GENERAL ACCOUNT OF THE DEARBORN OBSERVATORY.

The Dearborn Observatory was founded by citizens of Chicago by voluntary contributions. These men had confidence in the commercial future of their city and strove to keep her standing in learning abreast of her commercial progress. The foundation of the Observatory and the erection there of a great telescope was one expression of their desire that their city should contribute her share to the results of scientific research.

A complete record of the early operations of this group of citizens, who later organized as the Chicago Astronomical Society, is not available. The official record was destroyed in the great Chicago Fire of October 9, 1871. A fairly comprehensive account was compiled in 1902 by Mr. H. C. Ranney, principally from newspaper files, but in part from the recollections of the members and from letters. From this source and from the Secretary's official record, which is available subsequent to 1874, the material for this brief résumé of the history of the Dearborn Observatory has been gathered.

The movement originated in 1862, when the Reverend M. R. Forey came to Chicago to dispose of a Fitz refractor of 16-inches aperture. He broached the matter of the establishment of an observatory to the University of Chicago and interested its President, Dr. John C. Burroughs, and Albert H. Mixer, Professor of Greek. To further the project Mr. Forey delivered a lecture, "The Sidereal Heavens", at Bryan Hall on December 8, 1862. At the close of the lecture a meeting was held, with Hon. J. Y. Scammon in the chair. After considerable discussion a committee was appointed to take such action as was necessary to found an observatory in Chicago. The personnel of the committee included men prominent in Chicago's affairs: Messrs. J. Y. Scammon, J. H. Woodworth, W. H. Wells, Thomas Hoyne, J. F. Rumsey, E. B. McCagg, C. H. Walker, W. B. Ogden, J. M. Wilson, W. L. Newberry, W. E. Doggett, T. B. Bryan, A. H. Mixer, W. H. Ryder, A. E. Kent, Nathaniel Colver, S. S. Hayes, J. C. Haines, and P. W. Gates.

At a later meeting a plan was submitted for raising money whereby the subscribers were to be entitled to visit the Observatory. A subscription of $100 or more entitled the donor to life membership in the proposed Astronomical Society with a life observation ticket; contributions of less amounts, to privileges at the Observatory for a restricted term of years. It is seen, then, that membership to the Society was put on a purely pecuniary basis. This plan somewhat elaborated appears in the Constitution of the Society adopted at the time of its formal organization. A further provision of the plan was that the Observatory should be established as a part of the University of Chicago.

Quick response met the effort of the committee appointed to solicit subscriptions, whereupon a second committee was appointed, authorized to purchase the telescope. As some doubt had been cast on the merits of the Fitz telescope, characterized as a new and untried type, Professor Mixer was instructed to visit Ann Arbor for consultation with Professor Brünnow before final action should be taken. Incidentally he found Professor C. H. F. Peters of Hamil-

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1 This record is now deposited with the Chicago Historical Society. That the newspaper files should have been able to furnish a fairly connected account is due to Professor Elias Colbert, reporter and, later, editor of one of Chicago's great papers, who from the first took an active interest in the Society and detailed its activities in the press.

2 It should be borne in mind that all mention of the University of Chicago refers to the original University of Chicago, located in Douglas Park, founded in 1857 and closed in 1886, and not to the present flourishing institution.
ton College there. From Professors Brünnow and Peters he learned of the 18\frac{1}{2}-inch lens in the shop of Alvan Clark and Sons in Cambridge. This lens had been made upon the order of President F. A. P. Barnard of the University of Mississippi, under the stipulation that it should be equal in size and quality to the greatest objectives then in existence, the 15-inch lenses of the Harvard College Observatory and of Pulkova. The disks cast by Chance and Company of Birmingham, England, were somewhat larger than the size specified. The makers, by sacrificing none of the surplus margin, were enabled to produce an objective of 18\frac{1}{2}-inches aperture. This was the first instance in which the Clarks surpassed previous accomplish-
ments as to size of objective. Their later progressive attainments are well known. The breaking out of the War of the Rebellion and the consequent financial stringency had prevented the University of Mississippi from taking the lens. Upon hearing Professor Mixer’s report, and not feeling bound to take the Fitz instrument, the Society enlarged the power of the committee to permit of the purchase of any telescope it might see fit, “but to be satisfied with nothing less than an unquestionably first-class instrument.” With this authorization the committee decided to take the Clark lens under consideration.

Mr. Thomas Hoyne of the committee left Chicago on January 6, 1863, and reached Boston on the morning of January 10. He went immediately to see Mr. Clark at Cambridge and arrived at what proved to be a critical moment. A campaign for funds for the acquisition of the objective for the Harvard College Observatory had been under way for some time. He learned that the arrangements for the transfer of the telescope to that Observatory were being hurried to completion as Professor Brünnow had warned Professor George Bond, then the Director, of the Chicago movement. What follows is given in Mr. Hoyne’s words: “On the morning of the committee’s arrival, Mr. Clark had been summoned to Boston to close the negotiations with Professor Bond, and had actually gone to the place appointed. The Committee found a son at the house, saw the objective in the rude pine box, and realizing that something was transpiring which made it of the first importance that what he was to do there must be done quickly, came to business at once by asking for terms. Hearing them, he told Mr. Clark that he and his father need have no further anxiety as he was there to purchase the lens for Chicago and would pay the first installment, $1,500, that day. The surprise of Mr. Clark was expressed in a desire to see his father before he could thankfully accept the pur-
chaser. His interest was secure in favor of the city that did not haggle about price or terms, and he insisted that no incident should deprive Chicago of the priority of right, acquired by being the first actual purchaser. The son and the committee posted back to Boston and found the father before he had seen Mr. Bond. It may seem an exaggeration of the feeling, but nevertheless, it is in full accordance with the truth, that when it was announced that the great lens was sold he felt, as well as expressed, disappointment. He, like Mr. Bond, had set his heart upon the prospect that this latest achievement of his genius, the triumph of his advancing years, was to be kept in Cambridge near his own home. He suggested the economy of taking the Cambridge 15-inch, which might be had on reasonable terms, urged that his friends in Boston who had subscribed for the purchase would feel keen disappointment, but finally conceded to the Chicago committee the prior right as purchaser, and the memorable purchase was made.” The purchase price was $11,187.

