MANUAL

OF

SURVEYING INSTRUCTIONS

FOR THE

SURVEY OF THE PUBLIC LANDS

OF THE

UNITED STATES

AND

PRIVATE LAND CLAIMS.

Prepared in conformity with law under the direction of
THE COMMISSIONER OF THE GENERAL LAND OFFICE.

JANUARY 1, 1890.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1890.

DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE,
Washington, D. C., December 2, 1889.

GENTLEMEN: The following instructions, including full and minute directions for the execution of surveys in the field, are issued under the authority given me by sections 453, 456, and 2398 United States Revised Statutes, and must be strictly complied with by yourselves and your deputy surveyors.

Very respectfully,

LEWIS A. GROFF,
Commissioner.

TO SURVEYORS GENERAL OF THE UNITED STATES.

INTRODUCTORY.

The present system of survey of the public lands was inaugurated by a committee appointed by the Continental Congress, and consisting of the following delegates:

Hon. THOS. JEFFERSON, *Chairman*	Virginia.
Hon. HUGH WILLIAMSON	North Carolina.
Hon. DAVID HOWELL	Rhode Island.
Hon. ELBRIDGE GERRY	Massachusetts.
Hon. JACOB READ	South Carolina.

On the 7th of May, 1784, this committee reported "An ordinance for ascertaining the mode of locating and disposing of lands in the western territory, and for other purposes therein mentioned." This ordinance required the public lands to be divided into "hundreds" of ten geographical miles square, and those again to be subdivided into lots of one mile square each, to be numbered from 1 to 100, commencing in the *northwestern* corner, and continuing from west to east and from east to west consecutively. This ordinance was considered, debated, and amended, and reported to Congress April 26, 1785, and required the surveyors "to divide the said territory into townships of 7 miles square, by lines running due north and south, and others crossing these at right angles. * * * The plats of the townships, respectively, shall be marked by subdivisions into sections of 1 mile square, or 640 acres, in the same direction as the external lines, and numbered from 1 to 49. * * * And these sections shall be subdivided into lots of 320 acres." This is the first record of the use of the terms "township" and "section."

May 3, 1785, on motion of Hon. William Grayson, of Virginia, seconded by Hon. James Monroe, of Virginia, the section respecting the extent of townships was amended by striking out the words "seven miles square" and substituting the words "six miles square." The record of these early sessions of Congress are not very full or complete; but it does not seem to have occurred to the members until the 6th of May, 1785, that a township six miles square could not contain 49 sections of 1 mile square. At that date a motion to amend was made, which provided, among other changes, that a township should contain 36 sections; and the amendment was *lost*. The ordinance as finally passed, however, on the 20th of May, 1785, provided for townships, 6 miles square, containing 36 sections of 1 mile square. The first public surveys were made under this ordinance. The townships, 6 miles square, were laid out in ranges, extending northward from the Ohio River, the townships being numbered from south to north, and the ranges from east to west. The region embraced by the surveys under this law forms a part of the present State of Ohio, and is usually styled "The Seven Ranges." In these initial surveys only the *exterior lines* of the

townships were surveyed, but the plats were marked by subdivisions into sections of 1 mile square, and mile corners were established on the township lines. The sections were numbered from 1 to 36, commencing with No. 1 in the *southeast* corner of the township, and running from *south* to *north* in each tier to No. 36 in the *northwest* corner of the township, as shown in the following diagram:

36	30	24	18	12	6
35	29	23	17	11	5
34	28	22	16	10	4
33	27	21	15	9	3
32	26	20	14	8	2
31	25	19	13	7	1

The surveys were made under the direction of the Geographer of the United States.

The act of Congress approved May 18, 1796 provided for the appointment of a surveyor-general, and directed the survey of the lands northwest of the Ohio River, and above the mouth of the Kentucky River, "in which the titles of the Indian tribes have been extinguished." Under this law *one-half* of the townships surveyed were subdivided into sections "by running through the same, each way, parallel lines at the end of every two miles, and by making a corner on each of said lines at the end of every mile," and it further provided that "the sections shall be numbered, respectively, beginning with the number one in the northeast section and proceeding west and east alternately, through the township, with progressive numbers till the thirty-sixth be completed." This method of numbering sections, as shown by the following diagram, is still in use:

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

The act of Congress approved May 10, 1800, required the "townships west of the Muskingum, which * * * are directed to be sold in quarter townships, to be subdivided into half sections of three hundred and twenty acres each, as nearly as may be, by running parallel lines through the same from east to west, and from south to north, at the distance of one mile from each other, and marking corners, at the dis-

tance of each half mile, on the lines running from east to west, and at the distance of each mile on those running from south to north. * * * And the interior lines of townships intersected by the Muskingum, and of all the townships lying east of that river, which have not been heretofore actually subdivided into sections, shall also be run and marked. * * * And in all cases where the exterior lines of the townships thus to be subdivided into sections or half sections shall exceed, or shall not extend, six miles, the excess or deficiency shall be specially noted, and added to or deducted from the western and northern ranges of sections or half sections in such township, according as the error may be in running the lines from east to west or from south to north."

The act of Congress approved February 11, 1805, directs the subdivision of the public lands into quarter sections, and provides that all the corners marked in the public surveys shall be established as the proper corners of sections, or subdivisions of sections, which they were intended to designate, and that corners of half and quarter sections *not marked* shall be placed, as nearly as possible, "equidistant from those two corners which stand on the same line." This act further provides that "The boundary lines actually run and marked * * * shall be established as the proper boundary lines of the sections or subdivisions for which they were intended; and the length of such lines as returned by * * * the surveyors * * * shall be held and considered as the true length thereof, and the boundary lines which shall not have been actually run and marked as aforesaid shall be ascertained by running straight lines from the established corners to the opposite corresponding corners; but in those portions of the fractional townships, where no such opposite or corresponding corners have been or can be fixed, the said boundary line shall be ascertained by running from the established corners due north and south or east and west lines, as the case may be, to the * * * external boundary of such fractional township."

The act of Congress approved April 25, 1812, provided "That there shall be established in the Department of the Treasury an office to be denominated the General Land Office, the chief officer of which shall be called the Commissioner of the General Land Office, whose duty it shall be, under the direction of the head of the department, to superintend, execute, and perform all such acts and things touching or respecting the public lands of the United States, and other lands patented or granted by the United States, as have heretofore been directed by law to be done or performed in the office of the Secretary of State, of the Secretary and Register of the Treasury, and of the Secretary of War, or which shall hereafter by law be assigned to the said office."

The act of Congress approved April 24, 1820, provides for the sale of public lands in half quarter sections, and requires that "in every case of the division of a quarter section the line for the division thereof shall run north and south * * * and fractional sections, containing 160 acres and upward, shall, in like manner, as nearly as practicable, be subdivided into half quarter sections, under such rules and regulations as may be prescribed by the Secretary of the Treasury; but fractional sections containing less than 160 acres shall not be divided."

The act of Congress approved May 24, 1824, provides "That whenever, in the opinion of the President of the United States, a departure from the ordinary mode of surveying land on any river, lake, bayou, or watercourse would promote the public interest, he may direct the surveyor-general in whose district such land is situated, and where the change is intended to be made, under such rules and regulations as the

President may prescribe, to cause the lands thus situated to be surveyed in tracts of two acres in width, fronting on any river, bayou, lake, or watercourse, and running back the depth of forty acres." * * *

The act of Congress approved May 29, 1830 (Secs. 2412, 2413, R. S.), provides for the fine and imprisonment of any person obstructing the survey of the public lands, and for the protection of surveyors, in the discharge of their official duties, by the United States marshal, with sufficient force, whenever necessary.

The act of Congress approved April 5, 1832, directed the subdivision of the public lands into quarter-quarters; that in every case of the division of a half-quarter section the dividing line should run east and west, and that fractional sections should be subdivided under rules and regulations prescribed by the Secretary of the Treasury. Under the latter provision the Secretary directed that fractional sections containing less than 160 acres, or the residuary portion of a fractional section, after the subdivision into as many quarter-quarter sections as it is susceptible of, may be subdivided into lots, each containing the quantity of a quarter-quarter section, as nearly as practicable, by so laying down the line of subdivision that they shall be 20 chains wide, which distances are to be marked on the plat of subdivision, as are also the areas of the quarter-quarters and residuary fractions.

The two acts last above mentioned provided that the corners and contents of half-quarter and quarter-quarter sections should be ascertained, as nearly as possible, in the manner and on the principles directed and prescribed in the act of Congress approved February 11, 1805.

The act of Congress approved July 4, 1836, provided for the reorganization of the General Land Office, and that the executive duties of said office "shall be subject to the supervision and control of the Commissioner of the General Land Office under the direction of the President of the United States." The repealing clause is, "That such provisions of the act of the twenty-fifth of April, in the year one thousand eight hundred and twelve, entitled 'An act for the establishment of a General Land Office in the Department of the Treasury,' and of all acts amendatory thereof as are inconsistent with the provisions of this act, be, and the same are hereby, repealed."

From the working of this act it would appear that the control of the General Land Office was removed from the Treasury Department, and that the Commissioner reported direct to the President, but, as a matter of fact, the Secretary of the Treasury still had supervisory control, for the act of Congress approved March 3, 1849, by which the Department of the Interior was established, provided "That the Secretary of the Interior shall perform all the duties in relation to the General Land Office, of supervision and appeal, now discharged by the Secretary of the Treasury * * *." By this act the General Land Office was transferred to the Department of the Interior, where it still remains.

In 1855 a manual of instructions to surveyors general was prepared, under the direction of the Commissioner of the General Land Office, by John M. Moore, then principal clerk of surveys, and the act of Congress approved May 30, 1862 (Sec. 2399 R. S.), provided "That the printed manual of instructions relating to the public surveys, prepared at the General Land Office, and bearing the date February twenty-second, eighteen hundred and fifty-five, the instructions of the Commissioner of the General Land Office, and the special instructions of the surveyor-general, when not in conflict with said printed manual or the instructions of said Commissioner, shall be taken and deemed to be a part of every contract for surveying the public lands of the United States."

The instructions contained in this volume are issued under the authority given in the clause in said act providing that "The instructions of the Commissioner of the General Land Office * * * shall be taken and deemed to be a part of every contract for surveying the public lands of the United States."

The following comprise so much of the general laws relating to the survey of the public domain as it is deemed necessary to incorporate in this volume, reference being made by chapter and section to the codification of the Public Land Laws, prepared pursuant to acts of Congress approved March 3, 1879, and June 16, 1880, and by section number to the Revised Statutes of the United States.

CHAPTER TWO.

THE GENERAL LAND OFFICE.

Duties of Commissioner.

SEC. 32. The Commissioner of the General Land Office shall perform, under the direction of the Secretary of the Interior, all executive duties appertaining to the surveying and sale of the public lands of the United States, or in anywise respecting such public lands; and, also, such as relate to private claims of lands, and the issuing of patents for all grants of land under the authority of the Government. (R. S. 453.)

Returns and accounts relative to lands.

SEC. 35. All returns relative to the public lands shall be made to the Commissioner of the General Land Office; and he shall have power to audit and settle all public accounts relative to the public lands; and upon the settlement of any such accounts he shall certify the balance, and transmit the account with the vouchers and certificate to the First Comptroller of the Treasury for his examination and decision thereon. (R. S. 456.)

Commissioner to perform duties of surveyor-general, etc.

SEC. 38. Upon the discontinuance of any surveying district the authority, powers, and duties in relation to the survey, resurvey, or subdivision of lands therein, and all matters and things connected therewith, as previously exercised by the surveyor-general, shall be vested in and devolved upon the Commissioner of the General Land Office; and deputy surveyors or other agents under his direction shall have free access to any field-notes, maps, records, and other papers turned over to the authorities of any State, pursuant to law, for the purpose of making copies thereof, without charge of any kind. (R. S. 2219, 2220.)

Approval of surveying contracts.

SEC. 45. The Commissioner shall approve all contracts for the survey of the public lands. (R. S. 2398.)

Commissioner's instructions deemed part of contract for surveying.

SEC. 46. The instructions issued by the Commissioner of the General Land Office not in conflict with law shall be deemed part of every contract for surveying the public lands. (R. S. 2399.)

Power of Commissioner to make regulations.

SEC. 61. The Commissioner, under the direction of the Secretary of the Interior, is authorized to enforce and carry into execution every part of the public land laws not otherwise specially provided for. (R. S. 2478.)

CHAPTER THREE.

SURVEYS AND SURVEYORS.

Surveyors-general, how and where appointed.

SEC. 77. There shall be appointed by the President, by and with the advice and consent of the Senate, a surveyor-general for the States and Territories herein named, embracing respectively one surveying district, namely: Louisiana, Florida, Minnesota, Kansas, California, Nevada, Oregon, Nebraska and Iowa, Dakota, Colorado, New Mexico, Idaho, Washington, Montana, Utah, Wyoming, Arizona. (R. S. 2207.)

Residence of surveyor-general.

SEC. 83. Every surveyor-general, while in the discharge of the duties of his office, shall reside in the district for which he is appointed. (R. S. 2214.)

Bond of surveyor-general.

SEC. 84. Every surveyor-general shall, before entering on the duties of his office, execute and deliver to the Secretary of the Interior a bond, with good and sufficient security, for the penal sum of thirty thousand dollars, conditioned for the faithful disbursement, according to law, of all public money placed in his hands, and for the faithful performance of the duties of his office; and the President has discretionary authority to require a new bond and additional security, under the direction of the Secretary of the Interior, for the lawful disbursements of public moneys. (R. S. 2215, 2216.)

Duration of office.

SEC. 85. The commission of each surveyor-general shall cease and expire in four years from the date thereof, unless sooner vacated by death, resignation, or removal from office. (R. S. 2217.)

Continuance of duties and bond after expiration of commission.

SEC. 86. Every surveyor-general, except where the President sees cause otherwise to determine, is authorized to continue in the uninterrupted discharge of his regular official duties after the day of expiration of his commission and until a new commission is issued to him for the same office, or until the day when a successor enters upon the duties of such office; and the existing official bond of any officer so acting shall be deemed good and sufficient and in force until the date of the approval of a new bond to be given by him, if recommissioned, or otherwise, for the additional time he may so continue officially to act, pursuant to the authority of this section. (R. S. 2222.)

Transfer of papers and discontinuance of office in case of completed surveys.

SEC. 87. Whenever the surveys and records of any surveying district are completed the surveyor-general thereof shall be required to deliver over to the secretary of state of the respective States, including such surveys, or to such other officer as may be authorized to receive them, all the field-notes, maps, records, and other papers appertaining to land titles within the same; and the office of surveyor-general in every such district shall thereafter cease and be discontinued. (R. S. 2218.)

Devolution of powers upon Commissioner in case of discontinuance.

SEC. 88. In all cases of discontinuance, as provided in the preceding section, the authority, powers, and duties of the surveyor-general in relation to the survey, resurvey, or subdivision of the lands therein, and all matters and things connected therewith shall be vested in and devolved upon the Commissioner of the General Land Office. (R. S. 2219.)

Free access to public records delivered to States and conditions of such delivery.

SEC. 89. Under the authority and direction of the Commissioner of the General Land Office any deputy surveyor or other agent of the United States shall have free access to any such field-notes, maps, records, and other papers for the purpose of taking extracts therefrom or making copies thereof without charge of any kind; but no transfer of such public records shall be made to the authorities of any State until such State has provided by law for the reception and safe-keeping of such public records, and for the allowance of free access thereto by the authorities of the United States. (R. S. 2220, 2221.)

General duties of surveyor-general.

SEC. 90. Every surveyor-general shall engage a sufficient number of skillful surveyors as his deputies, to whom he is authorized to administer the necessary oaths upon their appointments. He shall have authority to frame regulations for their direction, not inconsistent with law or the instructions of the General Land Office, and to remove them for negligence or misconduct in office.

Second. He shall cause to be surveyed, measured, and marked, without delay, all base and meridian lines through such points and perpetuated by such monuments, and such other correction parallels and meridians as may be prescribed by law or by instructions from the General Land Office in respect to the public lands within his surveying district, to which the Indian title has been or may be hereafter extinguished.

Third. He shall cause to be surveyed all private land claims within his district, after they have been confirmed by authority of Congress, so far as may be necessary to complete the survey of the public lands.

Fourth. He shall transmit to the register of the respective land offices within his district general and particular plats of all lands surveyed by him for each land district; and he shall forward copies of such plats to the Commissioner of the General Land Office.

Fifth. He shall, so far as is compatible with the desk duties of his office, occasionally inspect the surveying operations while in progress in the field, sufficiently to satisfy himself of the fidelity of the execution of the work according to contract, and the actual and necessary expenses incurred by him while so engaged shall be allowed; and where it is incompatible with his other duties for a surveyor-general to devote the time necessary to make a personal inspection of the work in progress, then he is authorized to depute a confidential agent to make such examination, and the actual and necessary expenses of such person shall be allowed and paid for that service, and five dollars a day during the examination in the field; but such examination shall not be protracted beyond thirty days, and in no case longer than is actually necessary; and when a surveyor-general, or any person employed in his office at a regular salary, is engaged in such special service, he shall receive only his necessary expenses in addition to his regular salary. (R. S. 2223.)

