Fellow AAcAS 13. Mem. NAS 18; at the age of 34.1 years Birkhoff and Newcomb were the youngest of the 45 mathematicians and mathematical physicists who had been elected members of the Acad. up to 1937, when J. v. Neumann, aged 33.4, was elected. Awarded Quirini Stampalia Prize, of 3000 lire, by the Royal Venice Inst. Sci. Letters and Arts for realizing an important advance in the theory of periodic solutions of differential equations 18; the specific memoirs crowned listed in Bibl. nos. 23 and 27 below. VP AAAS and chm. sect. A 18. VP AMS 19. For. mem. Royal Danish So. Sci. 20. Colloq. Lect. AMS 20; see Bibl. no. 45. Mem. Amer. Phil. So. 21. Ed. AMS *Trans.* 21–24. For. Mem. So. Sci., Göttingen 22. Chm. comm. on revolving fund, NRC 22–36. Hon Sc.D. Brown U. 23; citation: "youngest professor of mathematics at our oldest university, already recognized throughout America and Europe as a leading discoverer and interpreter in the most fundamental of the sciences" (Faunce). Lect. Lowell Inst. 23 (Bibl. no. 40). First award AMS Bôcher Prize $200, "for a notable research memoir in analysis," "Dynamical systems with two degrees of freedom" (Bibl. no. 27) 23. Lect. at Yale U., 2d sem. 23. Harvard exchange prof. with Pomona C., Colorado C., Grinnell C., 1st sem. 24–25. P AMS 25–26. Mem. exec. comm. NRC 25–28. Mem. NRC Fellowship Board 25–36. Lect. U. St. Andrews math. colloq. 26. Cabot research fellow, Harvard U. 26–30. Fourth award of the prize of $1000 offered by a member of the AAAS for the most notable contribution to the advancement of science reported at the Philadelphia meeting, 26; the award was made for his ret. add. as P AMS, "A mathematical critique of some physical theories" (no. 49). Hon. mem. EMS 27. Hon. Sc.D. U. Wisconsin 27. General lect. Intern. Congress Mathems., Bologna 28 (no. 58) Lect. U. Berlin 28; "Einige Probleme der Dynamik" (no. 56). Mem. comm. eds. CMP *Rend.* 28–35. Corresp. mem., sect. geom., Acad. des Sci., Institut de France 29. For. assoc. Royal Acad. Lincei 29. Corresp. mem. Royal Acad. Sci. of the Institute, Bologna 30. Lect. under the foundation Michonis at Collège de France, Paris, 30; lectures: "Le dernier théorème de géométrie de Poincaré, ses généralisations, et ses applications à la dynamique." Lectures at L'Institut Henri Poincaré 31; "Sur l'existence de régions d'instabilité en dynamique" (no. 72). Hon. doctorate U. Poitiers 33, on the 500th anniversary of the founding of the U. Hon. Sc.D. Harvard U. 33; citation: "first in our land among masters of mathematics, that great tool of science, greater still in the realm of pure imagination" (Lowell). Awarded a prize of 10,000 lire by the Pontifical Acad. Sci. of the New Lincei for a memoir on systems of solutions of differential equations 33; the memoir is "Nouvelles recherches sur les systèmes dynamiques" (no. 93). Lect. at Phys. Math. So. of Japan, Tokyo, at Tsing-Hua U., Peiping, at Nat. U. of Peiping, at Higher Normal School, Pisa, 34. Hon. doctor U. Paris 36; in the notable and beautiful tribute to Birkhoff by M. Maurain, dean of the faculty of sci., it is mentioned incidentally that he played a prominent rôle in bringing about the establishment of the Institut Henri Poincaré. General lect. Intern. Congress Mathems., Oslo 36; see no. 97. Named one of 70 "pontifical academicians," who may be of any nationality or religion, in a newly organized Pontifical Acad. Sci. 36; the math. academicians named were U. Amaldi, Birkhoff, Carathéodory, de La Vallée Poussin, Levi-Civita, Picard, Volterra, E. T. Whittaker. Hon. doctor U. Athens on centenary celebration of its founding 37. P AAAS 37; the previous presidents who may be regarded as mathems. were: B. Peirce, W. Chauvenet, J. Lovering, S. Newcomb, H. A. Newton, and E. H. Moore. Officer in the French Legion of Honor, 37. Mem. exec. comm. AAAS 38– . Hon. mem. Amsterdam Math. So. 38; Vinogradov, H. Bohr, Blaschke and Godeaux were elected at the same time. Delegate to dedication of Benjamin Franklin Memorial, of the Franklin Institute 38; add. "Electricity as a fluid"; on this occasion hon. Sc.D. U. Pennsylvania. Lect. at Gregory Tercentenary celebration by the EMS July 38; 4 lects. Hon. LL.D. U. St. Andrews 38.



George D. Birkhoff

1925

Biographical Notes.—Prof. Birkhoff is a son of David Birkhoff a physician in Michigan, whose father George Birkhoff came from Middleharnis, Holland, in 1870, and settled in Chicago, Ill. His mother was also of Dutch extraction. During his two years at Harvard, one in college and one in the graduate school, Bôcher and Osgood were in their prime; but during the next two years he worked under Moore, Bolza, and Maschke, in the most inspiring mathematical center in the United States at that time. His dissertation was done quite independently, however.

Newcomb, Hill, and Birkhoff are the three Presidents whose achievements have been most extensively acclaimed internationally. But of these three the latter two have been especially outstanding in mathematical research. Hill was a remarkable instance of a man who was reserved and somewhat of a recluse, who had comparatively few contacts with fellow scientists, and who rarely went to meetings or congresses, but who, nevertheless, wrote extraordinarily original memoirs in the serenity of his home on a farm. His experiences in a classroom were excessively brief and he was not gifted in exposition. Birkhoff, on the other hand, is by nature intensely social; through many trips to Europe, and circumnavigation of the globe, he has been extensively in contact with scholars throughout the world; he is a constant attendant and participant at meetings and congresses, and has been frequently in demand as a writer and speaker on popular themes. In recent administrative gatherings the originality and breadth of his views have been noteworthy. For more than a generation he has been lecturing in university classrooms of the middle west and east. Like Hill he has had a hobby long occupying his attention. He has told us that the formal structure of western music, the riddle of melody, began to interest him in undergraduate days; somewhat intense consideration of the mathematical elements here involved led him to apply his theory also to aesthetic objects such as polygons, tilings, vases, and even poetry. And thus he was led to publish his volume *Aesthetic Measure* (no. 79; see also nos. 58, 66, 69, 76).