The acquisition of this lens and the generous offer of Hon. J. Y. Scammon to subscribe the amount of money necessary to build the tower of the Observatory, gave the movement an impetus that carried it to completion. The contract for the mounting was entered into with Messrs. Alvan Clark & Sons, who agreed to deliver an equatorial mounting for the 18\frac{1}{2}-inch objective to be made according to approved specifications. The contract is dated May 25,
Introduction

1863, and the contract price was $7,000. At a meeting of the trustees of the University of Chicago on March 20, 1862, Mr. Scammon had called the attention of the Board to the resolution of the subscribers of the Astronomical Society that the foundation of the Observatory should be placed under their charge as a part of the University. The subject of the location of the tower with respect to the proposed main building of the University, as well as the design of the tower, was referred to the architect, Mr. W. W. Boyington. On July 14, 1863, the Trustees adopted the following resolutions:

"Resolved: 1. That the Observatory of the Astronomical Society of Chicago be established at the University, and that the same shall constitute a part of said University; but the control and management shall be vested in the directors of said Observatory, who shall be nominated by the members of said association, and confirmed by the board of trustees of the University, saving to all persons who have contributed the sum of $500, their rights as life directors without election.

2. That in case the members of said association neglect or fail to nominate directors, such directors may be elected by the board of trustees without such nomination. The number of directors, exclusive of life directors, shall never exceed twenty-one, and seven directors shall constitute a quorum for business.

3. That the building, or additions to the University building, to be erected for the Observatory, shall constitute a part of the property of the University, and be subject to the control of the trustees, saving to the directors of the Observatory the right and authority implied in the foregoing resolutions."

Mr. Boyington prepared his plans for the Observatory tower after visiting various observatories. The work of construction was started in the autumn of 1863 and was completed, including the dome, in October, 1865. In compliance with the wish of Mr. Scammon who bore the entire expense of the erection, the Observatory was named the "Dearborn Observatory", as an expression of his regard for the memory of his deceased wife, whose maiden name was Mary Ann Haven Dearborn.\(^3\) The name was appropriate on other grounds, for the name of Dearborn is intimately associated with the early history of Chicago.

The shipment of the telescope was deferred until the appointment of the astronomer could be made. A further noteworthy addition to the equipment had been made possible by the donation of $5,000 by Mr. Walter S. Gurnee, former mayor of Chicago, for the purchase of a meridian circle. In November, 1865, the Society perfected a permanent organization, adopted a constitution, and prepared a draft of an act of incorporation to be submitted to the legislature. On December 1, 1865 the Society met and elected the following officers: President, Mr. J. Y. Scammon; Vice-President, Mr. W. H. Wells; Secretary, Mr. Thomas Hoyne; Treasurer, Mr. D. J. Ely. Further, they took the important step of calling Mr. Truman H. Safford to be the first Director of the Observatory and Professor of Astronomy in the University. The definite appointment was made on December 28, 1865. On the arrival of Professor Safford the contract was let for the meridian circle. The equatorial was sent to Chicago, arriving on March 25, 1866, and was installed and ready for observing on April 11, 1866. A description of the original observatory need not now be given. The appearance of it and its connection with the University building is well shown in Plate II.

The speedy accomplishment of the various steps of this movement from the purchase of the great lens, within a month of the inception of the project, to the completion, well illustrates the spirit of enterprise of the citizens of Chicago. It should not be forgotten that the whole was accomplished when all business was suffering from the depression caused by the

\(^3\) It is of interest to note that she was a relative of General Henry Dearborn for whom Fort Dearborn was named.
great War of the Rebellion. Nor should it be forgotten "that it was but a scant half century since the first settlement of Chicago, when the chief outlook was for hostile Indians, to the establishment of the Dearborn Observatory and viewing the heavens with the most powerful refractor of the World".  

Professor Safford immediately began observing and teaching. At the telescope he devoted himself largely to the nebulae, of which he discovered one hundred and eight. His interest in the nebulae had been aroused probably by his study of Bond’s observations on the Orion nebula, which he had prepared for publication, after Bond’s death. He had, however, a comprehensive program of observation, as is shown in his various reports to the Chicago Astronomical Society.

The original dome proved to be far from satisfactory. It could be turned only with great exertion, so that Professor Safford was severely restricted in the field of the sky available for study. As this difficulty increased progressively, he was virtually compelled to abandon any observing which necessitated movement of the dome. To get some effective use of the equatorial he began a series of zone observations, similar to those of the Harvard College Observatory, begun by Bond and in which Safford and Coolidge had participated. On this plan he observed about three thousand stars in a southern zone.

In the reports of this time there is frequent mention of his assistants, A. N. Skinner, Ormond Stone, and William A. Metcalf. The activities included an expedition to Des Moines to observe the solar eclipse of August 7, 1869, the determination of the longitude of Pembina, Canada, for the Manitoba Survey, the establishment of standard time service for Chicago, which brought some funds to the Observatory, and the preparation of many papers for presentation to the Chicago Academy of Sciences and publication in the scientific periodicals.

The meridian circle built by Repsold and Sons of Hamburg had now arrived and with its installation, Professor Safford transferred his activity to it. The cost of this instrument including transportation, insurance, duty, etc., was $7,416. The great Astronomische Gesellschaft catalogue project was just being launched and he accepted one zone, declination +40° to +45°. He entered immediately and vigorously upon the observation and had completed nearly one-half of the whole task when the Chicago fire of October 9, 1871, prostrated the city and wiped out the resources of the Observatory. From the first, Professor Safford’s salary had been paid by Mr. Scammon, but as he was now no longer able to maintain this burden, and as funds for the payment of the salary were not forthcoming from other sources, Professor Safford was given leave of absence for two years that he might turn to a more practical side of astronomy. He entered the Coast and Geodetic Survey of the United States. Professor Elias Colbert, who had been assistant director since September, 1870, continued in charge of the Observatory and maintained the time service. It should be stated that the many services of Professor Colbert toward the welfare of the Observatory and for which the Society is so deeply indebted, were rendered in all cases without remuneration.