Bond of deputy surveyor.

SEC. 91. Every deputy surveyor shall enter into bond, with sufficient security, for the faithful performance of all surveying contracts confided to him; and the penalty of the bond in each case shall be double the estimated amount of money accruing under such contract, at the rate per mile stipulated to be paid therein. The sufficiency of the sureties to all such bonds shall be approved and certified by the proper surveyor-general. (R. S. 2230.)

SEC. 92. The surveyors-general, in addition to the oath now authorized by law to be administered to deputies on their appointment to office, shall require each of their deputies, on the return of his surveys, to take and subscribe an oath that those surveys have been faithfully and correctly executed according to law and the instructions of the surveyor-general. (R. S. 2231.)

Oath of deputy surveyor

SEC. 93. The district attorney of the United States, in whose district any false, erroneous, or fraudulent surveys have been executed, shall, upon the application of the proper surveyor-general, immediately institute suit upon the bond of such deputy, and the institution of such suit shall act as a lien upon any property owned or held by such deputy or his sureties at the time such suit was instituted. (R. S. 2232.)

Suit on bond of deputy surveyor; lien of.

SEC. 98. The President is authorized, in any case where he thinks the public interest may require it, to transfer the duties of register and receiver in any district to the surveyor-general of the surveying district in which such land district is located. (R. S. 2228.)

Duties of register and receiver performed by surveyor-general.

SEC. 99. The public lands shall be divided by north and south lines run according to the true meridian, and by others crossing them at right angles, so as to form townships of six miles square, unless where the line of an Indian reservation, or of tracts of land heretofore surveyed or patented, or the course of navigable rivers may render this impracticable; and in that case this rule must be departed from no further than such particular circumstances require.

Rules of survey.

Second. The corners of the townships must be marked with progressive numbers from the beginning, each distance of a mile between such corners must be also distinctly marked with marks different from those of the corners.

Third. The township shall be subdivided into sections, containing, as nearly as may be, six hundred and forty acres each, by running through the same, each way, parallel lines at the end of every two miles; and by making a corner on each of such lines at the end of every mile. The sections shall be numbered, respectively, beginning with the number one in the northeast section, and proceeding west and east alternately through the township with progressive numbers till the thirty-six be completed.

Fourth. The deputy surveyors, respectively, shall cause to be marked on a tree near each corner established in the manner described, and within the section, the number of such section, and over it the number of the township within which such section may be; and the deputy surveyors shall carefully note, in their respective field-books, the names of the corner trees marked and the numbers so made.

Fifth. Where the exterior lines of the townships which may be subdivided into sections or half sections exceed, or do not extend six miles, the excess or deficiency shall be specially noted, and added to or deducted from the western and northern ranges of sections or half sections in such townships, according as the error may be in running the lines from east to west, or from north to south; the sections and half sections bounded on the northern and western lines of such townships shall be sold as containing only the quantity expressed in the returns and plats, respectively, and all others as containing the complete legal quantity.

Sixth. All lines shall be plainly marked upon trees, and measured with chains, containing two perches, of sixteen and one-half feet each, subdivided into twenty-five equal links; and the chain shall be adjusted to a standard to be kept for that purpose.

Seventh. Every surveyor shall note in his field-book the true situations of all mines, salt-licks, salt-springs, and mill-seats which come to his knowledge; all water-courses over which the line he runs may pass; and also the quality of the lands.

Eighth. These field books shall be returned to the surveyor-general, who shall cause therefrom a description of the whole lands surveyed to be made out and transmitted to the officers who may superintend the sales. He shall also cause a fair plat to be made of the townships and fractional parts of townships contained in the lands, describing the subdivisions thereof and the marks of the corners. This plat shall be recorded in books to be kept for that purpose; and a copy thereof shall be kept open at the surveyor-general's office for public information, and other copies shall be sent to the places of the sale and to the General Land Office. (R. S. 2395.)

SEC. 100. The boundaries and contents of the several sections, half sections, and quarter sections of the public lands shall be ascertained in conformity with the following principles:

Boundaries and contents of public lands, how ascertained.

First. All the corners marked in the surveys returned by the surveyor-general shall be established as the proper corners of sections, or subdivisions of sections, which they were intended to designate; and the corners of half and quarter sections, not marked on the surveys, shall be placed as nearly as possible equidistant from two corners which stand on the same line.

Second. The boundary lines, actually run and marked in the surveys returned by the surveyor-general, shall be established as the proper boundary lines of the sections or subdivisions for which they were intended, and the length of such lines as returned,

shall be held and considered as the true length thereof. And the boundary lines which have not been actually run and marked shall be ascertained by running straight lines from the established corners to the opposite corresponding corners; but in those portions of the fractional townships, where no such opposite corresponding corners have been or can be fixed, the boundary lines shall be ascertained by running from the established corners due north and south or east and west lines, as the case may be, to the water-course, Indian boundary line, or other external boundary of such fractional township.

Third. Each section or subdivision of section, the contents whereof have been returned, by the surveyor-general, shall be held and considered as containing the exact quantity expressed in such return; and the half-sections and quarter-sections, the contents whereof shall not have been thus returned, shall be held and considered as containing the one-half or the one-fourth part, respectively, of the returned contents of the section of which they may make part. (R. S. 2396.)

Lines of division of half-quarter sections, how run.

SEC. 101. In every case of the division of a quarter-section the line for the division thereof shall run north and south, and the corners and contents of half-quarter sections which may thereafter be sold shall be ascertained in the manner and on the principles directed and prescribed by the section preceding, and fractional sections containing one hundred and sixty acres or upwards shall in like manner, as nearly as practicable, be subdivided into half quarter-sections, under such rules and regulations as may be prescribed by the Secretary of the Interior, and in every case of a division of a half-quarter section, the line for the division thereof shall run east and west, and the corners and contents of quarter-quarter sections, which may thereafter be sold, shall be ascertained, as nearly as may be, in the manner and on the principles directed and prescribed by the section preceding; and fractional sections containing fewer or more than one hundred and sixty acres shall in like manner, as nearly as may be practicable, be subdivided into quarter-quarter sections, under such rules and regulations as may be prescribed by the Secretary of the Interior. (R. S. 2397.)

Variance in shape of surveys on rivers, &c.

SEC. 102. Whenever, in the opinion of the President, a departure from the ordinary method of surveying land on any river, lake, bayou, or water-course would promote the public interest, he may direct the surveyor-general, in whose district such land is situated, and where the change is intended to be made, to cause the lands thus situated to be surveyed in tracts of two acres in width, fronting on any river, bayou, lake, or water-course, and running back the depth of forty acres; which tracts of land so surveyed shall be offered for sale entire, instead of in half-quarter sections, and in the usual manner, and on the same terms in all respects as the other public lands of the United States. (R. S. 2407.)

Extension of public surveys over mineral lands.

SEC. 106. The public surveys shall extend over all mineral lands, and all subdividing of surveyed lands into lots less than one hundred and sixty acres may be done by county and local surveyors at the expense of claimants; but nothing in this section contained shall require the survey of waste or useless lands. (R. S. 2406.)

What instructions to be deemed part of contract.

SEC. 107. The printed manual of instructions relating to the public surveys, prepared at the General Land Office, and bearing date February twenty-second, eighteen hundred and fifty-five, the instructions of the Commissioner of the General Land Office, and the special instructions of the surveyor-general, when not in conflict with such printed manual or the instructions of the Commissioner, shall be taken and deemed to be part of every contract for surveying the public lands. (R. S. 2399.)

Contracts for surveys of public lands, when binding.

SEC. 111. Contracts for the survey of the public lands shall not become binding upon the United States until approved by the Commissioner of the General Land Office, except in such cases as the Commissioner may otherwise especially order. (R. S. 2398.)

Price of surveys, how established; cost of surveying private claims and railroad grants to be refunded.

SEC. 112. The Commissioner of the General Land Office has power, and it shall be his duty to fix the prices per mile for public surveys, which shall in no case exceed the maximum established by law; and, under instructions to be prepared by the Commissioner, an accurate account shall be kept by each surveyor-general of the cost of surveying and plotting private land claims, to be reported to the General Land Office, with the map of such claim; and patents shall not issue for any such private claim, nor shall any copy of such survey be furnished, until the cost of survey and platting has been paid into the Treasury by the claimant or other party; and before any land granted to any railroad company by the United States shall be conveyed to such company or any persons entitled thereto, under any of the acts incorporating or relating to said company, unless such company is exempted by law from the payment of such cost, there shall first be paid into the Treasury of the United States the cost of surveying, selecting, and conveying the same by the said company or persons in interest. (R. S. 2400, 19 Stats. 121.)

SEC. 115. When the settlers in any township, not mineral or reserved by government, desire a survey made of the same, under the authority of the surveyor-general, and file an application therefor in writing and deposit in a proper United States depository to the credit of the United States, a sum sufficient to pay for such survey, together with all expenses incident thereto, without cost or claim for indemnity on the United States, it may be lawful for the surveyor-general, under such instructions as may be given him by the Commissioner of the General Land Office, and in accordance with law, to survey such township and make return thereof to the general and proper local land office, provided the township so proposed to be surveyed is within the range of the regular progress of the public surveys embraced by existing standard lines or bases for the township and subdivisional surveys. (R. S. 2401.)

When survey may be had by settlers in township.

SEC. 116. The deposit of money in a proper United States depository, under the provisions of the preceding section, shall be deemed an appropriation of the sums so deposited for the objects contemplated by that section and the Secretary of the Treasury is authorized to cause the sums so deposited to be placed to the credit of the proper appropriations for the surveying service; but any excesses in such sums over and above the actual cost of the surveys, comprising all expenses incident thereto, for which they were severally deposited, shall be repaid to the depositors respectively. (R. S. 2402.)

Deposit for expenses of surveys deemed an appropriation, &c.

SEC. 117. Where settlers make deposits in accordance with the provisions of section one hundred and fifteen, the amount so deposited shall go in part payment for their lands situated in the townships, the surveying of which is paid for out of such deposits; or the certificates issued for such deposits may be assigned by indorsement and be received in payment for any public lands of the United States entered by settlers under the pre-emption and homestead laws of the United States, and not otherwise. (R. S. 2403.)

Settlers' deposits for surveys to go in part payment of lands, and are assignable.

SEC. 118. Each surveyor-general, when thereunto duly authorized by law, shall cause all confirmed private land claims within his district to be accurately surveyed, and shall transmit plats and field-notes thereof to the Commissioner of the General Land Office for his approval. When publication of such surveys is authorized by law, the proof thereof, together with any objections properly filed, and all evidence submitted either in support of or in opposition to the approval of any such survey, shall also be transmitted to said Commissioner. (R. S. 2447.)

Surveyors-general to survey private land claims when confirmed, &c.

SEC. 120. Every person who in any manner, by threat or force, interrupts, hinders, or prevents the surveying of the public lands, or of any private land claim which has or may be confirmed by the United States, by the persons authorized to survey the same, in conformity with the instructions of the Commissioner of the General Land Office, shall be fined not less than fifty dollars, nor more than three thousand dollars, and be imprisoned not less than one nor more than three years. (R. S. 2412.)

Penalty for interrupting surveys.

SEC. 121. Whenever the President is satisfied that forcible opposition has been offered, or is likely to be offered, to any surveyor or deputy surveyor in the discharge of his duties in surveying the public lands, it may be lawful for the President to order the marshal of the State or district, by himself or deputy, to attend such surveyor or deputy surveyor with sufficient force to protect such officer in the execution of his duty, and to remove force should any be offered. (R. S. 2413.)

Protection of surveyor by marshal of district.

SEC. 122. The President is authorized to appoint surveyors of public lands, who shall explore such vacant and unappropriated lands of the United States as produce the live-oak and red-cedar timbers, and shall select such tracts or portions thereof, where the principal growth is of either of such timbers, as in the judgment of the Secretary of the Navy may be necessary to furnish for the Navy a sufficient supply of the same. Such surveyors shall report to the President the tracts by them selected, with the boundaries ascertained and accurately designated by actual survey or water-courses. (R. S. 2459.)

Surveyors to explore and select timber lands to reserve for use of the Navy.

APPOINTMENT OF DEPUTY SURVEYORS.

Sec. 2223, U. S. Revised Statutes, provides that "Every surveyor-general shall engage a sufficient number of skillful surveyors as his deputies, to whom he is authorized to administer the necessary oaths upon their appointments. He shall have authority to frame regulations for their direction, not inconsistent with law or the instructions of the Gen-

eral Land Office, and to remove them for negligence or misconduct in office."

Each surveyor-general should exercise great care in the appointment of deputy surveyors, and should thoroughly satisfy himself, before making such appointments, that the applicants possess the proper theoretical and practical qualifications, as well as to their moral standing and fitness for the important trusts to be confided to them.

Commissions will be issued to deputy surveyors as follows:

FORM OF COMMISSION.

The United States of America.

To all whom these presents shall come, greeting:

Know ye, that, reposing special trust and confidence in the integrity, ability, and discretion of ——— ———, I do appoint him to be depnty surveyor of the United States for the district of ———, and do authorize and empower him to execute and fullfil the duties of that office according to law, and to hold the said office with all the rights and emoluments thereunto legally appertaining to him, the said ——— ———, during the pleasure of the surveyor-general of the United States for the district of ——— for the time being.

In testimony whereof I have hereunto affixed my signature.

Given under my hand at ———, the —— day of ———, 18—, in the year of our Lord one thousand eight hundred and ———, and of the independence of the United States of America the one hundred and ———.

———— ————,

United States Surveyor-General for ———.

The deputy surveyor will acknowledge in writing to the surveyor-general the receipt of such commission, stating in such letter that he accepts the same. He must also transmit, with such letter, his official oath, duly subscribed and sworn to, as follows:

Oath prescribed by act of Congress approved May 13, 1884, *to be taken by any person elected or appointed to any office of honor or profit either in the civil, military, or naval service of the United States (except the President of the United States):*

I, ——— ———, do solemnly ——— that I will support and defend the Constitution of the United States against all enemies, foreign and domestic; that I will bear true faith and allegiance to the same; that I take this obligation freely, without any mental reservation or purpose of evasion; and that I will well and faithfully discharge the duties of the office on which I am about to enter: So help me God.

———— ————.

Sworn to and subscribed before me this —— day of ———, A. D., 188—.

———— ————.

A full record of all commissions issued, together with letters of acceptance and official oaths, must be carefully filed in the office of the surveyor-general.

The deputy surveyor having been duly commissioned, and his letter of acceptance, oath of office, and official bond filed in the surveyor-general's office, contracts for surveys may then be entered into between the surveyor-general and such deputy surveyor, and all surveying contracts and bonds will be made out in the following form:

FORM OF CONTRACT.

This agreement, made this —— day of ———, 188—, between the surveyor-general of the United States for ———, acting for and in behalf of the United States, of the one part, and ——— ———, deputy surveyor, of the other part—

Witnesseth, That the said ——— ———, for and in consideration of the conditions, terms, provisions, and covenants hereinaftor expressed, and according to the true intent and meaning thereof, doth hereby covenant and agree with the said surveyor-general, in his capacity aforesaid, that —— the said ——— ———, in —— own proper

person–, with the assistance of such chain-men, ax-men, flag-bearers, and mound-men as may be necessary, in strict conformity with the laws of the United States, the printed manual of surveying instructions and other surveying instructions issued by the Commissioner of the General Land Office, and with such special instructions as he may receive from the said surveyor-general in conformity therewith (all of said instructions to be taken and deemed a part of this contract), will well, truly, and faithfully survey, mark, and establish —— —— and that —— will complete those surveys in the manner aforesaid, and return the true and original field-notes thereof to the office of the said surveyor-general on or before the —— day of —— next ensuing the date hereof, on penalty of forfeiture, and paying to the United States the sum mentioned in the annexed bond, if default be made in any of the foregoing conditions. And it is further expressly stipulated and made a condition of this contract that the surveys herein described shall not be commenced before the first day of the fiscal year ending the 30th day of June, 188—, or before the said —— —— shall have been officially notified by the said surveyor-general of the approval of this contract by the Commissioner of the General Land Office.

And the said surveyor-general, in his official capacity aforesaid, covenants and agrees with the said —— —— that on the completion of the surveys above named, in the manner aforesaid, there shall be paid to the said —— ——, by the Treasury Department of the United States, as a full compensation for all work performed under this agreement, at the rate of —— dollars for base, standard, meridian, and meander lines, —— dollars for township lines, and —— dollars for section lines, per mile, for every mile actually run and marked in the field, *random lines and offsets not included.*

It is further agreed by and between the parties to this agreement that no accounts shall be paid unless properly certified by the said surveyor-general (or by his successor in office) that the surveys are in accordance with the instructions herein referred to and the provisions of this agreement, and until approved plats and certified transcripts of field-notes of the surveys for which the accounts are rendered are filed in the General Land Office.