From the Bibliography it will be observed that Birkhoff's main research has been in the fields of differential and difference equations, calculus of variations, relativity, dynamical systems and stability, the problem of three bodies, and Poincaré's geometric theorem. This last theorem of Poincaré was announced in his posthumous paper "Sur un théorème de géométrie" (CMP, *Rend.*, v. 33, 1912, p. 375–407). It is of great importance, in particular for the restricted problem of three bodies; but having, after long-continued efforts, succeeded in treating only a great variety of special cases, he gave out the theorem for the consideration of other mathematicians. In a simple form the theorem may be stated as follows: "Suppose that a continuous, one-to-one transformation T takes the ring R, formed by two concentric circles C_a and C_b of radii a and b respectively ($a>b>0$), into itself in such a way as to advance the points of

C_a in the positive sense and the points of C_b in the negative sense, and at the same time to preserve areas. Then there are at least two invariant points." Birkhoff's proof, published in less than a year (see Bibl. nos. 15, 30, 53, and the generalization in no. 41), was possible because of the mathematical tools which he had been employing in earlier work.

A similar experience involving his two earlier papers (nos. 33, 54) and prepublication knowledge of a paper of J. von Neumann (NAS *Proc.*, v. 18, p. 70–82) who proved the existence of the ergodic theorem in the mean, of great importance in physical applications, led Birkhoff, by a stroke of genius to prove what Hopf (in *Ergodentheorie*, Berlin, 1937) calls the individual ergodic theorem, which is of much greater interest to the mathematician (Bibl. nos. 68, 73). The ergodic theorem may be stated as follows: "If $Z_{\alpha,\beta}$ $(P;M)$ denotes the relative sojourn of the moving point $P_t(P_0=P)$ in M in the time interval $\alpha \leqq t \leqq \beta$ (i.e. it is the length of this sojourn divided by $\beta-\alpha$), then $Z_{\alpha,\beta}(P;M) \rightarrow Z(P;M)$ as $\beta-\alpha \rightarrow +\infty$, for all P of Ω except for a set of measure zero."

But Birkhoff's great contributions to stability in dynamics were not only in the two directions just indicated, but also in discussions of other important papers and in the notable volume of his Colloq. Lects. before the AMS (see nos. 23, 27, 33, 41, 45, 46, 51, 54, 71, 87). His doctoral dissertation (no. 6) and paper 39 contain the first complete solution of the problem of asymptotic developments of solutions of differential equations and applications to systematic treatments of boundary value problems. Papers 11 and 61 presented important contributions to the existence theory of solutions of linear difference equations, and an entirely new method for a complete investigation of fundamental sets of solutions of difference equations; a new way was opened up for a complete solution of analogous problems for differential and more general equations. Papers 16, 17, 21 contain a complete solution of the famous Riemann problem concerning differential equations, and an extension to various more general situations. These notes suffice to indicate that Birkhoff has been attacking great problems and has already produced many inspired solutions.

The following 38 students have prepared their theses for the doctorate in association with Professor Birkhoff at Princeton, Yale, and Harvard U., and Radcliffe C., 1911–37: R. D. Carmichael (at Princeton), K. P. Williams (at Princeton), J. Slepian, R. B. Robbins, L. T. Wilson, P. M. Batchelder, R. W. Brink, N. Miller, H. C. M. Morse, C. N. Reynolds, Jr. (under Bôcher and Birkhoff), H. J. Ettlinger, J. L. Walsh, C. R. Adams, R. E. Langer, Eleanor Pairman (Mrs. B. H. Brown), C. A. Garabedian, B. Z. Linfield, F. H. Murray, J. L. Holley, D. V. Widder, H. Betz (at Yale), H. W. Brinkmann, L. E. Ward, B. O. Koopman, M. H. Stone, I. M. Sheffer, C. J. Coe, J. J. L. Hinrichsen, C. N. Liu, C. B. Morrey, Jr., T. L. Smith, H. Whitney, Mrs. Frances (Thorndike) Cope (at Radcliffe C.), D. C. Lewis, G. B. Price, F. H. Steen, A. S. Galbraith, O. E. Lancaster.

His son Garrett is a young mathematician of very exceptional promise.

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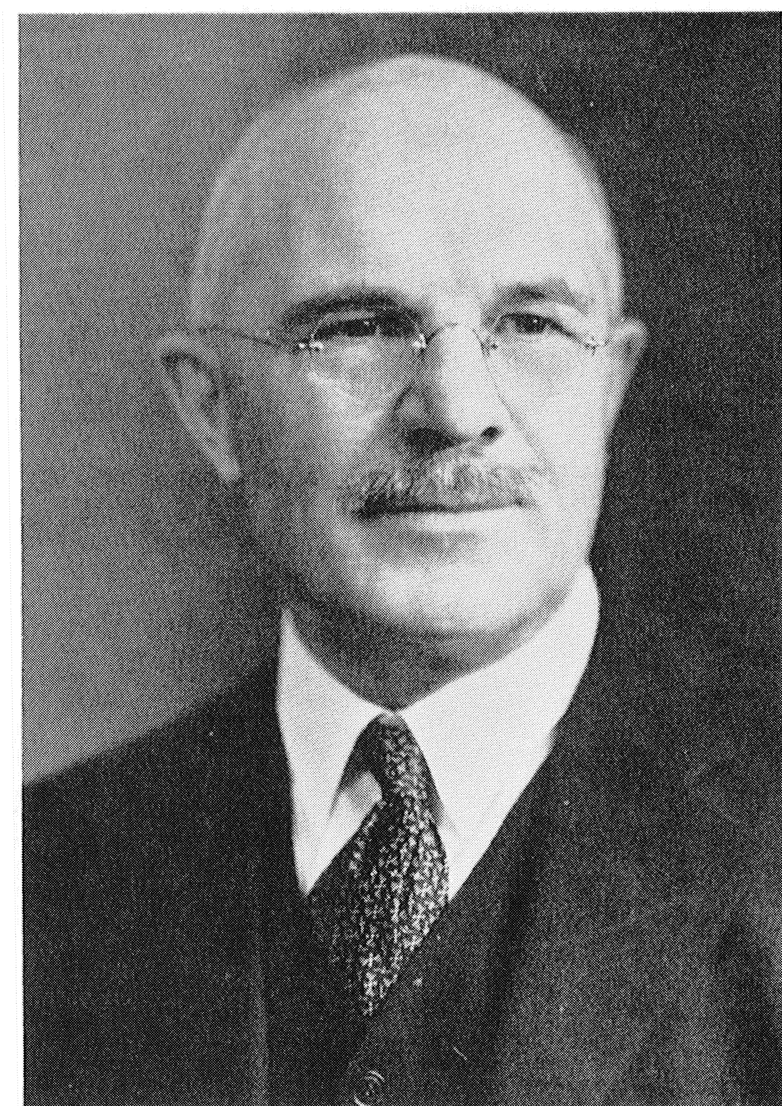
19. Virgil Snyder