The financial panic of 1873 came as Chicago was just beginning to rally from the fire losses. The unendowed Observatory felt the second blow keenly. In the spring of 1874 Professor Colbert made an effort to reawaken interest in the Observatory, looking toward its rehabilitation. One spur to action was found in an article in the Tribune for May 4, 1873, which stated: "It seems not very creditable to the Observatory that the great telescope should stand unused, given over to rust and dust, while the novice Burnham is publishing from

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4 Chicago Tribune, April 28, 1866.
5 Annals of the Harvard College Observatory, Vol. V.
PLATE II.

THE ORIGINAL DEARBORN OBSERVATORY TOWER.
Introduction

Chicago, lists of new double stars discovered with his 6-inch telescope.” At the request of the Society, Mr. R. A. Proctor gave four popular lectures in Kingsbury Music Hall on March 9, 10, 13, and 14, 1874, as the opening skirmish of a campaign to raise funds to build a new dome and to put the telescope again in working order. A call for funds was made to revive the enterprise. The campaign was furthered by Professor Safford who on April 16, 1874, presented a report to the Society reviewing the work on which he had been engaged during his absence. He reviewed the promising record of his former students, Stone, Skinner, Metcalf, Maryatt, and Olson. He recalled to the Society that after having undertaken the observation of the A. G. zone, it had been necessary to announce the suspension of the work, and concluded by making a stirring, impersonal appeal that the work be revived. “If we can accomplish this work, we shall be doing credit to Chicago; and at the same time establishing a fixed standard of Chicago scientific work, which will be known in all future history of Astronomy.”

During the year, chiefly through the efforts of Professor Colbert, sufficient money was raised to build a new dome. The order for this was given on March 11, 1875, and it was ready on July 19. In the meantime Mr. Clark had put the telescope again in excellent condition. The rehabilitation of the Observatory was complete and no debt hung over it. The only things lacking were an astronomer and the funds to support him. It should be noted that in April, 1874, Professor Colbert had been appointed Emeritus Director.

At this time the Society was reorganized and a revised constitution was adopted. As this is still in force it is given here in full:


Art. I. The object of this Society shall be the same as stated in the Charter of Incorporation passed by the General Assembly of this State, Feb. 19, 1867, to support the Astronomical Society Observatory in Chicago, and diffuse astronomical knowledge.

Art. II. Every person who has subscribed and paid, or may hereafter subscribe and pay, the sum of $100 toward the foundation, support, and maintenance of the Dearborn Observatory shall be considered and be thereby constituted a member of said Society, with the privilege of a visitor to said Observatory during his life, and shall receive a life Observation Ticket for himself and family, not transferable, and that such member be entitled to vote at all elections held for Directors of the Observatory Board at the annual meeting. Every person who shall pay and subscribe any sum over $100 shall, in addition to his right of membership, be entitled to an additional vote for every additional $100 by him subscribed and paid: Provided that in no case shall any person be entitled to cast more than five votes; but in all cases when any person subscribes and pays the sum of $500 he shall be a Life Director.

Art. III. An annual meeting of this Society shall be held on the second Thursday of May in each and every year, of which due notice by publication shall be made in some newspaper, by the Secretary, and a notice thereof mailed to each member at least three days previously; and at the first election, which shall be held immediately after the adoption hereof, there shall be an election held for nine Directors who, together with such persons as shall have become Life Directors by the payment of $500, as aforesaid, shall constitute the Board of Directors, or the executive and Observatory Board of said Association and, as such Executive Board, shall exercise all the powers of such Executive Board and perform all functions with respect to said Observatory and its management, and the care of the property thereof, as the same are specially defined and provided in the 3d section of said Act of Incorporation.

Art. IV. The said nine Directors so to be elected by said Association shall hold office one-third for one year, and one-third for two years, and one-third for three years from the first day of July, A.D., 1875; and at their first regular meeting after the adoption of this Constitution shall cast lots for their respective terms, and annually thereafter. On the second Thursday in May of each year the Society, at the annual meeting, shall elect three Directors to take the place of the three retiring Directors, who shall hold their office for three years, and until their successors are appointed. In case of any vacancy occurring during the year the same
Annals of the Dearborn Observatory

may be filled by the Directors until the next annual election, when such can be filled by an election for the unexpired term.

Art. V. The said Executive or Observatory Board shall annually at such time after the annual election as they may agree upon by resolution of said Board, elect the President, Vice-President, the Secretary, and Treasurer of said Board, who shall also be the officer of said Society the same as prescribed by said Act of Incorporation.

Art. VI. It is understood that the Constitution and By-Laws which were in force at the time the Charter of Incorporation was enacted, Feb. 19, 1867, are by the adoption of this Constitution totally repealed, the same having been destroyed with the original records of the Society, in the great fire of October, 1871.

Art. VII. The Board of Directors shall make an annual report to the Society at each annual meeting thereof, and before the election of the new Directors, in which shall be stated in a summary form the transactions of the Observatory during the year, and also the financial condition of the Society; and the Directors of the Observatory shall be required to make quarterly, yearly, or semi-annual reports of the condition of the Observatory and the progress of this work in the Observatory to the said Observatory Board.

Art. VIII. The Directors may call a special meeting of the Society at any time, and at the written request of any five members it shall be the duty of the president to call such meeting.

In compliance with Article II of the Constitution the following contributors, each having subscribed $500 or more, became Life Directors:

T. B. Bryan
Chicago City Railway Company
D. J. Ely
W. W. Farnum
W. S. Gurnee
T. C. Hoag
James B. Hobbs
C. N. Holden
Thomas Hoyne
Louis C. Jones
E. B. McCagg
C. H. S. Mixer
R. E. Moss
W. B. Ogden
J. R. Pollard
H. C. Ranney
J. Y. Scammon
Col. Samuel Stone
Frank Sturgess
W. H. Wells
C. G. Wicker
J. H. Woodworth

The following having contributed $100 constitute the Life Members. This list is divided into two sections. The first comprises the original contributors, and the second section those who contributed at the time of the reorganization in 1875. Those names distinguished by an asterisk contributed on both occasions.