And it is further understood and agreed by and between the parties to this agreement that the said surveys will not be approved by the said surveyor-general (or by his successor in office) unless they shall be found to be in exact accordance with the instructions hereinbefore specified: *Provided, also,* That no member of [or delegate to] Congress or subcontractor shall be admitted to any share or part of this contract, or to any benefit to arise thereupon, and that no payment shall be made for any surveys not executed by the said deputy surveyor —— —— in his own proper person.

In testimony whereof the parties to these articles of agreement have hereunto set their hands and seals the day and year first above written.

Signed, sealed, and acknowledged before us:

Witnesses to surveyor-general's signature.

—— ——

Residence: ——

—— ——

Residence: ——

—— ——, [SEAL.]

United States Surveyor-General for ——.

Witnesses to deputy surveyor's signature.

—— ——

Residence: ——

—— ——

Residence: ——

—— ——, [SEAL.]

United States Deputy Surveyor.

FORM OF BOND.

Know all men by these presents, that we, —— —— of ——, as principal, and —— —— of ——, —— ——, of ——, —— —— of ——, and —— —— of ——, as sureties, are held and firmly bound unto the United States of America in the sum of —— dollars, lawful money of the United States, for which payment, well and truly to be made, we bind ourselves, our heirs, executors, and administrators, and each and every one of us and them, jointly and severally, firmly by these presents.

Signed with our hands and sealed with our seals this —— day of ——, 188—.

The condition of the above obligation is such, That if the above-bounden —— ——, deputy surveyor, shall well, truly, and faithfully, according to the laws of the United States, the printed manual of surveying instructions and other surveying instructions issued, or which may hereafter be issued, by the Commissioner of the General Land Office, and with such special instructions as he may receive from the

surveyor-general in conformity therewith, make and execute the surveys which are required of him to be made by the foregoing contract, and return the true field-notes of the said surveys to the surveyor-general in the manner and within the period named in the said contract, then this obligation to be void; or otherwise, it shall remain in full force and virtue.

Signed, sealed, and acknowledged before us:

——— ——— ——— ——— [L. S.]*
Residence: ——— ——— ——— [L. S.]
——— ——— ——— ——— [L. S.]
Residence: ——— ——— ——— [L. S.]
——— ——— [L. S.]

*Attach an adhesive seal after each signature and covering L. S.

Affidavits of sureties.

——— OF ———,
County of ———, *ss*:

I, ——— ———, one of the sureties on the official bond of ——— ——— as ——— do depose and say that I am worth, in unincumbered property, not exempt from execution under the laws of the ——— of ——— dollars and upward, after payment of my just debts and liabilities, as follows:

Real estate, valued at $ ———, and consisting of * ———.
Personal estate, valued at $ ———, and consisting of †———.
Signature: ——— ———
(Post-office address:) ——— ———.
Sworn to and subscribed before me this —— day of ———, 188—.
[SEAL.] ——— ———
——— ———

*Here state whether city property, improved or unimproved, or improved farms or unimproved lands, and where situated.
†Here describe the nature of the property; whether bonds, stocks, merchandise, etc.

——— OF ———,
County of ———, *ss*:

I, ——— ———, one of the sureties on the official bond of ——— ——— as ——— do depose and say that I am worth, in unincumbered property, not exempt from execution under the laws of the ——— of ——— dollars and upward, after payment of my just debts and liabilities, as follows:

Real estate, valued at $ ———, and consisting of * ———.
Personal estate, valued at $ ———, and consisting of † ———.
Signature: ——— ———
(Post-office address:) ——— ———.
Sworn to and subscribed before me this —— day of ———, 188—.
[SEAL.] ——— ———,
——— ———.

——— OF ———,
County of ———, *ss*:

I, ——— ———, do hereby certify that ——— ——— who administered the above oath, was, at the time of doing so, a ——— in and for said ———, duly qualified to act as such, and that I believe his signature as above written is genuine.

In testimony whereof I have hereto set my hand and affixed the seal of ——— this —— day of ———, one thousand eight hundred and ——.

——— ———,
——— ———.

Certificate.

I, ——— ———, hereby certify that in my opinion the sureties to the above bond are sufficient, and I hereby approve the same.

——— ———,
United States Surveyor-General for ———.

1. The names of the surveyor-general, deputy surveyor, sureties, and witnesses must be written in full, and the residence of witnesses written after their signatures.
2. A full description of the surveys embraced in the contract must be written in the blank space left for that purpose.
3. The date when the surveys can be commenced shall not be earlier than the commencement of the fiscal year for which the appropriation is made, except in cases where the appropriation is made immediately available.

4. The rates named in any contract must not exceed those fixed by law.
5. The signature of the surveyor-general and of the deputy surveyor must each be witnessed by two persons.
6. All erasures, mutilations, and interlineations must be avoided.
7. The bond must be dated the date it is signed by all the parties thereto, and its execution must be subsequent to the execution of the contract.
8. The names of all the parties executing the bond, and of the witnesses thereto, must be written in full.
9. The affidavits of sureties must be made before some officer (preferably an officer of the United States) duly authorized to administer oaths and having a seal.
10. The sufficiency of sureties must be certified to by the surveyor-general.
11. The amount of the boud must be *at least* double the estimated amount that will be due to the deputy surveyor upon the completion of the contract made under the same.
12. The *duplicate* and *triplicate* contracts and bonds will be forwarded to the General Land Office, and when approved the Commissioner will forward the *triplicate* to the First Comptroller of the Treasury.

SYSTEM OF RECTANGULAR SURVEYING.

1. The public lands of the United States are ordinarily surveyed into rectangular tracts, bounded by lines conforming to the cardinal points.

2. The public lands shall be laid off, in the first place, into bodies of land of 24 miles square, as near as may be. This shall be done by the extension of standard lines from the principal meridian every 24 miles, and by the extension, from the base and standard lines, of guide meridians every 24 miles. Thereafter they shall be laid off into bodies of land of 6 miles square, as near as may be, called *townships*, containing as near as may be 23,040 acres. The townships shall be subdivided into 36 tracts, called sections, each containing as near as may be 640 acres. Any number or series of contiguous townships, situate north or south of each other, constitute a *range*.

The law requires that the lines of the public surveys shall be governed by the true meridian, and that the townships shall be *six miles square*—two things involving in connection a mathematical impossibility—for, strictly to conform to the meridian, necessarily throws the township out of square, by reason of the convergency of meridians, and hence, by adhering to the true meridian, results the necessity of departing from the strict requirements of law as respects the precise area of townships and the subdivisional parts thereof, the townships assuming something of a trapezoidal form, which inequality develops itself more and more as such, the higher the latitude of the surveys. It is doubtless in view of these circumstances that the law provides (see section 2 of the act of May 18, 1796) that the sections of a mile square shall contain the quantity of 640 acres, *as nearly as may be;* and, moreover, provides (see section 3 of the act of May 10, 1800) in the following words: "And in all cases where the exterior lines of the townships, thus to be subdivided into sections or half sections, shall exceed, or shall not extend 6 miles, the excess or deficiency shall be specially noted, and added to or deducted from the western or northern ranges of sections or half sections in such township, according as the error may be in running the lines from east to west, or from south to north; the sections and half sections bounded on the northern and western lines of such townships shall be sold as containing only the quantity expressed in the returns and plats, respectively, and all others as containing the complete legal quantity."

The accompanying diagram, marked B, and the specimen field-notes pertaining to the same, will serve to illustrate the method of running

lines to form tracts of land 24 miles square, as well as the method of running out the exterior lines of townships, and the order and mode of subdividing townships will be found illustrated in the accompanying specimen field-notes conforming with the township diagram C. The method here presented is designed to insure as full a compliance with all the requirements, meaning, and intent of the surveying laws as, it believed, is practicable.

The section lines are surveyed from *south* to north on true meridians,* and from *east* to west, in order to throw the excesses or deficiencies in measurements on the north and west sides of the township, as required by law. In case where a township has been partially surveyed, and it is necessary to complete the survey of the same, or where the character of the land is such that the only north or west portions of the township can be surveyed, this rule can not be strictly adhered to, but, in such cases, must be departed from only so far as is absolutely necessary. It will also be necessary to depart from this rule where surveys close upon State or Territorial boundaries, or upon surveys extending from different meridians.

3. The townships are to bear numbers in respect to the base line, either north or south of it; and the tiers of townships called "ranges" will bear numbers in respect to the meridian line according to their relative position to it, either on the east or west.

4. The thirty-six sections into which a township is subdivided are numbered, commencing with number *one* at the *northeast* angle of the township, and proceeding west to number six, and thence proceeding east to number twelve, and so on, alternately, until the number thirty-six in the southeast angle. In all cases of surveys of fractional townships, the sections should bear the same numbers as they would if the township was full.

5. Standard parallels shall be established at intervals of every 24 miles, north and south of the base line, and guide meridians at intervals of every 24 miles, east and west of the principal meridian; the object being to confine the errors resulting from convergence of meridians, and inaccuracies in measurements, within the tracts of lands bounded by the lines so established.

6. The survey of all principal base and meridian, standard parallels, and guide meridian, and township lines must be made with an instrument operating independently of the magnetic needle. Burt's *improved solar compass*, or other instrument of equal utility, must be used of necessity in such cases; and it is deemed best that such instrument should be used under all circumstances. Where the needle can be relied on, however, the ordinary compass, if provided with a revolving compass box and variation arc, may be used in subdividing and meandering. Whenever deputies use instruments with magnetic apparatus only, they must test the accuracy of their work and the condition of their instruments by at least three observations upon a circumpolar star, upon different days, between the commencement and the close of surveying operations in any given township, and preferably at the southeast and southwest corners of the township and at or near the corner to sections 9, 10, 15 and 16. Deputies using instruments with solar apparatus are also required to make observations of the star Polaris at the *beginning* of every survey and they must examine the adjustments of their instruments and take the latitude† daily, weather

* See method of subdividing and remarks under the heading "Table III. Azimuths of the tangent to the parallel."

† Taking the latitude does not necessarily prove the correctness of adjustments.

permitting, in running base, standard, meridian, and range lines, and upon three different days during the execution of subdivisional surveys in each township. They must make complete records in their field-notes, under proper dates, of the making of *all observations* in compliance with these instructions, showing the style and condition of the instrument in use, and the angle formed, by comparing the line run with the meridian as by observation determined.

7. The construction and adjustments of all surveying instruments used in the surveying of the public lands of the United States must be tested at least once a year,* and oftener if necessary, by comparison with the true meridian, established under the direction of the surveyor-general of the district; and the instruments must be so modified in construction, or in such a way corrected, as may be necessary to produce the closest possible approximation to accuracy and uniformity in the operation of all such instruments. A record will be made of such examinations, showing the number and style of the instrument, name of the maker, the quantity of instrumental error discovered by comparison, in either solar or magnetic apparatus, or both, and means taken for correction. The surveyor-general will allow no surveys to be made until the instruments to be used therefor have been approved by him.

8. The township lines and the subdivision lines will usually be measured by a two-pole chain of 33 feet in length,† consisting of 50 links, and each link being seven and ninety-two hundredths of an inch long. On uniform and level ground, however, the four-pole chain may be used. The measurements will, however, always be represented according to the four-pole chain of 100 links. The deputy surveyor must provide himself with a measure of the standard chain kept at the office of the surveyor-general, to be used by him as a field standard. The chain in use must be compared and adjusted with this field standard each working day, and such field standard must be returned to the surveyor-general's office for examination when his work is completed.

OF TALLY PINS.

9. You will use eleven tally pins made of steel, not exceeding 14 inches in length, weighty enough toward the point to make them drop perpendicularly, and having a ring at the top, in which is to be fixed a piece of red cloth, or something else of conspicuous color, to make them readily seen when stuck in the ground.

PROCESS OF CHAINING.

10. In measuring lines with a two-pole chain, every *five* chains are called "a *tally;*" and in measuring lines with a four-pole chain, every *ten* chains are called "a *tally*," because at that distance the last of the ten tally pins with which the forward chainman sets out will have been stuck. He then cries "tally:" which cry is repeated by the other chainman, and each registers the distance by slipping a thimble, button, or ring of leather, or something of the kind, on a belt worn for that purpose, or by some other convenient method. The hind chainman then comes up, and having counted in the presence of his fellow the tally pins which he has taken up, so that both may be assured that none of the pins have been lost, he then takes the forward end of the chain, and proceeds to set the pins. Thus the chainmen alternately change places, each setting the pins that he has taken up, so that one is forward in all

* The adjustments should be *verified daily* when the instrument is in use.

† See R. S. 2395, sec. 99, par. 6 (page 11).

the odd, and the other in all the even tallies. Such procedure, it is believed, tends to insure accuracy in measurement, facilitates the recollection of the distances to objects on the line, and renders a mis-tally almost impossible.

LEVELING THE CHAIN AND PLUMBING THE PINS.

11. The length of every line you run is to be ascertained by precise horizontal measurement, as nearly approximating to an air line as is possible in practice on the earth's surface. This all-important object can only be attained by a rigid adherence to the three following observances:

(1) Ever keeping the chain *stretched* to its utmost degree of tension on even ground.

(2) On uneven ground, keeping the chain not only stretched as aforesaid, but horizontally *leveled.* And when ascending and descending steep ground, hills or mountains, the chain will have to be *shortened* to one-half its length (and sometimes more), in order accurately to obtain the true horizontal measure.

(3) The careful plumbing of the tally pins, so as to attain precisely *the spot* where they should be stuck. The more uneven the surface, the greater the caution needed to set the pins.

MARKING LINES.

12. All lines on which are to be established the legal corner boundaries are to be marked after this method, viz: Those trees which may intercept your line must have two chops or notches cut on each side of them without any other marks whatever. These are called "*sight trees*" or "*line trees.*" A sufficient number of other trees standing within 50 links of the line, on either side of it, are to be *blazed* on two sides diagonally or quartering toward the line, in order to render the line conspicuous, and readily to be traced, the blazes to be opposite each other, coinciding in direction with the line where the trees stand very near it, and to approach nearer each other the farther the line passes from the blazed trees. Due care must ever be taken to have the lines so well marked as to be readily followed, and to cut the blazes deep enough to leave recognizable scars as long as the trees stand.

Where trees 2 inches or more in diameter are found, the required blazes must not be omitted.

Bushes on or near the line should be bent at right angles therewith, and receive a blow of the ax at about the usual height of blazes from the ground sufficient to leave them in a bent position, but not to prevent their growth.

ON TRIAL, OR RANDOM LINES,

the trees are not to be blazed, unless occasionally, from indispensable necessity, and then it must be done so guardedly as to prevent the possibility of confounding the marks of the trial line with the *true.* But bushes and limbs of trees may be lopped, and *stakes set* on the trial or random line, at every *ten* chains, to enable the surveyor on his return to follow and correct the trial lines and establish therefrom the *true line.* To prevent confusion, the temporary stakes set on the trial or random lines must be *pulled up* when the surveyor returns to establish the true line.

INSUPERABLE OBJECTS ON LINE—WITNESS POINTS.

13. Under circumstances where your course is obstructed by impassable obstacles, such as ponds, swamps, marshes, lakes, rivers, creeks, &c., you will prolong the line across such obstacles by taking the necessary right angle offsets; or, if such be inconvenient, by a traverse or trigonometrical operation, until you regain the line on the opposite side. And in case a north and south, or a true east and west, line is regained in advance of any such obstacle, you will prolong and mark the line back to the obstacle so passed, and state all the particulars in relation thereto in your field-book. And at the intersection of lines with both margins of impassable obstacles, you will establish a *witness point* (for the purpose of perpetuating the intersections therewith), by setting a post, and giving in your field-book the course and distance therefrom to two trees on opposite sides of the line, each of which trees you will mark with a blaze and notch facing the post; but on the margins of navigable water-courses, or navigable lakes, you will mark the trees with the proper number of the fractional section, township, and range.

☞The best marking tools adapted to the purpose must be provided for marking neatly and *distinctly* all the letters and figures required to be made at corners, *arabic* figures being used exclusively; and the deputy is always to have at hand the necessary implements for keeping his marking irons in order.

ESTABLISHING CORNERS.

To procure the faithful execution of this portion of a surveyor's duty is a matter of the utmost importance. After a true coursing and most exact measurements the establishment of corners is the consummation of the work. If, therefore, the corner be not perpetuated in a permanent and workmanlike manner the *great aim* of the surveying service will not have been attained.

The following are the different points for perpetuating corners, viz:

1. For township boundaries, at intervals of every 6 miles.
2. For section boundaries, at intervals of every mile, or 80 chains.
3. For quarter-section boundaries, at intervals of every half mile, or 40 chains. Exceptions, however, occur as fully set forth hereafter in that portion of the manual showing the manner of running township lines and methods of subdividing.
4. Meander corners are established at all those points where the lines of the public surveys intersect the banks of such rivers, bayous, lakes, or islands as are by law directed to be meandered.