Curriculum Vitae.—B. Dixon, Ia. 9 Nov. 1869. Educ. Iowa State C. (86–89; Sc.B. 89); Cornell U. (90–92), Brooks fellow from Cornell U. at U. Göttingen (92–94; Ph.D. Dec. 94). Instr. math. Cornell U. (95–03; assist. prof. 03–10; prof. 10–38; prof. emeritus 38–). Semi-centennial prof. U. California, summer 18.

Honors.—Starred *Amer. Men Sci.* 06. Ed. AMS *Bull.* 08-20. VP AMS 16. Fellow AAcAS 19. Fellow in Italy on Heckscher Foundation 21–22, 28–29. Hon. D. U. Padua on the celebration of the 700th anniversary of its founding 22. Del. NRC and Intern. Math. Union, Intern. Congress Mathems. Toronto 24; Bologna 28; Zürich 32. Chm. NRC Comm. on Rational Transformations 24–34. AMS nominee mem. Div. Phys. Sci. NRC 26–29. P AMS 27 -28; ret. P add. "The problem of the cubic variety in S_4" (Bibl. no. 70). Del. U. S. Govt. to Intern. Congress Mathems. Bologna 28; Oslo 36.

Biographical Notes.—Prof. Snyder is a son of Ephraim Snyder, a farmer and pioneer in the state of Iowa. He is descended from Johannes Schneider from Swabia, Germany, who first settled in Bethel, Pa., in 1777. His mother, Elisa Jane Randall, a native of New England and a school teacher, was of English-French descent.

During more than forty years at Cornell U., Prof. Snyder has devoted himself whole-heartedly, and with high idealism, to improving the teaching of mathematics, to promoting the welfare of his students and guiding them into research, and to carrying on his own original work in the fields of geometry of the line and sphere, configurations of ruled surfaces, and birational transformations. For the College Entrance Exam. Board he was chm. of the comm. of examiners in 1912, chief examiner in geometry 1912–14, and chief reader, 1912–17, 1919–23, 1925–32. He and J. H. Tanner were joint eds. of plane and solid geometries (no. 38); he was joint author with J. McMahon and with J. I. Hutchinson of three different works on the calculus (nos. 6, 16, 45); and with C. H. Sisam of an analytic



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geometry of space (no. 52). Turning to activities in the field of research, Prof. Snyder was an assist. ed. AMS *Bull.*, Feb. 1904–Dec. 1907, and a member of the comm. of pub. 1908–20. His paper no. 17 inspired Prof. R. P. Baker of Iowa to make a model of the quintic scroll, and the first purchaser of a copy was Mittag-Leffler who keenly appreciated the elegance of the results. Nos. 18, 19, 20 were written in ignorance of A. Wiman's Lund diss. *Klassifikation af Regelytorna af sjette Graden*, 1892 which inspired nos. 24, 26, where were listed the only two cases (as later proved by Wiman *Acta M.*, v. 57, 1931) overlooked by Wiman. In his paper on twisted curves whose tangents belong to a linear complex (no. 28) there is a theorem, contradicting one published by C. P. Steinmetz (1892), featured by Zindler in *Encyk. d. Math. Wiss.*, v. 3.2, p. 1024–5. There are more than fifty references to Snyder's work in this v. In no. 31, Snyder gives a proof of the interesting result that if two non-singular plane quartic curves are in (1, 1) correspondence they are projectively equivalent—a result duly set forth in the *Encyklopädie;* in no. 32 this is generalized to apply to all curves of order n, and of certain genus. But years later, proofs for part of the cases were given by Severi, Segre, Kapferer, and Wirtinger. The paper on the construction of plane curves of given order and genus, having distinct double points (no. 33) is most frequently cited by others. But the one written with Sharpe on certain types of involutorial space transformations (no. 60) is probably the most important. Prof. Snyder's most useful tool for the research worker, a very notable aid to the student in the field of rational transformations and related topics, is the large report (396+84 p.) on *Selected Topics in Algebraic Geometry* (nos. 69, 77) which he, as chm., and his five associates, A. B. Coble, A. Emch, S. Lefschetz, F. R. Sharpe, and C. H. Sisam, prepared for the NRC; it makes a report on 3585 books and papers (see reviews by T. R. Hollcroft in AMS *Bull.*, v. 38 and v. 42; by Van der Waerden in *Zentralblatt f. Math.*, v. 10). A. H. Black and L. A. Dye cooperated in preparing the supplementary part of the report.

Many developments of Prof. Snyder's work were carried out by the following 39 students who prepared their doctoral dissertations under his direction at Cornell U. 1902–37: P. Field, C. L. E. Moore, O. P. Akers, E. C. Colpitts, C. H. Sisam, Anna L. Van Benschoten, J. V. McKelvey, Mrs. Helen B. Owens, P. P. Boyd, F. M. Morgan, A. Helen Tappen, L. C. Cox, J. V. DePorte, T. R. Hollcroft, Anna M. Howe, J. O. Osborn, Marian M. Torrey, Fay Farnum, Hazel E. Schoonmaker, H. A. Davis, Ethel I. Moody, Mrs. Evelyn C. Rusk, H. N. Hubbs, W. R. Hutcherson, C. C. Torrance, A. H. Black, J. M. Clarkson, E. J. Purcell, Augustus Sisk, Mrs. Helen S. Adams, Roberta F. Johnson, J. A. Hyden, C. R. Wylie, Jr., Gertrude K. Blanch, L. H. Chambers, Harriet F. Montague, L. H. Bowen, R. A. Harrison, J. E. Ikenberry.

Prof. Snyder is a lover of travel, also intensely interested in politics.

His favorite recreation is mountain climbing and going on long hikes with Mrs. Snyder as companion.