W. T. Allen
I. N. Arnold
F. H. Ayers
Jerome Beecher
William Blair
E. W. Blatchford
N. S. Bouton
C. F. Bowen
James Boyd
Clinton Briggs
Jonathan Burr
J. C. Burroughs
J. K. Burtis
J. E. Chapman
Thomas Church
W. L. Church
John Clough
S. B. Cobb
J. G. Conrad
W. F. Coolbaugh*
A. B. Cort
U. H. Crosby
Isaac C. Day
Thomas Dickenson
H. T. Dickey
C. S. Dole
H. C. Durand
E. M. Edwards
W. J. Endicott
W. W. Everts
J. C. Fargo
J. V. Farwell
Marshall Field
J. S. Flint
C. Follansbee
John Forsythe*
Thomas Foster
S. W. Fuller
D. A. Gage
George W. Gage
B. E. Gallup
P. W. Gates
J. F. Gillette
W. R. Gould
F. D. Gray
C. F. Grey
W. L. Grey
S. C. Griggs
E. H. Hadduck
J. C. Haines
C. M. Henderson*
H. W. Hinsdale
R. M. Hough
Gilbert Hubbard
A. Huntington
H. A. Johnson
C. F. W. Junge
W. B. Klein
C. R. Larrabee
H. S. Loomis
J. H. McVicker
H. H. Magie
A. B. Meeker
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To this list of members should be added Elias Colbert, S. W. Burnham, T. H. Safford, W. W. Boyington, Carter H. Harrison, G. W. Hough, A. W. Harris, Henry Crew, Philip Fox, and Thomas F. Holgate, who have been elected Honorary Life Members.

![Image of a plaque with text](Image)

In December, 1875, the Observatory resumed the time service, supplying time to the Board of Trade, to the Elgin Watch Company, and others. This brought to the Observatory about $500 a year. The campaign to raise an endowment fund did not net a sufficient amount to afford the employment of an astronomer. As the outlook was not very promising, Pro-
Annals of the Dearborn Observatory

Professor Safford accepted in 1876, the Field Memorial Professorship of Astronomy in Williams College. There he remained actively teaching until his death on June 18, 1901.

On November 6, 1912, at a meeting of the Chicago Astronomical Society to celebrate its semi-centennial, a tablet was erected in Professor Safford's honor. On that occasion the prevailing note was of sincere regret that the Chicago fire with the consequent financial distress should have robbed the Dearborn Observatory of his services, and his brilliant intellect of the opportunity to come to full fruition.

On September 20, 1876, S. W. Burnham was appointed Acting Director of the Dearborn Observatory, to serve without pay and under the supervision and direction of the Executive Committee of the Chicago Astronomical Society. He began immediately a series of observations of double stars, continuing the remarkable work which he had accomplished with his own 6-inch refractor. Though he served but three months as acting director, he continued at intervals his observing; and the published records of his work constituted the chief claim of the Dearborn Observatory to fruitfulness prior to the work of his successor, Professor G. W. Hough.

Following the retirement of Mr. Burnham, Professor Colbert again assumed supervision of the Observatory. At this time also, and in fact since the departure of Professor Safford in 1873, Professor Colbert gave instruction in Astronomy in the University. Others who took part in the observing at different times were Professor C. A. Kenaston of Ripon College, G. W. Hough, and George P. Barton. The Observatory sent a party to Denver to observe the eclipse of July 29, 1878. The personnel of the party, under the leadership of Professor Colbert, was G. W. Hough, Lewis Swift, A. C. Thomas, and Professors Easterday and Tressler of Carthage, Illinois.

Professor Colbert resigned from the supervision on May 3, 1879, and on May 6, Mr. G. W. Hough was appointed Director. Though he entered at once upon his observing, it was not until 1881 that the Society, by consummating an agreement to furnish clock-time control to the Fire Alarm Telegraph of the City of Chicago, was able to pay him a suitable regular salary.

In 1881 the University of Chicago, after several years of financial embarrassment, became involved in litigation over its property. On June 15, 1881, The Mutual Life Insurance Company proceeded in the United States Circuit Court to foreclose the mortgage made by the University of Chicago to this company upon premises including the site of the Dearborn Observatory tower and meridian circle building. The action clearly and lawfully involved the Dearborn Observatory tower, as by the original agreement (p. 3) with the University these buildings and additions were a part of the University, subject to the control of the trustees. The action for a time seemed seriously to menace the title to the observing instruments. It was only after a rehearing, on January 16, 1886, that Judge Blodgett rendered an amended decision, where the telescope and mounting, dome and circular track, meridian circle and house, books and clocks, were declared to be the property of the Chicago Astronomical Society and within its disposition; but that the tower and real estate were the property of the University of Chicago, and therefore subject to the terms of the mortgage in process of foreclosure.

Through all this uncertainty the time service arrangement with the city and Board of Trade was maintained and the Observatory was enabled to continue its activity. On July 14, 1887, the Society was served with notice to vacate the property by October 1, and though President Burroughs spoke hopefully for the revival of the University and the probable perma-

Introduction

necy of the Dearborn Observatory on the old site, the Directors of the Society realized that they must make a decision as to the future home of the Observatory.

Following the court decision, communications came from various sources offering sites or buildings for the Observatory. The final choice was between Northwestern University and Lake Forest University. On August 10, 1887, the vote of the board gave a majority to Northwestern University, and the President and Secretary were requested to execute the agreement. The agreement drawn at that time and still in force, and essentially the same as that entered into with the University of Chicago at the time of the foundation of the Observatory, is given below:

**CONTRACT BETWEEN NORTHWESTERN UNIVERSITY AND THE CHICAGO ASTRONOMICAL SOCIETY.**

*WHEREAS,* the Chicago Astronomical Society, by reason of the failure of the University of Chicago to maintain its existence as an institution of learning in Chicago, and the loss of its campus and buildings under foreclosure of mortgage, has been released from its obligation to the said University of Chicago, and is required to remove its Observatory, telescopes, and other appliances and property from said campus; and

*WHEREAS,* The Trustees of the Northwestern University of Evanston, in the county of Cook and State of Illinois have made a proposition to said Society to remove and place said Observatory and instruments upon the grounds of said Northwestern University, and for this purpose to set apart a suitable plat of ground for the use of said Society, and to erect thereon and maintain at the expense of said last-named University, in perpetuity, Observatory buildings suited to the uses of said Society, with all necessary connections and appliances, and with appropriate and suitable provisions for the residence of the Director of the Observatory and his family, and to give such Director the title of Professor of Astronomy in said University—suitable provision to be made by the Astronomical Society, while retaining its autonomy and distinct corporate rights and authority, for an actual connection with said University, as a part of its educational establishment, the entire expense of this arrangement to be borne by said Northwestern University; and