DESCRIPTION OF CORNERS.

The following is the form and language to be used by deputy surveyors in describing the establishment of corners in their field-notes, and their work in the field must strictly comply with the same.

STANDARD TOWNSHIP CORNERS.

SEC. 1. Set a — stone — × — × — ins. — ins. in the ground, for Standard Cor. to (e. g.) Tps. 5 N., R's 2 & 3 W., marked S. C., with 6 notches on N., E., & W. edges, dug pits 24 × 18 × 12 ins. crosswise on each line, N., E., & W. of stone 6 ft. dist. and raised a mound of earth, 2½ ft. high, 5 ft. base alongside.

Stone with Pits and Mound.

Stone with Mound of Stone.

SEC. 2. Set a — stone —×—×— ins. — ins. in the ground, for Standard Cor. to (e. g.) Tps. 5 N., R's 2 & 3 W., marked S. C., with 6 notches on N., E., & W. edges, and raised a mound of stone,* 1½ ft. high, 2 ft. base, alongside. Pits impracticable.

Stone with Bearing Trees.

SEC. 3. Set a — stone —×—×— ins. — ins. in the ground, for Standard Cor. to (e. g.) Tps. 5 N., R's 2 & 3 W., marked S. C., with 6 notches on N., E. & W. edges, from which

A—, — ins. diam., bears N.—° E.—lks., dist. marked T. 5 N., R. 2 W. S. 31, B. T.

A—, — ins. diam., bears N.—° W.—lks., dist. marked T. 5 N., R. 3 W. S. 36, B. T.

A—, — ins. diam., bears S.—° W.—lks., dist. marked † S. C. T. 5 N., R's 2 & 3 W., B. T.

Post in Mound.

SEC. 4. Set a post, 4½ ft. long, 4 ins. square, with marked stone (charred stake or quart of charcoal), 12 ins. in the ground, for Standard Cor. to (e. g.) Tps. 5 N., R's 2 & 3 W., marked

S. C. T. 5 N. on N.

R. 2 W. S. 31, on E. and

R. 3 W. S. 36 on W. faces, with 6 notches on N., E., & W. faces, dug pits, 24×18×12 ins. crosswise on each line, N., E., & W. of post, 6 ft. dist. and raised a mound of earth 2½ ft. high, 5 ft. base, around post.

Post with Bearing Trees

SEC. 5. Set a post, 4½ ft. long, 4 ins. square, 24 ins. in the ground for Standard Cor. to (e. g.) Tps. 5 N., R's 2 & 3 W. marked.

S. C. T. 5 N. on N.

R. 2 W. S. 31, on E. and

R. 3 W. S. 36 on W. faces, with 6 notches on N., E., & W. faces; from which

A—,—ins. diam., bears N.—° E.—lks., dist. marked T. 5 N., R. 2 W. S. 31, B. T.

A—,—ins. diam., bears N.—° W.—lks., dist. marked T. 5 N., R. 3 W. S. 36, B. T.

A—,—ins., diam. bears S.—° W.—lks., dist. marked † S. C. T. 5. N., R's 2 & 3 W., B. T.

Mound without Post or Stone.

SEC. 6. Deposited a marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for Standard Cor. to (e. g.) Tps. 5 N., R's 2 & 3 W., dug pits, 24×18×12 ins. crosswise on each line, N., E., & W. of cor., 6 ft. dist. and raised a mound of earth 2½ feet high, 5 ft. base, over it. In E. pit drove a stake 2 ins. square, 2 ft. long, 12 ins. in the ground, marked

S. C. T. 5 N. on N.

R. 2 W. S. 31 on E. and

R. 3 W. S. 36 on W. faces, with 6 notches on N., E., & W. faces.

Tree Corner without Bearing Trees.

SEC. 7. A—, — ins. diam., which I marked (e. g.) S. C. T. 5 N. on N.

R. 2 W. S. 31, on E. and

R. 3 W. S. 36 on W. sides, with 6 notches on N., E., & W. sides, dug pits 24×18×12 ins. crosswise on each line, N., E., & W. of tree 6 ft. dist. and raised a mound of earth around tree, for Standard Cor. to Tps. 5 N., R's 2 & 3 W.

Tree Corner with Bearing Trees.

SEC. 8. A—, — ins. diam., which I marked (e. g.) T. 5 N. S. C. on N.

R. 2 W. S. 31, on E. and

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* To consist of not less than *four* stones. *Mound* to be *at least* 1½ ft. high, with 2 ft. base.

† See "Miscellaneous," sec. 4, page 32.

R. 3 W. S. 36 on W. sides, with 6 notches on N., E., & W. sides, for Standard Cor. to Tps. 5 N., R's 2 & 3 W.; from which

A—, —ins. diam., bears N.—° E.— lks. dist. marked T. 5 N., R. 2 W. S. 31, B. T.

A—, —ins. diam., bears N.—° W.— lks. dist. marked T. 5 N., R. 3 W. S. 36, B. T.

A—, —ins. diam., bears S.—° W.— lks. dist. marked* S. C. T. 5 N., R's 2 & 3 W., B. T.

CLOSING TOWNSHIP CORNERS.

Stone with Pits and Mound.

SEC. 1. Set a — stone — × — × — ins. — ins. in the ground for Closing Cor. to (e. g.) Tps. 4 N., R's 2 & 3 W., marked C. C. with 6 notches on S. E. & W. edges, dug pits, 24×18×12 ins., crosswise on each line, S., E. & W. of stone. 6 ft. dist., and raised a mound of earth, 2½ ft. high, 5 ft. base alongside.

Stone with Mound of Stone.

SEC. 2. Set a — stone — × — × — ins. — ins. in the ground for Closing Cor. to (e. g.) Tps. 4 N., R's 2 & 3 W., marked C. C. with 6 notches on S., E. & W. edges, and raised a mound of stone 1½ ft. high, 2 ft. base, alongside. Pits impracticable.

Stone with Bearing Trees.

SEC. 3. Set a — stone — × — × — ins. — ins. in the ground for Closing Cor. to (e. g.) tps. 4 N., R's 2 & 3 W., marked C. C. with 6 notches on S., E., & W. edges; from which

A—, —ins. diam. bears S.—° E.—lks. dist. marked T. 4 N., R. 2 W. S. 6, B. T.

A—, —ins. diam. bears S.—° W.—lks. dist. marked T. 4 N., R. 3 W. S. 1, B. T.

A—, —ins. diam. bears N.—° W.— lks. dist. marked* C. C. T. 4 N., R's 2 & 3 W., B. T.

Post in Mound.

SEC. 4. Set a post, 4½ ft. long, 4 ins. square, with marked stone (charred stake or quart of charcoal) 12 ins. in the ground for Closing Cor. to (e. g.) Tps. 4 N., R's 2 & 3 W., marked

C. C. T. 4 N. on S.

R. 2 W. S. 6, on E. and

R. 3 W. S. 1 on W. faces, with 6 notches on S., E., & W. faces, dug pits 24 × 18 × 12 ins., crosswise on each line, S., E., & W. of post, 6 ft. dist., and raised a mound of earth 2½ ft. high, 5 ft. base, around post.

Post with Bearing Trees.

SEC. 5. Set a post, 4½ ft. long, 4 ins. square, 24 ins. in the ground, for Closing Cor. to (e. g.) Tps. 4 N., R's 2 & 3 W., marked

C. C. T. 4 N. on S.

R. 2 W. S. 6, on E. and

R. 3 W. S. 1 on W. faces, with 6 notches on S., E. & W. faces; from which

A—, —ins. diam. bears S.—° E.—lks. dist. marked T. 4 N., R. 2 W. S. 6, B. T.

A—, —ins. diam. bears S.—° W.—lks. dist. marked T. 4 N., R. 3 W. S. 1, B. T.

A—, —ins. diam., bears N.—° W.—lks. dist., marked* C. C. T. 4 N., R's 2 & 3 W., B. T.

Mound without Post or Stone.

SEC. 6. Deposited a marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for Closing Cor. to (e. g.) Tps. 4 N., R's 2 & 3 W., dug pits 24 × 18 × 12 ins. crosswise on each line, S., E., & W. of corner, 6 ft. dist., and raised a mound of earth 2½ ft. high, 5 ft. base, over it. In E pit drove a stake 2 ins. square, 2 ft. long, 12 ins. in the ground, marked

C. C. T. 4 N. on S.

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*See "Miscellaneous," sec. 4, page 32.

R. 2 W. S. 6, on E. and
R. 3 W. S. 1 on W. faces, with 6 notches on S., E. & W. faces.

Tree Corner without Bearing Trees.

SEC. 7. A—, —ins. diam., which I marked (e. g.) C. C. T. 4 N. on S.

R. 2 W. S. 6, on E. and
R. 3 W. S. 1 on W. sides, with 6 notches on S., E. & W. sides, dug pits 24 × 18 × 12 ins. crosswise on each line S. E. & W. of tree, 6 ft. dist., and raised a mound of earth around tree, for Closing Cor. to Tps. 4 N., R's 2 & 3 W.

Tree Corner with Bearing Trees.

SEC. 8. A—, —ins. diam., which I marked (e. g.) C. C. T. 4 N. on S.

R. 2 W. S. 6, on E. and
R. 3 W. S. 1 on W. sides, with 6 notches on S., E. & W. sides for Closing Cor. to Tps. 4 N., R's 2 & 3 W.; from which
A—, — ins. diam. bears S.—° E.—lks. dist., marked T. 4 N. R., 2 W. S. 6, B T.
A—, —ins. diam. bears S.—° W. — lks. dist., marked T. 4 N., R. 3 W. S. 1, B. T.
A—, —ins. diam. bears N.—° W. —lks. dist., marked* C. C. T. 4 N., R's 2 & 3 W., B. T.

SEC. 9. All Closing Township Corners must be connected with the nearest standard corner on the Standard Line.

STANDARD SECTION CORNERS.

Stone with Pits and Mound.

SEC. 1. Set a—stone—×—×—ins.,—ins. in the ground, for Standard Cor. to (e. g.) Secs. 35 & 36, marked S. C., with 1 notch on E. and 5 notches on W. edges, dug pits, 18×18×12 ins., N., E. & W. of stone 5½ ft. dist., and raised a mound of earth 2 ft. high, 4½ ft. base, alongside.

Stone with Mound of Stone.

SEC. 2. Set a—stone—×—×—ins.,—ins. in the ground, for Standard Cor. to (e. g.) Secs. 33 & 34, marked S. C., with 3 notches on E. & W. edges, and raised a mound of stone, ½ ft. high, 2 ft. base, alongside. Pits impracticable.

Stone with Bearing Trees.

SEC. 3. Set a—stone—×—×—ins.,—ins. in the ground, for Standard Cor. to (e. g.) Secs. 35 & 36, marked S. C., with 1 notch on E. and 5 notches on W. edges, from which
A—, —ins. diam. bears N.—° E.—lks. dist. marked T. 5 N., R. 3 W. S. 36, B. T.
A—, —ins. diam. bears N.—° W. — lks. dist. marked T. 5 N., R. 3 W. S. 35, B. T.
A—, —ins. diam. bears S. —° E. —lks. dist. marked* T. 5 N., R. 3 W. S. C. S. 35 & 36, B. T.

Post in Mound.

SEC. 4. Set a post 4 ft. long, 4 ins. square, with marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for Standard Cor. to (e. g.) Secs. 35 & 36, marked
S. C. T. 5 N., R. 3 W., on N.
S. 36 on E., and
S. 35 on W. faces, with 1 notch on E. and 5 notches on W. faces, dug pits 18×18×12 ins., N., E. and W. of post, 5½ ft. dist., and raised a mound of earth 2 ft. high, 4½ ft. base round post.

Post with Bearing Trees.

SEC. 5. Set a post 4 ft. long, 4 ins. square, 24 ins. in the ground, for Standard Cor. to (e. g.) Secs. 35 & 36, marked
S. C. T. 5 N., R. 3 W., on N.
S. 36, on E. and

* See "Miscellaneous," sec. 4, page 32.

S. 35 on W. faces, with 1 notch on E. and 5 notches on W. faces; from which

A—, — ins. diam. bears N.—° E. —lks. dist., marked T. 5 N., R. 3 W. S. 36, B. T.

A —, — ins. diam. bears N.—° W. — lks. dist. marked T. 5 N., R. 3 W. S. 35, B. T.

A—,—ins. diam. bears S.—° E. —lks. dist. marked* T. 5 N., R. 3 W. S. C. S. 35 & 36, B. T.

Mound without Post or Stone.

SEC. 6. Deposited a marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for Standard Cor. to (e. g.) Secs. 33 & 34, dug pits, 18×18×12 ins., N., E. and W. of corner, 5½ ft. dist., and raised a mound of earth 2 ft. high, 4¼ ft. base, over it. In E. pit drove a stake 2 ins. square, 2 ft. long, 12 ins. in the ground, marked

T. 5 N., R. 3 W., S. C. on N.

S. 34 on E. and

S. 33 on W. faces, with 3 notches on E. & W. faces.

Tree Corner without Bearing Trees.

SEC. 7. A —, — ins. diam., which I marked (e. g.) S. C. T. 5 N., R. 3 W., on N.

S. 36. on E. and

S. 35 on W. sides, with one notch on E. and 5 notches on W. sides, dug pits, 18×18×12 ins. N., E. & W. of tree, 5½ ft. dist. and raised a mound of earth around tree, for Standard Cor. to Secs. 35 & 36.

Tree Corner with Bearing Trees.

SEC. 8. A, —, — ins. diam., which I marked (e. g.) S. C. T. 5 N., R. 3 W., on N.

S. 36, on E. and

S. 35 on W. sides, with 1 notch on E. and 5 notches on W. sides, for Standard Cor. to Secs. 35 & 36; from which

A —, — ins. diam. bears N. —° E. — lks. dist. marked T. 5 N., R. 3 W., S. 36, B. T.

A —, — ins. diam. bears N. —° W. — lks. dist. marked T. 5 N., R. 3 W., S. 35, B. T.

A —, —ins. diam. bears S. —° E. — lks. dist. marked* T. 5 N., R. 3 W., S. C. S. 35 & 36, B. T.

CLOSING SECTION CORNERS.

Stone with Pits and Mound.

SEC. 1. Set a — stone — × — × — ins., — ins. in the ground, for Closing Cor. to (e. g.) Secs. 1 & 2, marked C. C., with 1 notch on E. and 5 notches on W. edges, dug pits, 18×18×12 ins. S., E. & W. of stone, 5½ feet dist., and raised a mound of earth 2 ft. high, 4½ ft. base alongside.

Stone with Mound of Stone.

SEC. 2. Set a — stone — × — × — ins., — ins. in the ground, for Closing Cor. to (e. g.) Secs. 3 & 4, marked C. C., with 3 notches on E. and W. edges, and raised a mound of stone 1½ ft. high, 2 ft. base, alongside Pits impracticable.

Stone with Bearing Trees.

SEC. 3. Set a — stone — × — × — ins., — ins. in the ground, for Closing Cor. to (e. g.) Secs. 1 & 2, marked C. C., with 1 notch on E. and 5 notches on W. edges; from which

A —, — ins. diam., bears S. —° E. — lks. dist. marked T. 4 N., R. 3 W., S. 1 B. T.

A —, — ins. diam., bears S. —° W. — lks. dist. marked T. 4 N., R. 3 W., S. 2 B. T.

A —, — ins. diam., bears N. —° E. — lks. dist. marked* T. 4 N., R. 3 W., C. C. S. 1 & 2 B. T.

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* See "Miscellaneous," sec. 4, page 32.

Post in Mound.

SEC. 4. Set a post 4 ft. long, 4 ins. square, with marked stone (charred stake or quart of charcoal) 12 ins. in the ground for Closing Cor. to (e. g.) Secs. 1 & 2, marked

C. C. T. 4 N., R. 3 W., on S.

S. 1 on E., and

S. 2 on W. faces, with 1 notch on E. and 5 notches on W. faces, dug pits 18×18×12 ins., S., E. & W. of post 5½ ft. dist., and raised a mound of earth 2 ft. high, 4½ ft. base around post.

Post with Bearing Trees.

SEC. 5. Set a post 4 ft. long, 4 ins. square, 24 ins. in the ground, for Closing Cor. to (e. g.) Secs. 1 & 2, marked

C. C. T. 4 N., R. 3 W., on S.

S. 1 on E. and

S. 2 on W. faces, with 1 notch on E and 5 notches on W. faces; from which

A —, — ins. diam., bears S. —° E. — lks. dist. marked T. 4 N., R. 3 W., S. 1, B. T.

A —, — ins. diam., bears S. —° W. — lks. dist. marked T. 4 N., R. 3 W., S. 2, B. T.