SOURCES.—*Who's Who in Amer.*, v. 19. *Amer. Men Sci.*, 5th ed. "Lebenslauf" in doctoral diss. (Bibl. no. 1). Personal information.

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Grossmann, H. W. Miller, Ince, Hedrick, Hudson, Hatton, Klein, v. Sanden, Comessatti, Mukhopadhyaya, Julia, d'Ocagne, Graustein, Ciani, Edge, Coolidge, F. Morley and F. V. Morley, Godeaux, and a review of 1906 Mathematical Tripos in AMS *Bull.*, 1897–1935.

20. Earle Raymond Hedrick

Curriculum Vitae.—B. Union City, Ind. 27 Sept. 1876. Prepared at high school in Ann Arbor (91–92) for entering U. Michigan (92–96; A.B. 96). Instr. math. in high school, Sheboygan, Wis. 96–97. Student at Harvard U. (97–99; A.M. 98). Parker fellow from Harvard U. at U. Göttingen (99–01; Ph.D. Feb. 01); at École Normale Supérieure, Paris, 01. Instr. math. Yale Sci. School (01–03). Prof. math. U. Missouri (03–20; prof. math. and teaching math. 20–24); director math. educational corps, Amer. Exped. Force, Jan.–June 19. Prof. and head math. dept. U. California at Los Angeles (Sept. 24–10 Mar. 37); VP and provost U. California (10 Mar. 37–). Summer term U. Chicago 12. Summer term U. California 17. Summer term U. Texas 20. Summer terms Columbia U. 26, 27, and 35. Summer term New York U. 36.

Honors.—Mem. council AMS 05–07. Starred *Amer. Men Sci.* 06. Joint ed. *AMM* 13–15. VP AMS 16. First P MAA 16; mem. Board Trustees 17–22, 24–29, 32– . Chm. comm. of MAA on Math. Dictionary 17–35; see no. 36. Mem. Amer. Sect. Intern. Math. Union, representing MAA 20. MAA nominee mem. Div. Phys. Sci. NRC 20–23. Ed.-in-chief AMS *Bull.* 21–Mar. 37. Mem. sub-comm. on math. symbols of sectional comm. on sci. and engin. symbols and abbreviations 26–28. Coop. ed. *AM* 27–29. Fifth annual faculty research lect. U. California at L.A. 29; "Logical reasoning in mathematics and in science." P AMS 29–30; ret. add. "Non-analytic functions of a complex variable" (Bibl. no. 56). VP AAAS and chm. Sect. A 31; ret. add. "Tendencies in the logic of mathematics" (no. 57). AMS nominee mem. Div. Phys. Sci. NRC 31–34. Chm. Amer. Sect. Intern. Comm. Teaching Math. 32–36. Decorated "Officier d'Académie" (France) "for services rendered to the cause of culture and of science" 32. Chm. comm. on teaching math. in colleges and univs. of the North Central Assoc. 32. Secy. Sect. A AAAS 33– . Mem. comm. MAA on training and utilization of advanced students in math. 33. Hon. Sc.D. U. Michigan 36. Dedication of AMS *Bull.*, v. 44, to E.R.H., by order of the council 38.

Biographical Notes.—Prof. Hedrick was a son of Simon and Amy Isabella (Vail) Hedrick. His father was descended from Henrik or Heinrich Hetrig who came from Northern Germany or Holland to Pennsylvania about 1670. His exploration of higher mathematics under the direction of Bôcher, Byerly, Osgood, B. O. Peirce, J. M. Peirce, and F. S. Woods, met with such success that he was appointed a fellow for three successive years. In his second year at Harvard he wrote a paper on three-dimensional determinants (no. 1) which appreciably simplified earlier presentations and contained a number of new results. During three semesters at U. Göttingen he attended lectures by Hilbert, Klein, Voigt and Schur, and his dissertation dealt with the analytic character of solutions of differential equations (no. 2). It was in fields of differential equations, calculus of variations, derivatives over assemblages, and functions of a real variable that Hedrick's research interests later led to publications (nos. 4, 6, 8, 9, 19, 32, 40, 42, 46, 56). The months spent at Paris in contact with such men as Goursat, Picard, Hadamard, Appell, and Jules Tannery not only reinforced such interest, but brought to his attention problems in the teaching of mathematics, a subject which later, from secondary school to graduate school, became a major interest of his life. The following three students received their doctorate under his direction at the U. Missouri, 1913–15: L. L. Silverman, Eula A. Weekes (Mrs. H. L. King), and E. F. Allen.

His translation of Goursat's *Cours d'Analyse* (no. 5), the first part of which appeared soon after his return from France, and (in collaboration with Noble) of the first third of Klein's *Elementarmathematik vom höheren Standpunkte aus* (no. 50), rendered real service to students and college teachers of mathematics in this country. His interest in mechanics first aroused by Ziwet in Michigan days, resulted in the publication (with Kellogg) in 1909 of his *Applications of the Calculus to Mechanics* (no. 16), which became an especially useful book for those teaching calculus to engineers. The attractions which problems of the engineer held for Hedrick is evinced by his papers on a generalized form of Hooke's law, and the transmission of heat in boilers (nos. 29, 31), and by his activities in the Society for the Promotion of Engineering Education, The American Society of Mechanical Engineering and the American Institute of Electrical Engineers. But furthermore, during the past twenty-five years he has been the editor of 34 v., by various authors, in a notable *Engineering Science Series* (no. 64).

In similar fashion we may consider Hedrick's secondary school texts (nos. 12, 33), the fact that an important part of his work at the U. Missouri was to assist in training teachers of mathematics in secondary schools, his many addresses on timely secondary school topics before national organizations and local bodies, as well as the 35 v. which he edited in the *Series of Mathematical Texts* (no. 63). Apart from secondary school texts in this *Series* there are numerous elementary college texts as well as important works of a more advanced nature.

Turning now to his activities in certain national organizations: for the past five years as Secy. of Sect. A, AAAS, he has been alert in conserving the varied and important interests of mathematicians. As one of the founders of the MAA and its first P he had an important part in moulding her policies, and he has ever since been a most zealous promoter of her interests, and one of her most valued counsellors. The debt of AMS to Hedrick is very great indeed. In chapter V, on the *Bulletin*, an attempt has been made to suggest problems faced during the critical seventeen years of his service as editor-in-chief, and his solutions, some of them based on long research. And in chapter III we have occasion to record his great services to the Society in other directions (see AMS *Bull.*, v. 44, p. 1–2, and portrait).