*WHEREAS,* Said Society has accepted said proposition, it is, therefore, agreed as follows:

**AGREEMENT:** The Chicago Astronomical Society, first party, Northwestern University, second party.

*WHEREAS,* It has become necessary to remove from their present location the telescopes, meridian circle, clocks, library, and other observatory appliances, belonging to the first party, and

*WHEREAS,* The second party has offered to erect the necessary tower and building or buildings upon its land in the village of Evanston, Cook County, Illinois, for the proper accommodation of said Society and use of said telescopes, library, implements, and appliances, upon the terms and conditions, and to maintain and provide for and use the same for the purposes and in the manner hereinafter set forth;

Now, Therefore, This agreement witnesseth, that the parties hereto have and do hereby promise and agree as follows:

First, The second party agrees to erect and finish, upon land which it shall own, the suitable building or buildings, as aforesaid, including a tower for the telescopes, the dimensions, plans, materials, cost, and location thereof to be determined by a committee appointed by and on behalf of the said first party, and a committee appointed by and on behalf of the said second party.

Second, The second party agrees to take and remove from their present location said telescopes and other instruments, implements, and appliances, with their appurtenances, and said library, and carefully store, care for, and insure the same in the name of the Chicago Astronomical Society, and place and adjust the same in said tower and building or buildings to be erected as aforesaid, the same to be done by and under the supervision of such person or persons as may be agreed upon by the two committees provided for in item first, above, all to be at the expense of the said second party.

Third, The first party agrees to appoint a committee for the purpose, and with the power to carry out the provisions of items first and second, and agrees that the second party may take and remove and store the property aforesaid belonging to said Society, and place and adjust the same in the tower of building or buildings to be erected, all as provided in item second.

Fourth, It is mutually agreed that the title to the telescopes, meridian circles, clocks, library, and other observatory appliances herein referred to, and which now belong to said first party, shall be and remain in said first party, subject, however, to the provisions hereof, and that the tower and buildings herein provided
Annals of the Dearborn Observatory

to be erected shall be and remain the property of the said second party, subject to the provisions hereof, and their use in perpetuity by said Astronomical Society.

Fifth, It is also mutually agreed, that the tower and building or buildings to be erected as aforesaid, together with said Society and telescopes, meridian circle, and appliances, shall constitute a part of said Northwestern University and be a department thereof, and that the same shall hereafter and perpetually be known and designated as Dearborn Observatory of the Northwestern University.

Sixth, It is also mutually agreed that the use and management of said telescopes, instruments, and astronomical instruments and appliances in the interest and for the advancement of science, shall be by and under the direction of a competent astronomer, to be known as the Astronomical Director of said Society and of said University, and whose salary shall be paid by the second party. Said Astronomical Director shall be nominated by the directors of said first party and confirmed by the Trustees, or Executive Committee of said second party, and in case of failure of said first party to nominate within thirty days after it or said Society shall be requested by said Trustees to make such nomination, said Trustees or its Executive Committee may make the appointment without such nomination, and any vacancy in the office or place of Astronomical Director, caused by death, removal, resignation, or otherwise, shall be filled as above provided.

The present Director of said Observatory is retained in office until otherwise agreed between the parties hereto.

Seventh, It is also mutually agreed that any and all moneys earned by said instruments, or hereafter paid by any persons as contributors to said Astronomical Society, shall be paid to said second party, for the uses of said Observatory and its work, and shall be paid out by said second party in and about, and for the uses, purposes, and expenses of said Observatory and the erection and maintenance and support of the same, and of said Astronomical Director, and other employees of said Society and its transactions, or in such manner as shall be directed by the donor or donors thereof. And further, that any person who shall contribute the sum of five hundred dollars to said Astronomical Society, with its assent, shall thereby become a life director of the same, and that all persons chosen or elected directors of said Society shall be such persons, and only such persons as shall have contributed at least the sum of one hundred dollars to said Society; and that the number of directors, exclusive of life directors, shall never be more than twenty-one, and that the number of directors of said Society necessary to constitute a quorum for the transaction of business shall never be less than seven, provided that the unanimous action of five directors shall be as valid as if a quorum were present.

Eighth, It is further mutually understood and agreed that this agreement, and each and every of the provisions hereof, shall be in full force and effect, and binding upon the parties hereto in perpetuity; provided, however, and it is expressly understood and agreed, that in case said Society shall cease at any time to have at least seven directors, by reason of the death of life directors and contributors, or otherwise, that then, and in that case, the vacancies in the office of directors may be filled by appointment by the Trustees of the Northwestern University.

The following resolutions, which were substantially the basis of the connection of the said Society with the University of Chicago, are hereby made applicable to its connection with the Northwestern University:

Resolved, That the Observatory of the Chicago Astronomical Society be established at the University, and that the same shall constitute a part of the said University, but the control and management of the same shall be vested in the directors of the said Observatory, who shall be nominated by the directors of the said Society, and confirmed by the Board of Trustees of the University, saving to all persons who have contributed five hundred dollars the right of life directors without election.

Resolved, That in case the directors of said Society neglect or fail to nominate directors, said directors may be appointed by the Board of Trustees of the University without such nomination. The number of directors, exclusive of life directors, shall never exceed twenty-one, and seven directors shall constitute a quorum for the transaction of business.

Resolved, That the buildings or additions to the University to be erected for said Observatory shall constitute a part of the property of the University and be subject to the control of the Trustees, saving to the directors of the Observatory and of the Astronomical Society the rights and authority implied in the foregoing resolutions and in this agreement.

In witness of all which the said Chicago Astronomical Society has caused the President and Secretary of said Society to hereunto sign their names, and has affixed hereto its corporate seal.

And the Trustees of the Northwestern University, at Evanston, aforesaid, have caused the President and Secretary of their board to sign the same and affix the corporate seal of the said University.
Introduction

Done at Chicago, this 29th day of October in the year of our Lord, one thousand eight hundred and eighty-seven.