A —, — ins. diam., bears N. —° E. — lks. dist. marked* T. 4 N., R. 3 W., C. C. S. 1 & 2, B. T.

Mound without Post or Stone.

SEC. 6. Deposited a marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for Closing Cor. to (e. g.) Secs. 3 & 4, dug pits, 18×18×12 ins., S., E. & W. of Cor. 5½ ft. dist., and raised a mound of earth 2 ft. high, 4½ ft. base, over it. In E. pit drove a stake, 2 ins. square, 2 ft. long, 12 ins. in the ground, marked

C. C. T. 4 N., R. 3 W., on S.

S. 3 on E., and

S. 4 on W. faces, with 3 notches on E. & W. faces.

Tree Corner without Bearing Trees.

SEC. 7. A —, — ins. diam., which I marked (e. g.) C. C. T. 4 N., R. 3 W., on S.

S. 1, on E., and

S. 2 on W. sides, with 1 notch on E. and 5 notches on W. sides, dug pits 18×18×12 ins. S., E. & W. of tree, 5½ ft. dist., and raised a mound of earth around tree, for closing Cor. to Secs. 1 & 2.

Tree Corner with Bearing Trees.

SEC. 8. A —, — ins. diam., which I marked (e. g.) C. C. T. 4 N., R. 3 W., on S.

S. 1, on E., and

S. 2 on W. sides, with one notch on E. and 5 notches on W. sides for Closing Cor. to Secs. 1 & 2; from which

A —, — ins. diam., bears S. —° E. — lks. dist. marked T. 4 N., R. 3 W., S. 1, B. T.

A —, — ins. diam., bears S. —° W. — lks. dist. marked T. 4 N., R. 3 W., S. 2, B. T.

A —, — ins. diam., bears N. —° E. — lks. dist. marked* T. 4 N., R. 3 W., C. C. S. 1 & 2, B. T.

Connection Lines.

SEC. 9. All Section Closing Corners must be connected with the nearest standard corner on the Standard line.

CORNERS COMMON TO FOUR TOWNSHIPS.

Stone with Pits and Mound.

SEC. 1. Set a — stone —×—×— ins., — ins. in the ground for Cor. to (e. g.) Tps. 2 & 3 N., R's 2 & 3 W., marked with 6 notches on each edge, dug pits, 24×18×12 ins. lengthwise on each line, N., S., E. & W. of stone, 6 ft. dist., and raised a mound of earth 2½ ft. high, 5 ft. base alongside.

* See "Miscellaneous," sec. 4, page 32.

SEC. 2. Set a — stone —×—×— ins., — ins. in the ground, for Cor. to (e. g.) Tps. 2 & 3 N., R's 2 & 3 W. marked with 6 notches on each edge, and raised a mound of stone 1½ ft. high, 2 ft. base, alongside. Pits impracticable. Stone with Mound of Stone.

SEC. 3. Set a — stone — ×—×— ins., — ins. in the ground, for Cor. to (e. g.) Tps. 2 & 3 N. R. 2 & 3. W. marked with 6 notches on each edge; from which Stone with Bearing Trees.

A —, — ins., diam., bears N. —° E. — lks. dist. marked T. 3 N., R. 2 W., S. 31, B. T.

A —, — ins. diam., bears S. —° E. — lks. dist. marked T. 2 N., R. 2 W., S. 6, B. T.

A —, — ins. diam., bears S. —° W. — lks. dist. marked T. 2 N., R. 3 W., S. 1, B. T.

A —, — ins. diam., bears N. —° W. — lks. dist. marked T. 3 N., R. 3 W., S. 36, B. T.

SEC. 4. Set a post, 4½ ft. long 4 ins. square, with marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for Cor. to (e. g.) Tps. 2 & 3 N., R's 2 & 3 W., marked Post in Mound.

T. 3 N., S. 31, on N. E.

R. 2 W., S. 6, on S. E.

T. 2 N., S. 1, on S. W. and

R. 3 W., S. 36 on N. W. faces, with 6 notches on each edge, dug pits, 24×18×12 ins., lengthwise on each line, N., S., E., & W. of post, 6 ft. dist., and raised a mound of earth 2½ ft. high, 5 ft. base around post.

SEC. 5. Set a post 4½ ft. long, 4 ins. square, 24 ins. in the ground, for Cor. to (e. g.) Tps., 2 & 3 N., R's 2 & 3 W., marked Post with Bearing Trees.

T. 3 N. S. 31, on N. E.

R. 2 W. S. 6, on S. E.

T. 2 N. S. 1, on S. W. and

R. 3 W. S. 36 on N. W. faces, with 6 notches on each edge; from which

A —, — ins. diam., bears N. —° E. — lks. dist. marked T. 3 N., R. 2 W. S. 31, B. T.

A —, — ins. diam., bears S. —° E. — lks. dist. marked T. 2 N., R. 2 W. S. 6, B. T.

A —, — ins. diam., bears S. —° W. — lks. dist. marked T. 2 N., R. 3 W. S. 1, B. T.

A —, — ins. diam., bears N. —° W. — lks. dist. marked T. 3 N., R. 3 W. S. 36, B. T.

SEC. 6. Deposited a marked stone (charred stake or quart of charcoal) 12 ins. in the ground for Cor. to (e. g.) Tps. 2 & 3 N., R's 2 & 3 W., dug pits, 24×18×12 ins., lengthwise on each line, N., S., E., & W. of Cor., 6 ft. dist., and raised a mound of earth 2½ ft. high, 5 ft. base over it. In E. pit drove a stake 2 ins. square, 2 ft. long, 12 ins. in the ground, marked Mound without Post or Stone.

T. 3 N. S. 31, on N. E.

R. 2 W. S. 6, on S. E.

T. 2 N. S. 1, on S. W. and

R. 3 W. S. 36, on N. W. faces, with 6 notches on each edge.

SEC. 7. A —, — ins. diam., which I marked (e. g.) T. 3 N. S. 31, on N. E. Tree Corner without Bearing Trees.

R. 2 W. S. 6, on S. E.

T. 2 N. S. 1, on S. W. and

R. 3 W. S. 36 on N. W. sides, with 6 notches facing each cardinal point, dug pits, 24×18×12 ins. lengthwise on each line, N., S., E., &

W. of tree, 6 ft. dist., and raised a mound of earth around tree, for Cor. to Tps. 2 & 3 N., R's 2 & 3 W.

Tree Corner with Bearing Trees.

SEC. 8. A —, — ins diam., which I marked (e. g.) T. 3. N. S. 31, on N. E.

R. 2 W. S. 6, on S. E.

T. 2 N. S. 1, on S. W. and

R. 3 W. S. 36, on N. W. sides, with 6 notches facing each cardinal point, for Cor. to Tps. 2 & 3 N., R's 2 & 3 W., from which

A —, — ins. diam., bears N. —° E. — lks. dist. marked T. 3 N., R. 2 W. S. 31, B. T.

A. —, — ins. diam., bears S. —° E. — lks. dist. marked T. 2 N., R. 2 W. S. 6, B. T.

A. —, — ins. diam., bears S. —° W. — lks. dist. marked T. 2 N., R. 3 W. S. 1, B. T.

A. —. — ins. diam., bears N. —° W. — lks. dist. marked T. 3 N., R. 3 W. S. 36, B. T.

CORNERS COMMON TO FOUR SECTIONS.

Stone with Pits and Mound.

SEC. 1. Set a — stone —×—×— ins. — ins. in the ground for Cor. to (e. g.) Secs. 25, 26, 35, & 36, marked with 1 notch on S. & E. edges, dug pits, 18×18×12 ins. in each Sec., 5½ ft. dist., and raised a mound of earth 2 ft. high, 4½ ft. base alongside.

Stone with Mound of Stone.

SEC. 2. Set a — stone —×—×— ins. — ins. in the ground, for Cor. to (e. g.) Secs. 14, 15, 22, & 23, marked with 3 notches on S. and 2 notches on E. edges, and raised a mound of stone 1½ ft. high, 2 ft. base, alongside. Pits impracticable.

Stone with Bearing Trees.

SEC. 3. Set a — stone —×—×— ins. — ins. in the ground, for Cor. to (e. g.) Secs. 9, 10, 15, & 16, marked with 4 notches on S. & 3 notches on E. edges, from which

A —, — ins. diam., bears N. —° E. — lks. dist. marked T. 2 N., R. 2 W. S. 10, B. T.

A —, — ins. diam., bears S. —° E. — lks. dist. marked T. 2 N., R. 2 W. S. 15, B. T.

A —, — ins. diam., bears S. —° W.— lks. dist. marked T. 2 N., R. 2 W. S. 16, B. T.

A —, — ins. diam., bears N. —° W.— lks. dist. marked T. 2 N., R. 2 W. S. 9, B. T.

Post in Mound.

SEC. 4. Set a post 4 ft. long, 4 ins. square, with marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for Cor. to (e. g.) Secs, 15, 16, 21, & 22, marked

T. 2 N. S. 15, on N. E.

R. 2 W. S. 22, on S. E.

S. 21, on S. W. and

S. 16 on N. W. faces, with 3 notches on S. & E. edges, dug pits, 18×18×12 ins. in each Sec., 5½ ft. dist., and raised a mound of earth 2 ft. high, 4½ ft. base around post.

Post with Bearing Trees.

SEC. 5. Set a post 4 ft. long, 4 ins. square, 24 ins. in the ground, for Cor. to (e. g.) Secs. 25, 26, 35, & 36, marked

T. 2 N. S. 25, on N. E.

R. 2 W. S. 36, on S. E.

S. 35, on S. W. and

S. 26, on N. W. faces, with 1 notch on S. & E. edges; from which

A —, — ins. diam., bears N. —° E. — lks. dist. marked T. 2 N., R. 2 W. S. 25, B. T.

A —, — ins. diam., bears S. —° E. — lks. dist. marked T. 2 N., R. 2 W. S. 36, B. T.

A —, — ins. diam., bears S. —° W. — lks. dist. marked T. 2 N., R. 2 W. S. 35, B. T.

A —, — ins. diam., bears N. —° W. — lks. dist. marked T. 2 N., R. 2 W. S. 26, B. T.

SEC. 6. Deposited a marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for Cor. to (e. g.) Secs. 25, 26, 35, & 36, dug pits, 18×18×12 ins. in each Sec., 5½ ft. dist., and raised a mound of earth 2 ft. high, 4½ ft. base over it. Mound without Post or Stone.

In S. E. pit drove a stake 2 ins. square, 2 ft. long, 12 ins. in the ground, marked

T. 2 N. S. 25, on N. E.

R. 2 W. S. 36, on S. E.

S. 35, on S. W. and

S. 26, on N. W. faces, with 1 notch on S. & E. edges.

SEC. 7. A —, — ins. diam., which I marked (e. g.) T. 2 N. S. 29, on N. E. Tree Corner without Bearing Trees.

R. 2 W. S. 32, on S. E.

S. 31, on S. W. and

S. 30, on N. W. sides, with 1 notch on S. and 5 notches on E. sides, dug pits, 18×18×12 ins. in each sec. 5½ ft. dist. and raised a mound of earth around tree, for Cor. to Secs. 29, 30, 31, & 32.

SEC. 8. A—, — ins. diam., which I marked (e. g.) T. 2 N. S. 5, on N. E. Tree Corner with Bearing Trees.

R. 2 W. S. 8, on S. E.

S. 7, on S. W. and

S. 6, on N. W. sides, with 5 notches on S. & E. sides, for Cor. to Secs. 5, 6, 7 & 8; from which

A—, — ins. diam., bears N. —° E. — lks. dist. marked T. 2 N., R. 2 W. S. 5, B. T.

A—, — ins. diam., bears S. —° E. — lks. dist. marked T. 2 N., R. 2 W. S. 8, B. T.

A—, — ins. diam., bears S. —° W. — lks. dist. marked T. 2 N., R. 2 W. S. 7, B. T.

A—, — ins. diam., bears N. —° W. — lks. dist. marked T. 2 N., R. 2 W. S. 6, B. T.

ARTICLE X.

QUARTER SECTION CORNERS.

SEC. 1. Set a — stone —×—×— ins., —ins. in the ground, for ¼ Sec. Cor., marked ¼ on N. (or W.) face, dug pits, 18×18×12 ins., N. & S. (or E. & W.) of stone 5½ ft. dist., and raised a mound of earth 1½ ft. high, 3½ ft. base alongside. Stone with Pits and Mounds.

SEC. 2. Set a — stone — × — × — ins., — ins. in the ground, for ¼ Sec. Cor., marked ¼ on N. (or W.) face, and raised a mound of stone 1½ ft. high, 2 ft. base, alongside. Pits impracticable. Stone with Mound of Stone.

SEC. 3. Set a — stone — × — × — ins., — ins. in the ground, for ¼ Sec. Cor., marked ¼ on N. (or W.) face; from which Stone with Bearing Trees.

A—, — ins. diam., bears N. —° E. — lks. dist. marked ¼ S. B. T.

A—, — ins. diam., bears S. —° W. — lks. dist. marked ¼ S. B. T.

SEC. 4. Set a post 3 ft. long, 3 ins. square, with marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for ¼ Sec. Cor., marked ¼ S. on N. (or W.) face, dug pits, 18×18×12 ins., N. & S. (or E. and W.) of post 5½ ft. dist., and raised a mound of earth 1½ ft. high, 3½ ft. base around post. Post in Mound.

Post with Bearing Trees.

SEC. 5. Set a post 3 ft. long, 3 ins. square, 24 ins. in the ground, for ¼ Sec. Cor., marked ¼ S. on N. (or W.) face; from which

A—, —ins. diam., bears N. —° E. — lks., dist. marked ¼ S. B. T.

A—, — ins. diam., bears S. —° W. — lks. dist. marked ¼ S. B. T.

Mound without Post or Stone.

SEC. 6. Deposited a marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for ¼ Sec. Cor., dug pits, 18×18×12 ins., N. & S. (or E. & W.) of corner 5½ ft. dist. and raised a mound of earth 1½ ft high, 3½ ft. base over it. In E. (or N.) pit drove a stake 2 ft. long, 2 ins. square, 12 ins. in the ground, marked ¼ S. on N. (or W.) face.

Tree Corner without Bearing Trees.

SEC. 7. A—, — ins. diam., which I marked ¼ S. on N. (or W.) side, for ¼ Sec. Cor., dug pits, 18×18×12 ins. N. & S. (or E. & W.) of tree, 5½ ft. dist. and raised a mound of earth around tree.

Tree Corner with Bearing Trees.

SEC. 8. A—, — ins. diam., which I marked ¼ S. on N. (or W.) side, for ¼ Sec. Cor.; from which

A —, — ins. diam., bears N. —° E. — lks. dist. marked ¼ S. B. T.

A —, — ins. diam., bears S. —° W. — lks. dist. marked ¼ S. B. T.

Marks.

SEC. 9. On N. and S. lines the marks must be made on W. side, and on E. and W. lines on N. side of the stone, post, or tree.

Pits.

SEC. 10. On N. & S. lines the pits must be dug N. & S. of Cor., and on E. & W. lines E. & W. of Cor.

Stakes in Pits.

SEC. 11. On N. & S. lines the stakes must be driven in N. pit, and on E. & W. lines in E. pit.

STANDARD QUARTER SECTION CORNERS.

All Quarter Section Corners on Standard lines must be established in all respects like other Quarter Section Corners, with the addition of the letters S. C., and if bearing trees are established for such Corners, each tree must be marked S. C. ¼ S. B. T.

MEANDER CORNERS.

Stone with Pits and Mound.

SEC. 1. Set a — stone —×—×— ins., — ins. in the ground for Meander Cor. to (e. g.) Fractional Secs. 1 & 2, marked M. C. on — face, dug a pit 3 ft. square, 1 ft. deep, 8 lks.— of stone, and raised a mound of earth 2 ft. high, 4½ ft. base alongside.

Stone with Mound of Stone.

SEC. 2. Set a—stone—×—×—ins.,—ins. in the ground, for Meander Cor. to (e. g.) Fractional Secs. 35 & 36, marked M. C. on — face, and raised a mound of stone 1½ ft. high, 2 ft. base, alongside. Pits impracticable.

Stone with Bearing Trees.

SEC. 3. Set a—stone—×—×—ins.,—ins. in the ground, for Meander Cor. to (e. g.) Fractional Secs. 9 & 10, marked M. C. on — face; from which

A—, —ins. diam., bears S. —° E.— lks. dist. marked T. 2 N., R. 2 W. S. 10, M. C. B. T.

A—, —ins. diam., bears S. —° W.— lks. dist. marked T. 2 N. R. 2 W. S. 9, M. C. B. T.

Post in Mound.