These notes suggest in inadequate manner that Hedrick, with most extraordinary energy, has been notably contributing to the development of mathematics throughout this country, in the secondary field, in the highly important field of applied mathematics, and in national societies. But along with all this extra-mural activity for more than a decade he was

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so eminently successful in helping to develop a strong university at Los Angeles, that he finally became its leader. His remarkable organizing and administrative abilities, the fertility of his ideas, and the thoroughness with which he deals with problems, have led to his services being sought in many directions, so that he recently served in a single year as member of more than two score scientific and educational committees and commissions. But in spare moments six daughters, and three sons find a father who joyously participates in their enthusiasms, or who carries on long-continued experiments in crossing varieties of flowers to produce new types.

SOURCES.—*Who's Who in Amer.*, v. 19. Doctoral diss. "Lebenslauf" (no. 2). *Amer. Men. Sci.*, 5th ed. "Poggendorff," v. 5–6. *Scientific Mo.*, v. 34, 1932, p. 86, portrait. *Science*, n.s.. v. 85, p. 309. *Leaders in Educ.*, New York, 1932. *AMM*, v. 44, 1937, p. 274. Personal information.

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N. C. Riggs, *Applied Mechanics;* H. Rubey, (a) *Engineering Surveys;* (b) *Route Surveys;* G. D. Shepardson, *Elements of Electrical Engineering;* C. M. Smith, *Electric and Magnetic Measurements;* C. McD. Townsend, *The Hydraulic Principles Governing River and Harbor Construction;* A. V. Vallance and M. E. Farris, *Principles of Mechanism;* M. P. Weinbach, (a) *Alternating Current Circuits,* (b) *Principles of Transmission in Telephony;* G. Young, Jr. and H. E. Baxter, (a) *Descriptive Geometry,* (b) *Mechanics of Materials.*

21. Luther Pfahler Eisenhart

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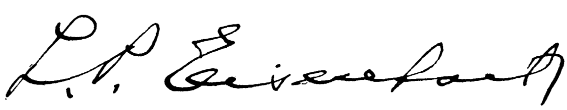
Honors.—Trustee Gettysburg C. 07–14. Starred *Amer. Men Sci.* 10. Joint ed. *AM* Sept. 11–June 25. Mem. Amer. Phil. So. 13. VP AMS 14. VP AAAS and chm. Sect. A 16. Ed. AMS *Trans.* 17–23; managing ed. 20–23. Hon. Sc.D. Gettysburg C. 21. Mem. NAS 22. VP MAA 23; trustee 19–22, 25–30. AMS nominee mem. Div. Phys. Sci. NRC Apr. 23–28; mem. exec. comm. 25–28. Colloq. Lect. AMS 25 (Bibl. no. 95). Trustee AMS 25–26, 31–34. Hon. LL.D. Gettysburg C. 26. P Assoc. Amer. Colleges 30. Mem. comm. (with S. P. Capen and G. S. Ford) surveying Brown U. 30; see Bibl. no. 104. Hon. Sc.D. Columbia U. 31. P AMS 31–32. Mem. Div. For. Relations NRC as chm. Amer. Sect. Intern. Math. Union 31–33. Hon. Sc.D. U. Pennsylvania 33. Assoc. ed. *Com. Mathem.* 34- . Mem. Visiting Comm. dept. math. Mass. Inst. Tech. 34–36. Hon. Sc.D. Lehigh U. 35. Chm. Div. Phys. Sci. NRC 37- .

Biographical Notes.—Prof. Eisenhart is a son of Charles Augustus and Emma Catherine (Pfahler) Eisenhart, each being of German descent. His father was a business man particularly in the field of electricity and telephony. Prof. Eisenhart is one who to an extraordinary degree is endowed with the ability to turn almost instantly from intense concentration in one field to similar concentration in an entirely different field. In this way he has not only ably dealt with his teaching, with the preparation of 8 young men for the doctorate 1903–28 (A. E. Young, F. W. Beal, J. M. Stetson, R. D. Beetle, E. S. Hammond, W. E. Cleland, H. Levy, and M. S. Knebelman), with exacting editorial work and university administrative obligations, with important undertakings outside of the university, but also has turned out a wealth of research work in the field of differential geometry and its physical applications. The recently published (1934) index to the *Encyk. d. Math. Wiss.*, v. 3, contains more than a score of references to his work. Some of his most important results are summed up in the four volumes which he published during the eleven years 1923–33 (nos. 85, 91, 95, 110). However, Prof. Eisenhart's first book in 1909 (no. 27) was *A Treatise on the Differential Geometry of Curves and Surfaces* and was a development of courses which had been given at Princeton for a number of years. It was not the first work in differential geometry to be published by an American, since Wilczynski's *Projective Differential Geometry of Curves and Ruled Surfaces* had appeared three years earlier; but it was the first general work in the field. It is in textbook form, with numer-



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ous problems, introducing the student to classical and modern methods (compare rev. by G. A. Bliss, AMS *Bull.*, v. 17). One of the most interesting novelties of the v. was the so-called "moving trihedrals" for twisted curves as well as surfaces so freely used in writings of Darboux and others. From the first, methods of the theory of functions of a real variable are employed. The work was of great value in introducing the American student to an important field by the most modern method of the time. The first of the other four v., *Transformations of Surfaces* (no. 85), was a work summarizing, developing, and unifying investigations, during the first quarter of the present century, by such men as Bianchi, Darboux, Demoulin, Eisenhart, Guichard, Jonas, Koenigs, Ribaucour, and Tzitzeica. They deal directly or indirectly with transformation of surfaces of a given kind into surfaces of the same kind (see rev. by W. C. Graustein, AMS *Bull.*, v. 30). The then recent physical interpretation of intrinsic differential geometry of spaces stimulated the preparation of the volume on *Riemannian Geometry* (no. 91). Riemann proposed the generalization of the theory of surfaces as developed by Gauss, to spaces of any order, and introduced certain fundamental ideas in this general theory. Important contributions to it were made by Bianchi, Beltrami, Christoffel, Schur, Voss, and others, and Ricci coordinated and extended the theory with the use of tensor analysis and his absolute calculus. The book gave a presentation of the existing theory of Riemannian geometry after a period of considerable study and development of the subject by Levi-Civita, Eisenhart and many others. "One more real contribution to the mathematical literature of America" (C. L. E. Moore, rev. in *AMM*, v. 33; see also S. Lefschetz, *DB*, v. 61). This work naturally paved the way for Eisenhart's next published work *Non-Riemannian Geometry* (1927, no. 95; rev. by J. M. Thomas in AMS *Bull.*, v. 35), although this was delivered in 1925 as Colloq. Lects., under the title, "The new differential geometry," before the *Riemannian Geometry* (no. 91) had appeared. Non-Riemannian geometry had its origin in an article by Weyl (*MZ*, v. 2, 1918) and the fundamental idea is the association with a given manifold of a connection which forms a basis for comparing vectors at different points. The work concludes with an excellent bibliography of books and memoirs referred to in the text, developments made by Finsler, Berwald, Synge, J. H. Taylor, etc. In accounts of this subject frequent reference is made to the paper by Eisenhart and Veblen (no. 73), and later papers by them on the geometry of paths.