H. A. Johnson,
President of the Chicago Astronomical Society.

Henry C. Ranney,
Secretary of the Chicago Astronomical Society.

Northwestern University,
By Orrington Lunt,
Vice-President.

Attest,

James G. Hamilton,
Secretary of Northwestern University.

The new Dearborn Observatory, for which the corner stone was laid on June 21, 1888, was the gift of Mr. James B. Hobbs of Chicago, and since 1883 a trustee of Northwestern University. The plans were prepared by Cobb and Frost, architects, under the supervision of the joint building committees of the University and the Society: President Joseph Cummings, Messrs. J. B. Hobbs, J. Y. Scammon, and Elias Colbert. The entire cost of construction was $25,000. The exercises of dedication were held on June 9, 1889; the orators of the occasion were Mr. E. B. McCagg and Dr. H. A. Johnson. On September 1st the observatory was in working order. As bearing on the oft heard query concerning the influence of proximity of a large body of water on observing conditions, it should be stated that the Observatory is less than one hundred metres from the shore of that great, fresh-water lake, Lake Michigan, and about ten metres above its surface.

Plate I and the cut of the ground floor, Fig. 1, show the general style of the building and the arrangement of rooms. The building faces to the west. It measures 81 feet from north to south, and the greatest width is 72 feet. It is constructed of rubble limestone and trimmed with dressed Bedford stone; the roof is red tile. There is a basement under the entire building which provides for shops and store-room, and until recently for furnace and coal bins. The building is now heated by steam from the central power plant which lies a kilometer to the south. The main hallway divides the observing section of the building from the office rooms. On the south are the tower for the equatorial, the meridian circle room, and one office, which contains also the overflow from the library. The library, which numbers about 2,200 bound volumes and 4,000 unbound pieces, and includes the principal astronomical periodicals and observatory publications, is in the center of the north half of the building. To the west of it are the Director's offices and to the east, three rooms used for offices and instrument cabinets. On the second floor, over the library, is a classroom. On either side of this, over the two rows of offices, are rooms which serve respectively as photographic dark room and living room for the caretaker. The observing room for the equatorial is on the third floor.

Surmounting the cylindrical tower is the revolving dome which measures 34 feet in diameter in the clear. The success of this most essential feature of the observatory building is due entirely to Professor Hough. At the time of its construction the dome presented some novel features. As smooth running domes are no longer a rarity, only a word of description is here necessary. It is made entirely of steel and iron, with a heavy cast iron base, on the under side of which is the track. The ribs are of light angle iron; the covering is galvanized iron plate with no sheathing of wood. The weight of the dome is about ten tons.

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8 Deceased, August 13, 1914.
9 See Sidereal Messenger, 8, 541, 1889.

II
Annals of the Dearborn Observatory

upon sixteen fixed wheels mounted upon the top of the tower. This arrangement is very satisfactory, but the inverted form adopted later by Warner and Swasey in their dome-running gears, in which the track is mounted on the tower and the wheels are bolted to the dome, is probably preferable. Eight guide wheels pressing against the inner edge of the track prevent lateral displacement. The dome is driven by rack and pinion, the pinion being fixed on the tower, and the rack being mounted on the heavy cast iron base ring of the dome. The motion formerly was given to this pinion by a hand-turned crank near the floor. In recent years an electric motor has been applied. The opening in the dome is four feet wide, and extends

from the horizon to two feet beyond the zenith. The shutter extends over the whole hemisphere. It is pivoted at the back and has rollers at the side of the opening; otherwise it has no connection with the dome. It is operated by an endless cable from the interior of the dome.

The mounting of the equatorial in use until the spring of 1911 was that set up in the original Dearborn Observatory. Its wooden tube and poor driving clock rendered it quite unsuitable for a general program of observation. At the date mentioned the telescope was completely remounted by Warner and Swasey, Plate III. In the new mounting, provision is made for the convenient attachment of various accessory apparatus, the plate holder, spectrograph, etc. At the present time the instrument gives entire satisfaction. The telescope is carried on a brick pier which is independent of the building. The base of this is a concrete block fifteen feet below the ground level. The soil is sand and gravel. The pier tapers from
The 18½-Inch Telescope of the Dearborn Observatory.
Introduction

a diameter of fifteen feet at the base to ten feet at the top. It is surmounted by a stone slab, to which the telescope is anchored.

The mounting of the meridian circle has been described by Professor Hough in the Astronomische Nachrichten, No. 3902, where he gives the results of careful investigation on the variation of the adjustments of the instrument with varying temperature.

The investigations made in the new Dearborn Observatory by Professor G. W. Hough have been published for the most part in the Reports of the Chicago Astronomical Society, in the Astronomische Nachrichten, the Astronomical Journal, Monthly Notices, and Popular Astronomy, and consist of observations of comets and difficult double stars; the physical observations of the planets, and more especially of Jupiter; the various satellite systems, including measures of such difficult objects as the four moons of Uranus; occultations of stars by the Moon, etc. Throughout all the years, time service has been conducted. Professor Hough remained in charge of the work of the Observatory and conducted the instruction in astronomy until his death on January 1, 1909. The tablet erected in the Observatory by the Chicago Astronomical Society commemorates his service.

During the interim until the appointment of the present Director on September 1, 1909, Professor Malcolm McNeill, of Lake Forest University, was in charge of the Observatory and conducted the instruction.

This volume gives the principal results of observations during the first three years of the present directorship.

Investigation of the 18½-Inch Objective.

The excellence of this objective is well established by the long list of difficult double-stars which have been discovered and observed with it. There is no better evidence of quality than that of actual accomplishment. The application of the Hartmann test to it is therefore of peculiar interest, as the investigation constitutes not only a test of the objective, but in a way a test of the Hartmann method.