SEC. 4. Set a post 4 ft. long, 4 ins. square, with marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for Meander Cor. to (e. g.) Fractional Secs. 35 & 36, marked M. C. on — face, with

T. 2 N. on N.

R. 2 W. S. 36, on E. and

S. 35 on W. faces, dug a pit 3 ft. square, 1 ft. deep, 8 lks.—of post, and raised a mound of earth 2 ft. high, 4½ ft. base, around post.

SEC. 5. Set a post 4 ft. long, 4 ins. square, 24 ins. in the ground, for Meander Cor. to (e. g.) Fractional Secs. 20 & 21, marked M. C. on—face, with Post with Bearing Trees.

T. 2 N. on S.
R. 2 W. S 21 on E. and
S. 20 on W. faces; from which

A—, —ins. diam., bears S. —° E.—lks. dist. marked T. 2 N., R. 2 W. S. 21, M. C. B. T.

A—, —ins. diam., bears S.—° W.—lks. dist. marked T. 2 N., R. 2 W. S. 20, M. C. B. T.

SEC. 6. Deposited a marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for Meander Cor. to (e. g.) Fractional Secs. 11 & 12, dug a pit, 3 ft. square, 1 ft. deep, 8 lks. — of Cor., and raised a mound of earth 2 ft. high, 4½ ft. base, over it. In pit drove a stake 2 ins. square, 2 ft. long, 12 ins. in the ground, marked M. C. on — face, with Mound without Post or Stone.

T. 2 N. on S.
R. 2 W. S. 12 on E. and
S. 11 on W. faces.

SEC. 7. A —, — ins. diam., which I marked (e. g.) M. C. on — side, with Tree Corner without Bearing Trees.

T. 2 N. on W.
R. 2 W. S. 13 on N. and
S. 24 on S. sides, for Meander Cor. to Fractional Secs. 13 & 24.

SEC. 8. A—, — ins. diam., which I marked (e. g.) M. C. on — side, with Tree Corner with Bearing Trees.

T. 2 N. on E.
R. 2 W. S. 6 on N. and
S. 7 on S. sides, for Meander Cor. to Fractional Secs. 6 & 7; from which

A —, — ins. diam. bears N. — ° W. — lks. dist. marked T. 2 N., R. 2 W. S. 6, M. C. B. T.

A —, — ins. diam. bears S. — ° W. — lks. dist., marked T. 2 N., R. 2 W. S. 7, M. C. B. T.

SEC. 9. When a pit is dug at a Meander Cor. it must be 8 lks. from the Cor., on the side opposite the river or lake meandered. Pits.

SEC. 10. The letters "M. C." for Meander Corner must be marked on the side facing the river or lake meandered. Marks.

WITNESS CORNERS.

A Witness Corner must bear the same marks that would be placed upon the Corner for which it is a witness, with the addition of the letters W. C., and be established in all respects like such Corner.

If bearing trees are established for a Witness Corner, each tree must be marked W. C., in addition to the usual marks.

MISCELLANEOUS.

SEC. 1. When a rock in place is established for a Corner, its dimensions above ground must be given, and a cross (×) marked at exact Corner point. In other respects the form for stone corners will be used. Rock in Place.

SEC. 2. Where mounds of earth are raised "alongside" of Corners, on N. and S. lines, they must be placed on the W. and on E. and W. lines on the N. side of Corner. In case the Mounds of Earth.

character of the land is such that this can not be done, the deputy will state in his notes instead of "alongside," "S" (or E.).

Mounds of Stone.

SEC. 3. In case where pits are practicable the deputy prefers raising a mound of stone, or stone covered with earth,* as more likely to perpetuate the Corner, he will use the form given for mound of stone, omitting the words "pits impracticable," and adding "covered with earth," when so established. (See foot-note, p. 22.)

Bearing Trees.

SEC. 4. Where the requisite number of trees can be found within 300 links of the Corner point, three (3) bearing trees should be established for every Standard or Closing Cor., four (4) for every Cor. common to (four) Townships or Sections, and two (2) for every Quarter Sec. Cor. or Meander Cor. When a bearing tree is located on the side of a Base Line or Standard Parallel *opposite* the township to which the corner it witnesses belongs, it will be marked with the township and ranges, (if a *township* corner), and, (if a *section* corner), with the township, range, and sections *to which it belongs*, and with the letters S. C. (for Stand Cor.), or C. C. (for Closing Cor.), as the case may require. The number of the Section *in which the tree stands* will be omitted. See "Description of Corners." In case the requisite number of trees can not be found within limits, the deputy must state in his field notes after describing those established, "no other trees within limits," and "dug pits in Secs.— & —," or "raised a mound of stone alongside." The bearing trees, being the most important adjuncts of the corners, their *exact* bearings from the true meridian must be taken with the *instrument used in running the lines of survey*, and the distance should be measured *from* the center of the tree *to* the center of the corner. The height of the *top* of all blazes and markings on trees must be limited to *two and one-half feet above the ground.*

Stones.

SEC. 5. Stones 18 ins. and less long must be set two-thirds, and over 18 ins. long, three-fourths, of their length in the ground. No stones containing less than 504 cubic inches must be used for corners.

Objects to be Noted.

SEC. 6. Particular attention is called to the "Summary of objects and data required to be noted," on pages 44 and 45 of these instructions, and it is expected that the deputy will thoroughly comply with same in his work and field notes.

Lines Discontinued at Legal Corners.

SEC. 7. No mountains or lands not classed as surveyable are to be meandered, and all lines approaching such lands must be discontinued at the section or quarter-section corner.

Fractional Townships.

SEC. 8. Where by reason of impassable objects the south boundary of a township can not be established, an auxiliary base-line should be run through the township, first random, then corrected, from one range line to the other, connecting corresponding corners, and as far south as possible, and from such line the section lines will be extended northwardly in the usual manner, and any fraction *south* of said line may be surveyed in the opposite direction from the Section Corners on the auxiliary base thus established.

Boundaries.

SEC. 9. When no part of the east or west boundaries can be run, both the north and south boundaries will be established as true lines.

Convergency.

SEC. 10. Allowance for the convergency of meridians must be made whenever necessary.

Red Chalk.

SEC. 11. All letters and figures cut in posts or trees must be marked over with red chalk to make them still more plain and durable.

* For mound of *stone* "covered with earth," the height and base will be the same as for mound of *earth*.

SEC. 12. Township corners common to four townships, and section corners common to four sections, are to be set diagonally in the earth, with the angles in the direction of the lines. All other corners are to be set square, with the sides facing the direction of the lines. Mode of Setting Corners.

SEC. 13. The sizes of wooden posts, mounds, and pits noted in foregoing descriptions of corners are to be regarded as *minimum*, and whenever practicable to increase their dimensions it is desirable to do so. Size of Posts, etc.

SEC. 14. In establishing corners, stones should be used wherever practicable; then, posts; and lastly, mounds, with stake in pit. Corner Materials.

SEC. 15. It is expected that the deputy surveyors will carefully read and familiarize themselves with these instructions and all others contained in this volume, and will instruct their assistants as to their duties before commencing work. Extra copies will be furnished the deputies for the use of their assistants. Examine Instructions.

MEANDERING.

SEC. 1. Proceeding *down* stream, the bank on the *left* hand is termed the "left bank," and that on the *right* hand the "right bank." These terms are to be universally used to distinguish the two banks of a river or stream.

SEC. 2. Both banks of *navigable* rivers, as well as of all rivers not embraced in the class denominated as "navigable," the right-angle width of which is *three chains* and upwards, will be meandered on *both* banks by taking the general courses and distances of their sinuosities, and the same are to be entered in the field-book. Rivers not classed as navigable will not be meandered above the point where the average right-angle width is less than three chains.

At those points where either the township or section lines intersect the banks of a navigable stream, or any meanderable line, corners are to be established at the time of running these lines. These are called "meander corners;" and in meandering you are to commence at one of those corners, coursing the banks or boundary line, and measuring the distance of each course from your commencing corner to the next "meander corner." By the same method you are to meander the opposite bank of the same river.

The crossing distance *between* the MEANDER CORNERS on same line and the true bearing and distance between opposite meander corners is to be ascertained by triangulation or direct measurement, in order that the river may be protracted with entire accuracy. The particulars to be given in the field-notes.

The subdividing deputies will be required to establish meander corners on both banks of such meanderable streams at the intersection of all section lines, and the distances across the river, determined as above directed, will be noted in the field-book.

In meandering water-courses, where a distance is more than *ten chains* between stations, whole chains only should be taken; but if the distance is *less* than ten chains, and it is found convenient to employ chains and links, the number of links should be a multiple of ten, thereby saving time and labor in testing the closings both in the field and in the surveyor-general's office.

SEC. 3. You are also to meander, in manner aforesaid, all *lakes*, and deep ponds of the area of twenty-five acres and upwards; also naviga-

ble bayous; *shallow* ponds, readily to be drained, or likely to dry up, are not to be meandered.

In meandering lakes, bayous, or ponds you are to commence at a meander corner, and proceed as above directed for meandering the banks of navigable streams; and from said corner take the courses and distances of the entire margin of the same, noting the intersections with all meander corners established thereon.

You will notice all streams of water falling into the river, lake, or bayou you are surveying, stating the width of the same at their mouth; also all springs, noting the size thereof and depth, and whether the water be pure or mineral; also the head and mouth of all bayous; and all islands, rapids, and bars are to be noticed, with intersections to their upper and lower points to establish their exact situation. You will also note the elevation of the banks of rivers and streams, the heights of falls and cascades, and the length of rapids.

To meander a lake or deep pond lying entirely within the boundaries of a section, you will run and measure *two* lines thereunto from the nearest section or quarter-section corner on *opposite* sides of such pond, giving the courses of such lines. At *each* of the points where such lines shall intersect the margin of such pond or lake you will establish a meander corner as above directed. (See "Meander corners.")

The relative position of these points being thus definitely fixed in the section, the meandering will commence at one of them, and be continued to the other, noting the intersection, and thence to the beginning. The proceedings are to be fully entered in the field-book.

SEC. 4. Meander lines should not be established at the segregation line between dry and swamp or overflowed land, but at the ordinary low-water mark of the actual margin of the rivers or lakes on which such swamp or overflowed lands border. In cases where such meander lines were formerly established at the segregation line between dry and swamp or overflowed lands, new and proper meander lines may be established under the direction of the surveyor-general, and the township and section lines extended over such swamp or overflowed lands and the corners established, as hereinbefore provided, in order that the plats and field notes of surveys may show the actual facts in the case.

5. The precise relative position of islands, in a township made fractional by the river in which the same are situated, is to be determined trigonometrically; sighting to a flag or other fixed object on the island, from a special and carefully measured base line, connected with the surveyed lines, on or near the river bank, you are to form connection between the meander corners on the river to points corresponding thereto, in direct line, on the bank of the island, and there establish the proper meander corners, and calculate the distance across.

6. In taking the connection of an island with the main land, when there is no meander corner in line, opposite thereto, to sight from, you will measure a special base from the most convenient meander corner, and from such base you will triangulate to some fixed point on the shore of the island, ascertain the distance across, and there establish a *special* meander corner, wherefrom you will commence to meander the island.

7. In the survey of lands bordering on *tide water*, "meander corners" are to be established at the points where surveyed lines intersect *high-water mark*, and meanders are to follow the *high-water line*.

8 The field-notes of meanders will be set forth in the field-books showing the dates when the work is performed, as illustrated in the specimen notes annexed. They are to state and describe particularly

the meander corner from which they commenced, and each one upon which they close, and are to exhibit the meanders of each fractional section separately; following, and composing a part of such notes, will be given a description of the land, timber, depth of inundation to which the bottom is subject, and the banks, current, and bottom of the stream or body of water you are meandering. The utmost care must be taken to pass no object of topography, *or change therein*, without giving a particular description thereof in its proper place in your meander notes.

SURVEYING.

Initial points from which the lines of the public surveys are to be extended must be established whenever necessary under such special instructions as may be prescribed in each case by the Commissioner of the General Land Office. The locus of such initial points must be selected with great care and due consideration for their prominence and easy identification, and must be established astronomically.

The initial point having been established, the lines of the public surveys are to be extended therefrom as follows:

BASE LINE.

The base line shall be extended east and west from the initial point by the use of solar instruments or transits, as may be directed by the surveyor-general, in his special written instructions. The *transit* should be designated for the alignment of all important lines. Where solar instruments are used the deputy must test said instruments in every 12 miles of line run by observation on the polar star; and in *all* cases where he has reason to suppose that said instrument is in error, he must take an observation on the polar star, and if error be found, must make the necessary corrections before proceeding with his survey. The proper corners shall be established at each 40 and 80 chains, and at the intersection of the line with rivers, lakes, or bayous that should be meandered, in accordance with the instructions for the establishment of corners. In order to check errors in measurement, two sets of chainmen, operating independently of each other, must be employed.

Where transits are used, the line will be run by setting off at the point of departure on the principal meridian* a tangent to the parallel of latitude, which will be a line falling at right angles to said meridian. The line thus determined will be prolonged by *two* back and *two* fore sights at *each* setting of the instrument, turning the horizontal limb 180° in azimuth between the observations. The survey will be continued on this line for twelve (12) miles,‡ but the corners will be established at the proper points by offsets northerly from said line, at the end of each half mile. In order to offset correctly from the tangent to the parallel, the deputy will be guided by the tables of offsets and azimuths contained in this volume†. As the azimuth of the tangent is shown, the angle thence to the true meridian at each mile is readily found, thus indicating the direction of the offset line. The computations are made for a distance of 12 miles, at the end of which observations on the polar star must be taken for the projection of a new tangent. The computations are also upon whole degrees of latitude; offsets for intervening parallels can be readily determined by interpolation. Where offset distances to quarter-section corners exceed 50 links, their direction to the parallel can be determined in like manner by interpolation for azimuth.

* See diagram A, Fig. 1.
† See Tables III, IV, and V, and Diagram A, Fig. 1.
‡ Or a less distance.

Where said distances are less than 50 links interpolations for determining directions will not be required.

PRINCIPAL MERIDIAN.

The principal meridian shall be extended north and south from the initial point, by the use of solar instruments or transits, as may be directed by the surveyor general in his special written instructions. Where solar instruments are used, the line will be run in the same manner as prescribed for running the base line by solar instruments. Where transits are used, observations upon the polar star must be taken within each 12 miles of line run. In addition to the above general instructions, it is required that in all cases where the establishment of a new principal meridian seems to be necessary to the surveyor-general, he shall submit the matter, together with his reasons therefor, to the Commissioner of the General Land Office, and the survey of such principal meridian shall not be commenced until written authority, together with such special instructions as he may deem necessary, shall have been received from the Commissioner. Two set of chainmen, operating independently of each other, must be employed.

STANDARD PARALLELS.

Standard parallels, which are also called correction lines, shall be extended east and west from the principal meridian, at intervals of every 24 miles north and south of the base line, in the same manner as prescribed for running the base line, and two sets of chainmen must be employed.

GUIDE MERIDIANS.

Guide meridians shall be extended north and south from the base line, at intervals of every 24 miles east and west from the principal meridian, in the same manner as prescribed for running the principal meridian, and two sets of chainmen must be employed.

It is contemplated that these base, principal meridian, standard, and guide meridian lines shall first be extended over the territory to be surveyed, and that afterwards township and section lines shall be run, where needed, within these tracts of 24 miles square, formed by the extension of these principal lines; and each surveyor-general will therefore cause said principal lines to be extended as rapidly as practicable.

Paragraph 5, "System of rectangular surveying,"* declares that the object of running standard parallels and guide meridians is "to confine the errors resulting from convergency of meridians, and inaccuracies in measurement, within the tracts of lands bounded by the lines so established."

As the convergency is rapidly increased in the higher latitudes and resulting inaccuracies developed in about the same proportion, it would seem to be consistent with the spirit of the above paragraph to so contract the blocks of 24 miles square, by diminishing either the distances between correction lines, or by reducing the interval between guide meridians, or by using both contractions simultaneously, as to confine convergency errors, as near as practicable, to a uniform amount.

Unfortunately, guide meridians have been so irregularly spaced in the several surveying districts, in some cases exceeding the authorized 24 miles by *three times its amount* or even more, that any attempt to provide a general rule for use in all parts of the country would

* Page 18.

probably result in failure to correct existing irregularities and help still further to increase the present confusion.

Therefore, the only thing that can be done is to reiterate the above directions limiting the tracts bounded by guide meridians and standard parallels to 24 *miles square* and direct, *that in future, compliance with the above requirement will be insisted upon.*

EXTERIORS OR TOWNSHIP LINES.