Eisenhart's *Continuous Groups of Transformations* (1933, no. 110; rev. by A. Wintner, AMS *Bull.*, v. 40) is a natural development of his earlier books, and sets forth the general theory of Lie and his contemporaries and the results of recent investigations with the aid of the methods of the tensor calculus and concepts of the new differential geometry. The study of continuous groups of transformations inaugurated by Lie resulted in the developments by Engel, Killing, Scheffers, Schur, Cartan, Bianchi and Fubini, a chapter which closed at about the turn of the century. The new chapter began about 1920 with the extended studies of tensor analysis, Riemannian geometry and its generalizations, and the application of the theory of continous groups to the new physical theories. Eisenhart has thus developed a remarkable body of original material and has notably served his colleagues by frequent surveys of fields in which he had become a specialist.

Professor Eisenhart's son Churchill has specialized in the field of mathematical statistics and is instructor in mathematics at the U. Wisconsin.

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22. Arthur Byron Coble

Curriculum Vitae.—B. Williamstown, Pa. 3 Nov. 1878. Educ. Pennsylvania C. whose name was changed in 1921 to Gettysburg C. (93–97, A.B. 97; A.M. 00); teacher public schools (97–98); student and student assist. JHU (98-01; fellow 01–02; Ph.D. 02). Instr. U. Missouri (02-03); research assist. Carnegie Inst. at JHU (03), and Greifswald U. and Bonn U. (04); instr. math. JHU (04–06; assoc. 06–09; assoc. prof. 09–18; prof. 27–28). Prof. math. U. Illinois (18–27 and since 28). Visiting prof. U. Chicago 19.

Honors.—Starred *Amer. Men Sci.* 10. VP AMS 17. Joint ed. AMS *Trans.* 20–25. Chm. Chicago Sect. AMS 22. Mem. NAS 24. Mem. NRC Comm. on Rational Transformations 24–28;

see Bibl. no. 32. Ed., repr. AMS, *AJM* 27–33; assoc. ed. 18-26. Colloq. lect. AMS 28; see Bibl. no. 33. Hon. Lt.D. Gettysburg C. 32. AMS nominee mem. Div. Phys. Sci. NRC 32–35. P AMS 33–34; ret. add. see Bibl. no. 37. Joint ed. *DMJ* 36–38.

BIOGRAPHICAL NOTES.—Prof. Coble is a son of Reuben Coble, a merchant and banker in Lykens, Pa., whose grandfather emigrated from Württemberg, Germany to America in 1810 and settled in York County, Pa. His mother Emma I. Haegy, was of Scotch-Irish extraction.

Among Prof. Coble's publications one set (nos. 7, 8, 13, 14, 15, 19) consists of investigations which relate to configurations which occur in finite geometries or in connection with finite groups. In the most significant of these (no. 15) we find for the first time a clear-cut presentation of the different rôles played by the period characteristics and theta characteristics in the theta function theory. In no. 16, on restricted systems of equations, formulae are obtained, not merely for the order of a manifold defined by the vanishing of determinants of a matrix, but also for the genus of the curve which is a linear section of such a manifold. In no. 31, written in collaboration with Prof. Frank Morley, the range of cases in which algebraic resultants can be specifically given is greatly extended. The papers on symmetric binary forms and involutions (no. 10) present some new interpretations of such forms as primals of a particular character with respect to a rational norm-curve. Closely related to these are the studies of porisms, and of algebraic forms with a closure property (nos. 18, 23, 30), which contain the first systematic study of such problems.

A considerable body of Coble's research (nos. 9, 11, 12, 17, 20, 22, 26, 28) was suggested by the fact that in the Galois theory of equations, and in other algebraic situations, the representations which are desired are rational rather than linear. One would naturally expect to find in such situations more important applications of Cremona transformations and groups than had appeared. This expectation is realized in connection with the quintic equation (nos. 9, 11, 12, 28). In pursuing this application of Cremona groups, it seemed necessary to relieve in some measure the exceptional character of the F-points of the transformations. This was accomplished by the introduction of the idea of congruence of sets of points under Cremona transformations. From this more general point of view it was possible to handle satisfactorily more difficult algebraic problems such as that of the determination of the twenty-seven lines of a cubic surface (no. 17). A general account of this is given in no. 25; its position in the field of Cremona transformations is set forth in no. 32; its relation to theta and theta modular function theory is brought out in no. 33; and a résumé is found in *Encyk. d. Math. Wiss.* v. 3, part 2 B, p. 2107–2113. There are scores of other references to work of Coble in this v. (see index).

Studies of the relations between hyperelliptic theta functions and irrational binary invariants, and of generalizations of the Weddle surface and hyperelliptic Kummer surface are made in nos. 34, 35, 37, 38. In an at-

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tempt to bring our knowledge of the Abelian theta functions of genus four, and the allied geometry into the same satisfactory state as obtains in the case of the functions of genus three, a considerable variety of geometric configurations associated with an algebraic curve of genus four has been discussed in no. 27. The linear groups with a quadratic invariant associated with certain Cremona groups are discussed in nos. 36, 39, 40, and 41.

The following 22 students received their doctorate under the direction of Professor Coble at JHU and U. Illinois, 1914–38: Bessie I. Miller, W. F. Shenton, C. P. Sousley, J. R. Musselman, C. C. Bramble, Jessie M. Jacobs (Mrs. H. J. Müller, and Mrs. C. Offerman), R. Woods, R. M. Mathews, T. L. Bennett, H. L. Black, Elizabeth M. Cooper, Frances Harshbarger, G. E. Moore, C. W. Strom, Mildred E. Taylor, S. F. Barber, Josephine H. Chanler, E. R. Ott, B. G. Clark, G. B. Huff, F. C. Gentry, R. W. Kempfer.