The zone plate had ninety-six apertures arranged at the corners of squares on twenty-four different zones. The apertures were 12 mm in diameter; one, at the arbitrary zero of position angle, was of 16 mm diameter. The arrangement of holes is seen in the actual extra-focal photographs, Fig. 2. The images for 0° may be easily identified. For each of the twenty-four zones the focal-length was determined in two planes perpendicular to each other. In practice the screen was in general mounted on the cell of the objective with the arbitrary 0°
of the screen at the bottom of the cell when the telescope was on the west side of the pier and pointed toward the south. The readings for the various position angles, as referring to positions on the objective, are not directly comparable. In September, 1912, a date intermediate in the series, the lenses were removed from the cell and cleaned. No effort was made to replace them in the previous position in the cell. It was the custom of the Clarks to mark the elements of their lenses on the edge so that their original orientation with respect to each other might be preserved. Their system of local correction required that the relative position of the lenses when figured, should be maintained. It should be stated that on the date mentioned the lenses were found in maladjustment in this regard, and in replacing them the correct orientation was restored. Another reason for the impossibility of directly comparing results for various angles is that the zone plate was rotated 45° between the two sets made on February 4, 1913. These things affect the direct intercomparison of individual zone results but more especially the results for astigmatism.

During the exposures the telescope was guided, using for this purpose the long-focus finder (f = 670 cm). The telescope was moved with the slow motions when necessary. The images in all the plates measured were very good. For each set the two exposures, one inside the focus, the other outside, are on a single plate. The photographic plate for the two extrafocal exposures was set about 125 mm inside and then outside of the focal plane, except in the first pair of plates where the two settings were not equidistant from the focus, being 114 mm inside and 156 mm outside.

The results from the different plates are given in Table I. The first column gives the zonal radius, the second the position angle from the arbitrary zero, the succeeding five columns give the focal-scale readings of the various zones for the five plates, and columns 8 and following give the mean of these determinations in the two perpendicular planes. These results are shown graphically in Fig. 3. The curves are very smooth, quite free from those abnormal zones seen in the 40-inch objective of the Yerkes Observatory, and the 80-cm at Potsdam. It does show, however, somewhat shorter focal-length at the center and edge than in the intermediate zones. One rather astonishing result is apparent and that is that the focal-setting remains practically constant throughout a wide range of temperature. This had been noted previously in visual work, and for all subsequent photographic work we have used a constant focal-setting, a great convenience.

![Fig. 2. Out-of-Focus Images for the Zonal Foci Test.](image-url)
### Introduction

The values given in Table I have been used to derive Hartmann's criterion "T", defined as the weighted mean diameter expressed in hundred-thousandths of the focal-length, of the cones of light from the various zones, in that plane, $F_0$, where the circle of light containing all the converging pencils is smallest. In the “Investigation of the 40-Inch Objective of the Yerkes Observatory” it was shown that the location of this plane, $F_0$, might depend on one abnormal zone and an alternative was suggested, that $F_0$ be chosen as that plane where the sum of the weighted diameters of the cones [rd] is a minimum. In Table II are given the values of $F_0$ as defined by Hartmann and by Fox, and the number $T$ derived from the zonal-readings, using the different values of $F_0$. This objective is free from freak zones so that the two values of $F_0$ are in very close agreement and consequently also the values of $T$.

The marked difference in the value of $T$ in the first three tests from those in the last two is probably mainly due to the restoration of the proper relative adjustment of the two elements of the lens or to the type of star furnishing the images. It was pointed out on page 13 that between the first three and last two sets the lenses were cleaned and again properly oriented.

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Table I.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Angle</th>
<th>$O_{14}$</th>
<th>$O_{15}$</th>
<th>$O_{16}$</th>
<th>$O_{17}$</th>
<th>$O_{18}$</th>
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</table>

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This may well be the most potent reason for the better showing of the later tests, which probably more truly represent the quality of the lens. For a visually corrected objective, where the use of a color-screen is necessary, the observations should be confined to stars of the solar type. For first-type stars the color-filter may serve less satisfactorily as a screen against the

![Graph](image-url)

**Fig. 3.** Zonal Foci of the 183-inch Objective of the Dearborn Observatory.

<table>
<thead>
<tr>
<th>Plate Number</th>
<th>Date</th>
<th>Star</th>
<th>Exposure</th>
<th>Zenith Distance</th>
<th>Temperature</th>
<th>$r_0$</th>
<th>$T$</th>
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<tbody>
<tr>
<td>O 14</td>
<td>July 9, 1912</td>
<td>Vega</td>
<td>20-20</td>
<td>6° 7'</td>
<td>26° C</td>
<td>204.73</td>
<td>295.10</td>
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<td>O 15</td>
<td>July 9, 1912</td>
<td>Vega</td>
<td>20-27</td>
<td>11 21</td>
<td>26</td>
<td>295.21</td>
<td>295.15</td>
</tr>
<tr>
<td>O 16</td>
<td>Aug. 20, 1912</td>
<td>Vega</td>
<td>20-20</td>
<td>23 54</td>
<td>22</td>
<td>294.47</td>
<td>294.90</td>
</tr>
<tr>
<td>O 20</td>
<td>Feb. 4, 1913</td>
<td>Arcturus</td>
<td>10-10</td>
<td>35 41</td>
<td>19</td>
<td>295.25</td>
<td>295.40</td>
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<tr>
<td>O 21</td>
<td>Feb. 4, 1913</td>
<td>Arcturus</td>
<td>10-10</td>
<td>23 21</td>
<td>19</td>
<td>295.37</td>
<td>295.37</td>
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</table>

*After cleaning and readjusting the lenses.*

concentrated blue light of the image outside the focus. This precaution was complied with only in the last two plates, Table II, in which Arcturus was used, Vega being used in the other cases. The exposures on Vega for O 15 were made when there was a fog so dense that ε and ζ Lyrae were scarcely visible to the naked eye. The blue light must then have been considerably less effective, and consequently the star gave results more like those from Arcturus. The low value of $T$ from this plate gives additional indication that the difference in $T$ may be due at least in part to difference in spectrum type. There seems to be no relation
between $T$ and the zenith distance, but the smaller values for the two tests using Arcturus may possibly be a temperature effect, for it is seen that the tests were made at a temperature differing by 45° C from that of the tests on Vega.