The east and west boundaries of townships are always to be run from south to north on a true meridian line; and the north and south boundaries are to be run from east to west, or from west to east (according to the location of the township to be surveyed with reference to prior surveys), on a *random* or trial line and corrected back on a true line. The distance north or south of the township corner to be closed upon, from the point of intersection of these random lines with the east or west boundary of the township, must be carefully measured and noted. Should it happen, however, that such random line should fall short, or overrun in length, or intersect the east or west boundary more than *three chains'* distance from the township corner thereon, as compared with the corresponding boundary on the south (due allowance being made for convergency), the line, and if necessary the entire exterior boundaries of the township, must be retraced, so as to discover and correct the error. In running random lines temporary corners are to be set at each 40 and 80 chains, and permanent corners established upon the true line as corrected back, in accordance with instructions, throwing the excess or deficiency on the west half mile, as prescribed by law. Permanent corners are to be established in accordance with instructions on the east and west township boundaries at the time they are run. Whenever practicable the township lines within these tracts of 24 miles square must be surveyed in regular order from *south* to *north*, *i. e.*, the exterior boundaries of the township in any one range lying immediately north of the south boundary of such tract of 24 miles square must first be surveyed, and the exteriors of the other three townships in said range extended therefrom, in regular order from *south* to *north*, and it is preferable to first survey the entire range of townships in such tract adjoining the east boundary or adjoining the west boundary, and the other three ranges in regular sequence. In cases, however, where the character of the land is such that this rule cannot be complied with, the following will be observed:

In extending the *south* or *north* boundaries of a township to the *west*, where the *southwest* or *northwest* corners cannot be established in the regular way by running a north and south line, such boundaries will be run *west on a true* line, allowing for convergency on the west half mile; and from the township corner established at the end of such boundary, the west boundary will be run *north* or *south*, as the case may be. In extending *south* or *north* boundaries of a township to the *east*, where the *southeast* or *northeast* corner cannot be established in the regular way, the same rule will be observed, except that such boundaries will be run *east on a true line*, and the *east* boundary run *north* or *south*, as the case may be. One set of chainmen only is required in running township lines.

METHOD OF SUBDIVIDING.

1. The variation is to be found by observations on Polaris taken at or near the S. E. corner of the township. The first mile, both of the

south and east boundaries of each township you are required to subdivide, is to be carefully traced and measured before you enter upon the subdivision thereof. This will enable you to observe any errors that may have been made in former surveys either in direction or length of the lines and will also enable you to compare your chaining with that upon the township boundaries.

2. Any discrepancy arising either from a disagreement of bearings or a difference in measurement, is to be carefully noted in the field-notes. In this article the term "bearing" is to be construed to mean the *true* bearing or angle made with the *true meridian.*

3. After adjusting your compass to the variation which you have determined by observation, you will commence at the corner to sections 35 and 36, on the south boundary, and run a line northwardly *with the true bearing of the range line,* forty chains, to the quarter-section corner, which you are to establish between sections 35 and 36; continuing on said course forty chains farther, you will establish the corner to sections 25, 26, 35, and 36.

4. From the section corner last named run a *random* line, without blazing, *parallel to the south boundary of section* 36, for the corner of sections 25 and 36, on east boundary, and at forty chains from the starting point set a post for *temporary* quarter-section corner. If you intersect exactly at the corner, you will blaze your random line back, and establish it as the *true* line; but if your random line intersects the said east boundary, either north or south of said corner, you will measure the distance of such intersection, from which you will calculate a course that will run a *true* line back to the corner from which your random started. You will establish the *permanent* quarter-section corner at a point equidistant from the two terminations of the *true* line.

5. From the corner of sections 25, 26, 35, and 36, run northwardly with the *true* bearing of the range line between sections 25 and 26, setting the quarter-section post as before, at forty chains, and at eighty chains establishing the corner of sections 23, 24, 25, and 26. Then run a random *parallel to the south boundary of section* 36 for the corner of sections 24 and 25 on east boundary; setting temporary quarter-section post at forty chains; correcting back, and establishing *permanent* quarter-section corner at the equidistant point on the *true* line, in the manner directed on the line between sections 25 and 36.

6. In this manner you will proceed with the survey of each successive section in the first tier, until you arrive at the north boundary of the township, which you will reach in running up a random line between sections 1 and 2, *with the true bearing of the range line,* setting the temporary quarter-section corner at forty chains from the interior section corner so as to throw the excess or deficiency of measurement on the quarter-sections adjoining the north boundary of the township. If this random line should not intersect at the corner established for sections 1, 2, 35, and 36, upon the township line, you will note the distance that you fall east or west of the same, from which distance you will calculate a course that will run a *true line* to the corner from which your random started, on which line you will establish the permanent quarter-section corner. If the north boundary of a township is a base or standard line, the line between sections 1 and 2 is to be run *with the true bearing of the range line* as a *true* line, and the closing corner established at the point of intersection with such base or standard line; and in such case the distance from said closing corner to the nearest standard corner on such base or standard line must be carefully measured and noted as a *connection line.*

7. In like manner proceed with the survey of each successive tier of sections, until you arrive at the fifth tier; and from each section corner which you establish upon the west boundary of this tier you are to run random lines *parallel to the south boundary of section* 31, towards the corresponding corners established upon the range line forming the western boundary of the township; setting, as you proceed, each *temporary* quarter-section corner at forty chains from the interior section corner, so as to throw the excess or deficiency of measurement on the extreme tier of quarter sections contiguous to the township boundary; and on returning establish the *true* line, and establish thereon the *permanent* quarter-section corner. The *random* of an east and west section line must always be run *parallel to the south boundary of the tier of sections to which it belongs and with the true bearing of said boundary.*

8. It is not required that the deputy shall complete the survey of the first tier of sections from south to north, before commencing the survey of the second or any subsequent tier, but the corner on which the random line closes must have been previously established by running the line which determines its position, except as follows: Where it is impracticable to establish such section corner in the regular manner it may be established by running the east and west line as *a true line*, with a *true bearing*, determined as above directed for *random* lines, setting the quarter-section corner at 40 chains and the section corner at 80 chains.

9. Quarter-section corners, both upon north and south and upon east and west lines, are to be established at a point *equidistant* from the corresponding section corners, *except* upon the lines closing on the north and west boundaries of the township, and in those situations the quarter-section corners will always be established at precisely *forty chains* to the north or west (as the case may be) of the respective section corners from which those lines respectively *start*, by which procedure the excess or deficiency in the measurements will be thrown, according to law, on the extreme tier of quarter sections.

If, in the subdivision of part of a township, the lands to be surveyed can not be reached by lines extending from the south boundary of the township, a line corresponding to the south boundary of the same shall be extended from some section corner on the east boundary of the township to the west boundary thereof, in order that it may constitute the south boundary of the surveyable area; from which subdivisional meridian lines will be projected northward, and the surveys carried forward in the same manner as for the subdivision of a full township, in order that regular and fractional areas shall occupy their true and legal positions.

Fragmentary portions of surveyable lands lying south of the provisional base last described may be included in the survey by extending lines *southwardly* from the same in harmony with the general system.

When the proper point for the establishment of a section corner is inaccessible, and a witness monument can be erected upon each of the two lines which approach the same at distances not exceeding twenty chains therefrom, the quarter-sections depending thereon will be disposed of in the same manner as if the corner had been regularly established.

The witness monument must be marked as conspicuously as a section corner, and bearing trees used wherever possible.

The deputy will be required to furnish good evidence that the section corner is actually inaccessible.

PRESCRIBED LIMITS FOR CLOSINGS AND LENGTH OF LINES IN CERTAIN CASES.

1. Every north-and-south section line, except those terminating in the north boundary of the township, must be *eighty chains* in length.

2. The east-and-west *section lines*, except those terminating in the west boundary of the township, are to be within *eighty links* of the actual distance established on the south boundary line of the township for the width of said tier of sections, and must close within fifty links north or south of the section corner.

3. The north boundary and south boundary of any one section, except in the extreme western tier, are to be within *eighty links* of equal length.

4. The meanders within each fractional section, or between any two meander posts, or of an island in the interior of a section, must close within a limit determined by allowing *five-eighths of a link* for *each chain* of said meander line when less than 80 chains in length. When the meander line is more than 80 chains in length the closing error must in no case *exceed* 150 links.

5. In running *random* township exteriors, if such random lines fall short or overrun in length, or intersect the eastern or western boundary, as the case may be, of the township, at more than *three chains* north or south of the true corner, the lines must be *retraced*, even if found necessary to remeasure the meridional boundaries of the township. One set of chainmen only is required in subdividing.

RETRACING TOWNSHIP LINES AND BOUNDARIES OF PRIVATE LAND CLAIMS.

If, in subdividing a township, it is found that the exterior boundaries have been improperly run, measured, or marked, or the corners established thereon have been obliterated, the deputy will resurvey so much of said exterior boundaries as may be necessary, and establish new corners upon same wherever necessary. Where no subdivisions have been made on either side of a township boundary, it will be corrected, if necessary, in point of alignment as well as measurement, by establishing the section corners at lawful distances from the south or east boundaries of the township (as the case may be), and upon a right line extending between the township corners; and in such case, the old corners on said township boundaries will be destroyed.

Where subdivisional lines have been closed upon a township boundary in advance of the preliminary survey of the same, its alignment will not be changed. If it is found necessary to establish new corners on such boundary they will receive only the marks referring to the sections in the township being subdivided, and the marks on the old corners on such boundary, which refer to such sections, will be obliterated.

In all cases such necessary corrections will be made as will place the section corners at the aforesaid lawful distances from the south or east boundary, in order that a legal subdivision of the township may be made, and where new corners are thus necessarily established, the distance and direction between new and old corners must be carefully noted.

New corners on township boundaries must be established by a survey of such lines, and *in no case* will such corners be established from *data* acquired in running lines closing on such boundaries. One set of chainmen, only, is required in retracing township lines.

When township or subdivision lines intersect the boundaries of confirmed private land claims, the latter must be retraced so far as may be necessary to establish the corners to the fractional sections at their

proper places, and such corners must be established, in all respects, like meander corners, except that instead of the letters "M. C." the letters used to designate such private land claim must be marked on corners. In retracing the boundary of such claim the deputy must set stakes thereon, at each forty chains, where the ground is level, and on broken ground, at every spur, ridge, or other prominent point, and also at each angle formed by a change in the direction of such boundary.

SPECIAL INSTRUCTIONS ISSUED BY UNITED STATES SURVEYORS-GENERAL TO UNITED STATES DEPUTY SURVEYORS.

One of the most important duties to be performed by the surveyor-general, is to provide the deputy surveyor with *Special Instructions*, in connection with the contract, prepared in accordance with law, which instructions are not to be limited to calling attention to certain paragraphs in this Manual; reiteration of its requirements and in providing the deputy with a printed copy of directions of a *general* nature; but they must, in all cases, and particularly for the survey of exteriors, be *specific* in character, with all necessary *detailed statements* setting forth *what* the deputy is to do and *how* the work is to be performed. Before making out special instructions, the surveyor-general will cause a thorough examination to be made of the field notes and plats of older surveys of standard and township lines upon which the deputy is to base his work, and give him *full* information—both *written* and *graphic*—of the exact condition of adjoining surveys, with all *irregularities* that may be found, carefully and clearly noted, with all necessary instructions for his guidance if he finds everything *as it should be*, and, in addition, advise him, so far as he can, what to do in case the surveys on the ground are *not as represented* in the old notes.

If the contract includes exterior lines, the surveyor-general will specify in detail *where* the deputy is to commence, in what *order* and in what *direction* he is to run the lines, inform him how much *convergency* to use, and provide for his use a *diagram*, giving full and accurate information in regard to lengths and bearings of all lines of old surveys, *from* which he is to work, or *upon* which he is to close. The diagrams will be made in triplicate, one copy for the General Land Office, one for the deputy, and one to be retained. They may be either original drawings, blue prints, or tracings. *In no case must the deputy be sent into the field without full and accurate information in regard to all irregularities which will in any manner affect the extent or accuracy of his survey.*

FIELD NOTES.

The proper blank books for field notes will be furnished by the surveyor-general, and in such books the deputy surveyor must make a faithful, distinct, and minute record of everything officially done and observed by himself and his assistants, pursuant to instructions, in relation to running, measuring, and marking lines, establishing corners, etc., and present, as far as possible, a full and complete topographical description of the country surveyed.

From the *data* thus recorded at the time when the work is done on the ground, the deputy must prepare *true* field notes of the surveys executed by him, in the manner hereinafter prescribed, and return same to the surveyor-general, together with the required sketches, at the earliest practicable date after the completion of his work in the field.

The true field notes are in no case to be made out in the office of the surveyor-general.

The field notes of the survey of base, meridian, standard, exterior,

and subdivision lines are each to be written in *separate books*. The subdivisions of *each* township will form one book. *No adhesive material of any kind will be used to fasten the leaves or covers.*

The first, or title page of *each* field-note book is to describe the subject matter of the same, the locus of the survey, by whom surveyed, date of contract, and the dates of commencement and completion of the work. The second page is to contain the names and duties of the assistants, and the index is to be placed on same or following page. Whenever a new assistant is employed, or the duties of any one of them changed, such facts are to be stated in an appropriate entry immediately preceding the notes taken under such changed arrangements.

The exhibition of every mile of surveying, whether on township, or subdivisional lines, and of meanders in each section, must be *complete in itself*, and be separated by a black line drawn across the paper.

The *change* in the variation, if any is observed, the *hour* of the day and *cause* of the change will be stated at the commencement of every line run.

The variation of the *needle* must always occupy a *separate line* preceding the notes of measurements on line.

The description of the surface, soil, minerals, timber, undergrowth, etc., on *each mile* of line, is to follow the notes of survey of such line, and not be mixed up with them.

The date of each day's work must follow immediately after the notes thereof.

No abbreviations of words are allowable, except of such words as are *constantly* occurring, such as "*sec.*" for "*section*"; "*in. diam.*" for "*inches diameter*"; "*chs.*" for "*chains*"; "*lks.*" for "*links*"; "*dist.*" for "*distant*"; "$\frac{1}{4}$ *sec. cor.*" for "*quarter-section corner*"; "*va.*" for "*variation*," etc.; for 14 inches long, 12 inches wide, and 3 inches thick, in describing a corner stone, use $14\times12\times3$, being particular to always observe the same order of length, width, and thickness. Proper names must never be abbreviated, however often their recurrence.

When the lines of survey cross hills or ravines, the height or depth of same, in feet, must be noted as nearly as practicable.

The corners established in previous surveys, from which the lines start, or upon which they close, must be fully described in the field notes. A full description of such corners will in all cases be furnished the deputy from the surveyor-general's office at the date authority is given for commencing work.

In all cases where a corner is re-established the field notes must describe fully the manner in which it is done.

Field notes of the survey of base, standard, and meridian lines must describe all corners established thereon, how established, the crossings of streams, ravines, hills, and mountains; character of soil, timber, minerals, etc.; and after the description of each township corner established in running such lines, the deputy will note particularly in the "general description" the townships on each side of the lines run.

Field notes of the survey of exterior boundaries of townships must describe the corners and topography, as above required, and the "general description" at the end of such notes must describe the townships as fully as may be, and also state whether or not they should be subdivided.

Near the end of his field notes and immediately before the "general description," the deputy surveyor will add, in form similar to that shown in specimen field notes, No. 3, a tabular statement of the latitude and departure of each boundary line of the township, taken from a traverse table, giving the *totals* and *errors* in latitude and departure,

which must in no case exceed the "prescribed limits for closings" contained in this manual.* If a part or the whole of one or more of the boundaries is made up of meander lines,† the *total* northings, southings, eastings and westings of such lines will take the place of the missing N. and S. or E. and W. lines, so as to present the *total errors* of the township boundaries, considered as a closed survey. If all the exterior lines have been surveyed by the deputy, the bearings and distances for the table will be taken from his own notes. In a case where some of the boundaries have been surveyed under an older contract, the deputy will use the bearings and distances supplied by the Surveyor General in connection with his own lines, and if the errors *exceed* the allowance defined in paragraphs 4 and 5 of the "prescribed limits," he will determine *where* the error occurs, correct the same *before he leaves the field*, and place the table in his *field note book*. This requirement is made necessary by the frequent occurrence of errors in the exterior lines, of which nothing is known in this office until after the township has been subdivided and the returns taken up for examination and settlement of the account, and *then* much correspondence and delay results in injury to the service and sometimes in trouble for settlers.

Field notes of the subdivisional survey of townships must describe the corners and topography as above required, and the "general description" at the end of such notes must state minutely the character of the land, soil, timber, etc., found in such townships.

The topography must be given on the *true line* in all cases, and must be taken correctly, not estimated or approximated.

A blank line must be left at the bottom of each page of the field notes, and the notes must be written in a plain, legible hand, and in clear and precise language, so that the figures, letters, words, and meaning will always be unmistakable, and erasures and interlineations avoided, as far as possible.

With the notes of the survey of principal lines forming a tract of 24 miles square the deputy will submit a plat of the lines run on a scale of one-half inch to the mile, and with the notes of survey of the exterior lines of townships a plat of the lines run on the scale of two inches to the mile, on which are to be noted all the objects of topography on line necessary to illustrate the notes, viz, the distance on line at the crossings of streams, so far as such can be noted on the paper, and the direction of each by an arrow-head pointing down stream; also, the intersection of line by prairies, marshes, swamps, ravines, ponds, lakes, hills, mountains, and all other matters indicated by the notes, to the fullest extent practicable.