Professor Coble enjoys as recreations, golf, tennis, swimming, tramping, bridge, billiards, and light reading.

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43. Reviews of books by H. P. Hudson, and H. Malet in AMS *Bull.*, 1923 and 1928 and by Coolidge in *AMM*, 1932.

23. Solomon Lefschetz

Curriculum Vitae.—B. Moscow, Russia, 3 Sept. 1884. Reared in Paris, France; student École Centrale, Paris (02–05; degree as "ingénieur des arts et manufactures"). Upon graduation in autumn 05, came to the U.S. and was a few months with the Baldwin Locomotive works. An engineering apprentice and then on the engineering staff of Westinghouse Electric and Mfg. Co.,

1935

Pittsburgh, Pa. 07–10. Fellow Clark U. (10–11; Ph.D. 11). Instr. math. U. Nebraska (11-13); instr. U. Kansas (13–16; assist. prof. 16-19; assoc. prof. 19–23; prof. 23–25). Visiting prof. Princeton U. (24–25; assoc. prof. 25–28; prof. 28–33; H. B. Fine research prof. 33–). Naturalized citizen of U.S. 17 June 12.

HONORS.—Awarded the Prix Bordin (3000 francs) by the Acad. des Sci., Institut de France, for a notable contribution in the fields of algebraic multiplicities and topology 19; the memoir was a manuscript afterwards published in somewhat modified form as Bibl. no. 24. Collaborating ed. *DB*, Paris, 23– . Second award of Bôcher Memorial Prize ($100) offered for a notable research memoir in AMS *Trans.* v. 19–24, divided equally between E. T. Bell and S. Lefschetz 24; the latter's memoir was entitled "On certain numerical invariants . . . " (no. 24). Mem. NRC research comm. on Analysis Situs 24–32. Mem. NRC comm. on Rational Transformations 24–28; see Bibl. no. 42. Mem. NAS 25. Joint ed. *AM* April 28– . Mem. comm. eds. CMP *Rend.* 28–35. Mem. Amer. Phil. So. 29. Lect. at Moscow (5 lects.), Hamburg (2), Göttingen (1) 31. Assoc. ed. *Com. Mathem.* 34– . Invited lect. second Soviet Math. Congress, Moscow 34; add., Bibl. no. 62. Invited speaker Topological Congress, Moscow, 35. P AMS 35–36. For. mem. Royal Bohemian So. of Sci., Prague 35. Five lects. at Paris (Sorbonne 3, So. Math. d. France, séminaire Julia); short course, 3 weeks, at Warsaw; at Prague 2 lects. and at Brno 1, all in 36. Hon. mem. Czechoslovakian Union of Math. and Phys. 36. Corresp. mem. Royal Acad. Sci., Letters and Arts, Padua 37.

BIOGRAPHICAL NOTES.—Prof. Lefschetz is one of America's foreign-born mathematicians who has very notably enriched its literature, and he is internationally recognized as a leader in the fields of algebraic geometry and topology. He lost both of his hands in 1907; the heroic spirit which later enabled him to overcome all but insurmountable obstacles, and to attain to his present position of eminence, must be unique in the annals of the mathematical brotherhood. Some years before he had left the U. Kansas the French crowned his research achievements by the award of the Prix Bordin; for the report of the commission, consisting of Jordan, Appell, Painlevé, Humbert, Hadamard, Goursat, Boussinesq, Lecornu, Picard, see *CR* Paris, v. 169, p. 1200–1202.

In Prof. Lefschetz's research in Algebraic Geometry the central problem with which he has been occupied has been the classification of curves and surfaces and related questions. One of his chief results may be described as follows: Severi introduced an algebraic relation of equivalence between algebraic curves on a surface. Referring to the Riemann manifold M which represents the surface, each algebraic curve determines a unique z-dimensional cycle of the manifold. Lefschetz showed that the relations of homology between these cycles correspond exactly to Severi's relation of equivalence. He has also given the necessary and sufficient condition in order that a z-dimensional cycle on M be equivalent to the cycles just considered. Other noteworthy results are that the Kronecker index of two algebraic cycles and the number of intersections of the corresponding curves or manifolds counted in the usual sense are the same, and similarly for higher dimensions. This enabled him to give a topological treatment of the classification of multiple periodic functions, intersections on Abelian varieties, and the theory of correspondences on an algebraic curve. The influence of these results in recent research may readily be traced in the work of the younger algebraic geometers, notably Hodge and Zariski.

Lefschetz's first research in pure topology was concerned with the fixed point problem and this has occupied him off and on ever since (see nos. 33, 38, 41, chapter 7 in no. 48, 67). The main result may be stated as follows: Given a separable metric space it is possible in many cases to calculate an invariant number θ attached to transformations of the space and having the property that $\theta \neq 0$ implies that there is at least one fixed point. The number θ depends only upon the transformations of the rational cycles or cocycles. In this respect compare the work of H. Hopf and A. W. Tucker. Other important contributions are, the introduction of rational coefficients (no. 41), relative cycles (nos. 34, 41), and of cocycles, called pseudocycles (no. 46), which are of constant use in modern topology. Among important recent contributions are the method of the semisingular complex which made it possible to free local connectedness and Borsuk's theory of retraction from all restrictions regarding dimension. Spaces of type *LC* or *HLC* (endowed with a strongly uniform local connectedness) are the maximal spaces compact metric for which the fixed point formulas are known to hold (see nos. 56, 58, 67). The *Encyk. d. Math. Wiss.*, v. 3. 1. 2. B and 3. 2. 2. give nearly two scores of references to results of Prof. Lefschetz's research (see index).

The following 8 men received their doctorate under the direction of Prof. Lefschetz at Princeton U., 1926–37: P. A. Smith, W. W. Flexner, A. W. Tucker, R. J. Walker, N. E. Steenrod, H. Wallman, S. Wylie, C. H. Dowker.

SOURCES.—*Who's Who in Amer.*, v. 19. *Amer. Men Sci.*, 5th ed. "Poggendorf," v. 5. Personal information.

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24. Robert Lee Moore

Curriculum Vitae.—B. Dallas, Tex. 14 Nov. 1882. Student U. Texas (98–01; Sc.B. 01; fellow 01–02); instr. math. High School, Marshall, Tex. (02–03); student U. Chicago (03–05; Ph.D. 05). Assist. prof. U. Tennessee (05-06); instr. Princeton U. (06–08); instr. Northwestern U. (08-11); U. Pennsylvania (11–16; assist. prof. 16–20); assoc. prof. U. Texas (20–23; prof. 23–).