There are still some objections to be raised against the method of determining the criterion $T$, especially when we use it to compare different objectives. One has been pointed out by Stetson,\footnote{Popular Astronomy, 22, 422, 1914.} who suggests that the resolving power of the objective should in some way be considered. Another difficulty enters through the random choice of zones. Some investigators have spaced the zones nearly equidistantly. Others, accepting the opportunity offered by the space available on the zone plate, have inserted as many apertures as possible, which gives results from widely spaced zones near the center of the lens and closely packed zones near the edge. The edge, therefore, has been given excessive weight. To overcome the objection from this source, investigators should either space the zones according to some accepted plan, or, since this is not feasible, should draw a smooth curve through their zonal-foci readings and choose points on this curve according to an accepted plan. The general trend of the plotted zonal-foci readings gives perhaps as good an indication of the relative quality as does the numerical value of $T$. No attempt has been made in the present observations to select times when the temperature was invariable. Further, it was found that the images on some of the plates are not uniform in intensity but show decided reticular structure. This peculiarity probably arises from the fact that the holes in the zonal-plate were too small, and under conditions of good seeing the diffraction patterns were strong enough to have appreciable effect. The tests should perhaps be repeated with a zonal screen having larger apertures, to see if herein lies the cause of this peculiarity.

### Table III.

<table>
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<tr>
<th>Zone</th>
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Table III gives the zonal astigmatic errors, the difference in focal-length in the two planes, found by subtracting the mean zone values of Table I from the individual results. The signs of the errors are given for the position angle indicated in column 2. It is of course understood that the values for the planes at right angles have opposite signs. The errors are exceedingly
small, about of the order of the error of measurement. Their reality is therefore questionable. The mean value, however, for all zones of the five tests irrespective of sign is 0.152 mm. For comparison it may be stated that the mean astigmatic error for the 40-inch of the Yerkes Observatory, derived in the same way, is 0.726 mm. Again it should be stated that the results for the five different tests are not directly comparable.

The determination of the form of the color-curve of the objective was also a part of the investigation, in fact preceded the zonal-foci tests. A knowledge of its form was one of the essential items in the preparation of the specifications for the color-filter used in later photographic observations. A make-shift spectrograph was applied by two methods, that of Hartmann, using a zone-plate and extra focal exposures; and the older method of constrictions in stellar spectra obtained at various focal settings. For the Hartmann test the diaphragm had apertures on zones of radius 110 and 200 mm. All the tests were made on Vega in April, 1912. The agreement of results from the two methods is shown in Table IV, or perhaps to better advantage in the platted curve, Fig. 4. In the Table the first column gives the wavelengths for which succeeding columns give focal-settings. As the slit of the spectrograph was

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not at the same distance from the zero of the focal-setting scale as the plate in the double-slide plate holder, the reading for the yellow is not identical with that indicated by the zonal-foci tests. Column 2 gives results from the method of strictures; the remaining columns, from
PLATE IV.

The Micrometer on the 18½-Inch Refractor.
the two Hartmann tests. Three different plates are employed in $H_2$ at the focal-settings indicated. In the curve the stricture values of column 2 are represented by circles; the mean values from the Hartmann tests, by black dots.

**Observations.**

It is fitting that the first volume of publications from the Dearborn Observatory should be one of measures of double stars, for its telescope had leaped to fame in this field before leaving the makers' hands, by the detection with its use of the well-known, though hitherto invisible companion of Sirius.\(^\text{12}\) And since that time much of the observing with it has been in this field. The measure of its activity is revealed in the long series of double stars discovered and measured with it by Hough and by Burnham.

An investigation of the value of one revolution of the screw of the Saegmüller micrometer, Plate IV, confirmed the value which had been used by Hough and Burnham, and has been used throughout the present series of observations: $r^N = 14''.840$. Some slight alteration was found necessary in the electric illumination of the cross wires, but otherwise the instrument is in the form in which they used it.

\(^\text{12}\) For this discovery Mr. A. G. Clark was awarded the Lalande Prize of the French Academy of Sciences. C. R., LV, 937, 1861.
Annals of the Dearborn Observatory

It has been the aim to measure each star on three nights and to make on each night four settings for position angle and three or more settings of double distances. In measuring the angle the head has been held in such position that the cross wires were always either perpendicular or parallel to the pupillary line. In general the stars have been set midway between the cross wires in seeking parallelism; but in case of wide pairs they have been bisected by a single wire. The choice of eye-piece has been guided by the character of the star and the seeing, the range being between power of 275 and 1,100. For each star are given the Burnham General Catalogue number, the name of the star, and the right ascension and declination for 1880. In some cases also the magnitudes are given. The first column gives the date; the second, the position angle; the third, the distance; and the fourth, the aperture of the telescope employed. In this column ‘40’ and ‘12’ refer to the 40-inch and 12-inch telescopes at the Yerkes Observatory; where no designation is given, it is understood that the 18½-inch of the Dearborn Observatory was used.

The measures are grouped in four parts. First, a complete series of measures of the stars discovered by Edward S. Holden at the Washburn Observatory of the University of Wisconsin. To this list has been added a few miscellaneous stars discovered by him at other stations. I wish here to acknowledge with thanks the courtesy of Mr. R. T. A. Innes, Director of the Union Observatory at Johannesburg, Transvaal, South Africa, who very kindly measured those southern stars discovered by Holden while on an eclipse expedition to Caroline Island. These stars are too far south to be included within the limitation of Burnham’s General Catalogue but all are found in Innes’ Reference Catalogue of Southern Double Stars. Some of them had been previously detected by other observers, but all are given here in regular sequence to make the list complete, although proper credit to the original discoverer is noted. For the Holden stars, as well as those of Küstner which follow them, references are given to every measure of them published subsequent to the appearance of Burnham’s General Catalogue and down to 1914.

The second part is a similar complete list of measures of the stars discovered by Professor F. Küstner, at Bonn. The third part is a series of observations of miscellaneous double stars, for the most part selected from Burnham’s General Catalogue. In this section are reprinted two short lists of observations previously published in the Astronomische Nachrichten and the Astronomical Journal. For a considerable number of pairs, additional stars have been measured for the purpose of future use for the determination of proper motion, etc. In the fourth part is given a short list of new double stars which have been discovered in the course of the observations.

I wish here to express my appreciation to the Trustees of the University for appropriating funds for the publication of this volume and also to the Chicago Astronomical Society for contributing toward this purpose, and personally to Professor Elias Colbert for reading and verifying the historical notes.

Philip Fox.

Dearborn Observatory,
April 30, 1915.

13 A. N. (4336)
14 A. J. 611.