Honors.—Assoc. ed. AMS *Trans.*, 14-Jan. 27. Starred *Amer. Men Sci.* 21. VP AMS 23. Colloq. lect. AMS 29. Mem. AMS comm. *Colloq. Pubs.* 29-36; chm. 30-Nov. 33. Mem. NAS 31. Visiting Lect. AMS academic year 31-32. P AMS 37-38.

Biographical Notes.—Prof. Moore was the fifth of six children of Charles J. and Louisa Ann (Moore) Moore. His father came from New England and his mother from Kentucky; both were of English descent.

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We have already noted that President Fine was led to adopt mathematics as a career mainly through the influence of George Bruce Halsted, at one time "instructor in post graduate mathematics" in Princeton U. The same may be said of President R. L. Moore who specialized in mathematics during the regime of Halsted as professor at the U. Texas. R. L. Moore's first publication (Bibl. no. 1) was a neat redundancy proof which he discovered while a graduate student in 1902, and which Halsted published. This led to a delightfully friendly and encouraging letter to R. L. Moore from E. H. Moore, then ed.-in-chief of AMS *Trans.*, who had there published a paper on projective axioms of geometry, a few months earlier.

R. L. Moore has not only achieved success notably by research in fields of importance and current interest, such as foundations of mathematics, analysis situs, point sets, and functions of a real variable, but he has also been a source of inspiration to disciples, particularly those (13) who have written doctor's dissertations under his direction, at the U. Pennsylvania (1916–18), and U. Texas (1922–35), namely: J. R. Kline (U. Pa.), G. H. Hallett, Jr. (U. Pa)., Anna M. Mullikin,[1] R. L. Wilder, R. G. Lubben, G. T. Whyburn, J. H. Roberts, J. L. Dorroh, C. M. Cleveland, C. W. Vickery, E. C. Klipple, R. E. Basye, F. B. Jones. The bibliographies of Whyburn (66 titles) and Wilder (32) were published in *Scripta Mathem.*, v. 4, among those of leading Amer. mathems., not more than 40 years of age. Such National Research Fellows as W. L. Ayres, H. M. Gehman, N. E. Rutt, and L. Zippin (also in *Scripta Mathem.* series) have gone to Texas to work under Moore. Three of his doctors (Kline, Wilder, Whyburn) have given invited addresses before the AMS (*Bull.*, 1928, 1932, 1936). Indeed Moore may almost be thought of as the founder of a "school" in analysis situs. While his Bibliography must here very largely speak for itself, a few comments and references to sources for more detailed discussions may be furnished.

Veblen's "Theory of plane curves in non-metrical analysis situs" (AMS *Trans.*, 1905) is based on axioms in his doctoral diss. Moore showed (Bibl. no. 8) that any plane satisfying these axioms is really metrical in the sense that it contains a system of continuous curves such that, with reference to these curves regarded as straight lines, it is an ordinary Euclidean plane. Of his set of axioms for plane analysis situs (no. 10) Chittenden has written (AMS *Bull.*, v. 33, p. 22): "The importance of the regularly and perfectly separable, therefore metric, spaces in the analysis of continua is indicated by the fact that nine years before the publication of the discoveries of Urysohn, R. L. Moore assumed these properties in the first of a system of axioms for the foundations of plane analysis situs." In no. 13 Moore estab-

[1] Compare Mazurkiewicz, "Remarque sur un théorème de M. Mullikin," *FM*, v. 6, 1924, p. 37.

lished the fact that every space satisfying axioms of the system Σ_1 or the system Σ_2 (of no. 10) is topologically equivalent to an ordinary Euclidean plane. A point set M is said to be arc-wise connected if every two points of M are extremities of a simple continuous arc lying wholly in M. Theorem 15 in no. 10 is to the effect that every domain is arc-wise connected; it was found in no. 11 that every continuous curve is arc-wise connected (also obtained by Mazurkiewicz and Tietze). Still later (no. 51) Moore extended this result and proved that every connected, and connected im Kleinen inner limiting set, is arc-wise connected (also proved by Menger, *MMP*, v. 36, p. 210; see AMS *Bull.*, v. 35, p. 776–777).

In no. 12 it is shown that in order for a simply connected, bounded plane domain R to have a simple closed curve as its boundary, it is necessary and sufficient that R should be uniformly connected im Kleinen. The problem of determining conditions under which the any-to-finite Borel theorem is valid in a space $\mathcal{L}$ was first solved in no. 15 (cf. T. H. Hildebrandt, AMS *Bull.*, v. 32, p. 462; and Frechet, École Normale Sup., *Annales*, v. 38, p. 342 f.). In no. 23 it is shown that if, in a Euclidean space of three dimensions, K is an open curve, and G is a self-compact set of simple open curves such that (i) through each point of k there is only one curve of the set G, (ii) each curve of the set G contains a point k, (iii) no two curves of the set G have a point in common, and (iv) the set of curves G is equi-continuous with respect to every bounded point set; then the point set obtained by adding together all the curves of the set G is a simple open surface.

In no. 32 the notion of upper semi-continuous collection is introduced and in no. 37 it is shown that if G is an upper semi-continuous collection of mutually exclusive compact continua filling up a plane S and no element of G separates S then, with respect to its elements regarded as points, G is topologically equivalent to a plane. In no. 45 the notion of junction point of a continuum is introduced; and in no. 48 the notion of a triodic continuum. The volume of Colloquium Lectures (no. 50) was intended to be a self-contained treatment of the foundations of the point-set theoretic branch of analysis situs and is chiefly concerned with those topics which are the results of Moore's own work (see rev. by Gehman, AMS *Bull.*, v. 39). For a discussion of Moore's papers on separation theorems (no. 36, 43, 44, 46, 47) reference may be made to Kline's report on "Separation theorems and their relation to recent developments in analysis situs" referred to above; the reports of Wilder and Whyburn also discuss some other work of Moore. There are many references to Moore's work in *FM* v. 4–26, especially by Kuratowski, but among other foreigners are Borsuk, Chojnacki, Eilenberg, and Zarankiewicz. The survey of W. Wilkosz, in his *Les Propriétés topologiques du plan Euclidien* (*Mém. d. Sci. Mathém.*, no. 45) Paris, 1931 may be also mentioned in conclusion.

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