With the instructions for making subdivisional surveys of townships into sections, the deputy will be furnished by the surveyor-general with a diagram of the *exterior* lines previously established of the townships to be subdivided (on the above-named scale), upon which are carefully to be laid down the measurements of each of the lines on such boundaries whereon he is to close, and the magnetic variation of each mile. And on such diagram the deputy who subdivides will make appropriate sketches of the various objects of topography as they occur on his lines, so as to exhibit not only the points on line at which the same occur, but also the direction and position of each between the lines, or within each section, as far as practicable, so that every object of topography may be properly completed or connected in the showing.

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* See page 40.

† In the table, meanderable lines of *new* surveys will be left blank.

SUMMARY OF OBJECTS AND DATA REQUIRED TO BE NOTED.

1. The precise length of every line run, noting all necessary offsets therefrom, with the reason and mode thereof.

2. The kind and diameter of all "*bearing trees*," with the course and distance of the same from their respective corners; and the precise relative position of WITNESS CORNERS to the *true corners*.

3. The kind of materials of which corners are constructed.

4. *Trees on line.* The name, diameter, and distance on line to all trees which it intersects.

5. Intersections by line of *land objects.* The distance at which the line first intersects and then leaves every *settler's claim and improvement;* prairie, river, creek, or other "bottom;" or swamp, marsh, grove, and wind-fall, with the course of the same at both points of intersection; also the distances at which you begin to ascend, arrive at the top, begin to descend, and reach the foot of all remarkable hills and ridges, with their courses, and *estimated* height, in feet, above the level land of the surrounding country, or above the bottom lands, ravines, or waters near which they are situated.

6. Intersections by line of *water objects.* All rivers, creeks, and smaller streams of water which the line crosses; the distances on line at the points of intersection, and their *widths on line.* In cases of *navigable* streams, their width will be ascertained between the *meander corners*, as set forth under the proper head.

7. The land's *surface*—whether level, rolling, broken, or hilly.

8. The *soil*—whether first, second, third, or fourth rate.

9. *Timber*—the several kinds of timber and undergrowth, in the order in which they predominate.

10. *Bottom lands*—to be described as wet or dry, and if subject to inundation, state to what depth.

11. *Springs of water*—whether fresh, saline, or mineral, with the course of the stream flowing from them.

12. *Lakes* and *ponds*—describing their banks and giving their height, and also depth of water, and whether it be pure or stagnant.

13. *Improvements.* Towns and villages; houses or cabins; fields, or other improvements; sugar-tree groves, sugar camps, mill seats, forges, and factories. To be located by bearing and distance or intersecting bearings from given points.

14. *Coal* banks or beds; *peat* or turf grounds; *minerals* and ores; with particular description of the same as to quality and extent, and all *diggings* therefor; also *salt* springs and licks. All reliable information you can obtain respecting these objects, whether they be on your immediate line or not, is to appear on the general description to be given at the end of the notes.

15. *Roads* and *trails*, with their directions, whence and whither.

16. Rapids, cataracts, cascades, or falls of water, with the estimated height of their fall in feet.

17. Precipices, caves, sink holes, ravines, stone quarries, ledges of rocks, with the kind of stone they afford.

18. *Natural curiosities*, interesting fossils, petrifications, organic remains, etc.; also all ancient works of art, such as mounds, fortifications, embankments, ditches, or objects of like nature.

19. The *variation* of the needle must be noted at all points or places on the lines where there is found any material *change* of variation, and the position of such points must be perfectly identified in the notes.

20. Besides the ordinary notes taken on line (and which must always be written down on the spot, leaving nothing to be supplied by mem-

ory), the deputy will subjoin, at the conclusion of his book, such further description or information touching any matter or thing connected with the township (or other survey) which he may be able to afford, and may deem useful or necessary to be known—with a *general description* of the township in the *aggregate*, as respects the face of the country, its soil and geological features, timber, minerals, waters, etc.

Following the "general description" of the township is to be "A list of the names of the individuals employed to assist in running, measuring, and marking the lines and corners described in the forgoing field notes of township No. ——— of the BASE LINE of range No. ——— of the ——— MERIDIAN, showing the respective capacities in which they acted."

AFFIDAVITS TO FIELD NOTES.

The following are the forms of official oaths to be taken by deputy surveyors and their assistants. The original oaths are to be affixed to the *true* field notes returned to the surveyor-general by the deputy surveyor; the preliminary oaths being placed immediately after the index of the first book, and the final oaths at the end of the last book of field notes of the surveys to which they refer:

PRELIMINARY OATHS OF ASSISTANTS.

We, ——— ——— and ——— ———, do solemnly swear that we will well and faithfully execute the duties of chain-carriers; that we will level the chain upon even and uneven ground and plumb the tally pins, either by sticking or dropping the same; that we will report the true distance to all notable objects, and the true length of all lines that we assist in measuring, to the best of our skill and ability, and in accordance with instructions given us, in the survey of the ——— ———.

——— ———, *Chainman.*
——— ———, *Chainman.*
——— ———, *Chainman.*
——— ———, *Chainman.*

Subscribed and sworn to before me this —— day of ———, 18—.

——— ———,
———.

We, ——— ——— and ——— ———, do solemnly swear that we will well and truly perform the duties of axemen, in the establishment of corners and other duties, according to instructions given us, and to the best of our skill and ability, in the survey of ——— ———.

——— ———, *Axeman.*
——— ———, *Axeman.*

Subscribed and sworn to before me this —— day of ———, 18—.

——— ———,
———.

I, ——— ———, do solemnly swear that I will well and truly perform the duties of flagman, according to instructions given me, to the best of my skill and ability, in the survey of ——— ———.

——— ———, *Flagman.*

Subscribed and sworn to before me this —— day of ———, 18—.

——— ———,
———.

FINAL OATHS FOR SURVEYS.

List of names.

A list of the names of the individuals employed by ——— ———, United States deputy surveyor, to assist in running, measuring, and marking the lines and corners described in the foregoing field notes of the survey of ——— ———, showing the respective capacities in which they acted.

——— ———, *Chainman.*
——— ———, *Chainman.*
——— ———, *Chainman.*
——— ———, *Chainman.*
——— ———, *Axeman.*
——— ———, *Axeman.*
——— ———, *Flagman.*

FINAL OATHS OF ASSISTANTS.

We hereby certify that we assisted ——— ———, United States deputy surveyor, in surveying all those parts or portions of the ——— of the ——— base and ——— meridian, ——— of ———, as are represented in the foregoing field notes as having been surveyed by him and under his direction; and that said survey has been in all respects, to the best of our knowledge and belief, well and faithfully surveyed, and the corner monuments established according to the instructions furnished by the United States surveyor-general for ———.

——— ———, *Chainman.*
——— ———, *Chainman.*
——— ———, *Chainman.*
——— ———, *Chainman.*
——— ———, *Axeman.*
——— ———, *Axeman.*
——— ———, *Flagman.*

Subscribed and sworn to before me this —— day of ———, 18—.

——— ———,
———.

FINAL OATH OF UNITED STATES DEPUTY SURVEYOR.

I, ——— ———, United States deputy surveyor, do solemnly swear that in pursuance of instructions received from ——— ———, United States surveyor-general for ———, bearing date of the —— day of ———, 18—, I have well, faithfully, and truly, in my own proper person, and in strict conformity with the instruction furnished by the United States surveyor-general for ———, the surveying manual, and the laws of the United States, surveyed all those parts or portions of ——— ——— of the ——— base and ——— meridian in the ——— of ———, as are represented in the foregoing field notes as having been surveyed by me and under my directions; and I do further solemnly swear that all the corners of said survey have been established and perpetuated in strict accordance with the surveying manual, printed instructions, the special written idstructions of the United States surveyor-general for ———, and in the specific manner described in the field notes, and that the foregoing are the *true* field notes of such survey; and should any fraud be detected, I will suffer the penalty of perjury, under the provisions of an act of Congress approved August 8, 1846.

———,
United States Deputy Surveyor.

Subscribed by said ——— ———, deputy surveyor, and sworn to before me this —— day of ———, 18—.

———.
U. S. Surveyor-General for ——— ———.

The final oath of the deputy surveyor must, in all cases, be taken before the *U. S. Surveyor-General* for the State or Territory in which the survey is executed. Before the above final oath is administered to the deputy surveyor, the surveyor-general will make such *personal* examination of *the notes taken in the field* and such general investigation of the returns as he may consider necessary to fully assure himself that *all* the observations for determination of the true meridian and variation and the tabular statement of closing errors, when one is required, are actually contained in the *original notes taken by the deputy on the ground*, and that his contract and special instructions have been complied with *in every particular*. It is preferable that all oaths—both preliminary and final—of assistants should be taken before some officer duly authorized to administer oaths other than the deputy surveyor. In cases, however, where great delay, expense, or inconvenience would result from a strict compliance with this rule, the deputy surveyor is authorized to administer the necessary oaths to his assistants, but in each case where this is done he must submit a full written report to the proper surveyor general of the circumstances of such case.

To enable the deputy surveyor to fully understand and appreciate the responsibility under which he is acting, his attention is invited to the

provisions of the second section of the act of Congress approved August 8, 1846, entitled "An act to equalize the compensation of the surveyors-general of the public lands of the United States, and for other purposes," and which is as follows:

"SEC. 2. That the surveyors-general of the public lands of the United States, in addition to the oath now authorized by law to be administered to deputies on their appointment to office, shall require each of their deputies, on the return of his surveys, to take and subscribe an oath or affirmation that those surveys have been faithfully and correctly executed according to law and the instructions of the surveyor-general; and on satisfactory evidence being presented to any court of competent jurisdiction that such surveys, or any part thereof, had not been thus executed, the deputy making such false oath or affirmation shall be deemed guilty of perjury, and shall suffer all the pains and penalties attached to that offense; and the district attorney of the United States for the time being in whose district any such false, erroneous, or fraudulent surveys shall have been executed, shall, upon the application of the proper surveyor-general, immediately institute suit upon the bond of such deputy; and the institution of such suit shall act as a lien upon any property owned or held by such deputy, or his sureties, at the time such suit was instituted."

SPECIMEN FIELD NOTES AND PLATS.

Diagram B illustrates the method of laying off tracts of land 24 miles square, as nearly as practicable, by the survey of principal lines, and the survey of exteriors or township lines within such tracts, north of the base line and east of the principal meridian. The same general principles will apply equally to the survey of such tracts differently located with reference to the initial point. The topography noted on said diagram is on those portions of the lines of surveys for which specimen field notes are given.

Diagram C illustrates the method of laying off a township into sections and quarter sections. In the subdivision of townships lying *south* of and *contiguous* to the base line, or to any standard parallel, the lines between the sections of the northern tier will be run with the true bearing of the east boundary of the township as *true* lines; quarter-section corners will be established at 40 chains, closing section corners will be established at the points of intersection of such lines with the base or standard lines (as the case may be), and the *course* and *distance* from such corners to the nearest standard corner upon the line closed upon are to be accurately ascertained and set down in the field notes.

Diagram D illustrates the mode of establishing stone, post, and mound corners for townships, sections, and quarter sections.

Specimen field notes Nos. 1, 2, 3, 4, and 5 illustrate, respectively, the mode and order of surveying standard lines, meridian lines, exteriors or township lines, resurveying exteriors or township lines, and subdividing a township into sections and quarter sections. The attention of the deputy is particularly directed to these specimens, as indicating not only the method in which his work is to be conducted, but also the order, manner, language, etc., in which his field notes are required to be returned to the surveyor general's office; and such specimens are to be deemed part of these instructions, and any *departure* from their details, without special authority, in cases where the circumstances are

analogous in practice, *will be regarded as a violation of his contract and oath.*

The subdivisions of fractional sections into the 40-acre lots (as near as may be) are to be so laid down on the official township plat in broken black lines as to admit of giving to each a specific designation, if possible, according to its relative position in the fractional section, as per example afforded by Diagram C, as well as by a number, in all cases where the lot can not properly be designated as a quarter-quarter. Those fractional subdivision lots which are not susceptible of being described according to relative local position, are to be numbered in regular series; those bordering on the north boundary of a township to be numbered progressively from east to west, and those bordering on the west boundary of a township to be numbered progressively from north to south, in each section. As section 6 borders on both the north and west boundaries of the township, the fractional lots in the same will be numbered as follows: Commencing with No. 1 in the northeast, thence progressively west to No. 4 in the northwest, and south to No. 7 in the southwest corner of the section.

In numbering fractional lots, other than those above specified (wherever practicable and as a general rule), the series should commence with No. 1 in the northeastern or the most easterly fractional lot, and continue from east to west, and west to east, alternately, to the end of the series, as shown in Diagram C; but such general rule is departed from under circumstances given as examples in said diagram.

Interior lots are to be, as nearly as possible, 20 chains long by 20 chains wide; and the excess or deficiency of measurement is always to be thrown on the lots bordering on the northern and western boundaries of the township, or those made fractional by meander lines.

The official township plat to be returned to the General Land Office is to show on its face, on the right-hand margin, the meanders of navigable streams, islands, and lakes. Such details are wanted in the adjustment of the surveying accounts, but may be omitted in the copy of the township plat to be furnished to the district land office by the surveyor general. A suitable margin for *binding* is to be preserved on the left-hand side of each plat. Each plat is to be certified, with table annexed, according to the forms subjoined to "Diagram C," and is to show the areas of public land, of private surveys, and of water, with the aggregate area as shown on the diagram.

Each township plat is to be prepared in *triplicate:* one for the General Land Office, one for the United States district land office, and the third to be retained as the record in the office of the surveyor-general.

The plat for the local land office must not be forwarded until notice is received by the surveyor-general from the Commissioner of the General Land Office that the survey represented on said plat has been accepted, and that he is authorized to file the triplicate plat.

The plats must be prepared as nearly as possible in accordance with the specimen plat designated as "Diagram C." The use of all fluids, except a preparation of India ink of good quality, must be avoided by the draughtsman in delineations relating to the public surveys. All lines, figures, etc., must be sharply defined. All lettering on the plats must be clear and sharp in outline and design, and ornamentation of any kind is prohibited. These requirements are necessary in order that everything shown upon original plats may be fairly reproduced in making photolithographic copies of the same.

All towns, settlements, permanent buildings, private claims, reservations, water courses, ditches, lakes, islands, mountains, buttes, cañons,

roads, railroads, telegraph lines, canals, etc., will be shown upon the plats and designated by proper names where such are known.

The true meridian and declination of the magnetic needle, or variation of the compass, must be determined, by *observation on Polaris*, at or near the southeast corner of the township, or at the point where the survey begins. The mean local time of observation and all particulars will be stated in the field notes. In all cases the *mean declination* will be the value to insert in the tabular statement (See Diagram C), below the plat. A table will be found in this manual* for reducing the *observed* to the *mean* declination. If the observation is taken away from the corner, the point must be so connected with the township line as to define its exact direction with reference to the *true meridian*. For the above determination the surveyor may use any one of methods herein described.

All township plats are to be drawn to a uniform scale of 40 chains to 1 inch, United States standard, and diagrams of exteriors to a scale of 160 chains to 1 inch.

Surveyors-general will require that the specimen plat shall be closely followed in order that uniformity of appearance and expression of drawings representing the public land surveys may be attained.

The true field books, each bearing the *written approval* of the surveyor-general, are to be substantially bound into volumes of suitable size, and retained in the surveyor-general's office, and certified *transcripts* of such field books (to be of *foolscap* size) are to be prepared and forwarded, from time to time, to the General Land Office.

All transcripts of surveys, made out as described under the head "FIELD NOTES," must be written in a bold, legible hand, with durable black ink, and such transcripts of any series of surveys included in one account forwarded to the General Land Office must be securely put up in *one package*, but not fastened together, at the office of the surveyor-general prior to transmittal.

With the copy of each township plat furnished to a district land office, the surveyor-general is required by law to furnish *descriptive notes* as to the character and quality of the soil and timber found on and in the vicinity of each surveyed line, and giving a description of each corner.

Printed blank forms for such notes will be furnished by the General Land Office. The forms provide eighteen spaces for *meander corners*, which, in most cases, will be sufficient; but when the number shall exceed eighteen, the residue will have to be inserted on the face of the township plat, to be furnished to the register of the district land office, or on the supplemental blank form.

There is shown a series of meander corners on Diagram C, viz, from No. 1 to No 12 on the river and island, No. 1 to No. 5 on Lin's Lake, and No. 1 to No. 2 on small lake in Sec. 33.

GEOGRAPHICAL POSITIONS OF BASE-LINES AND PRINCIPAL MERIDIANS GOVERNING THE PUBLIC SURVEYS.

Since the adoption of the rectangular system of public surveys, May 20, 1785, twenty-four initial points, or the intersection of the principal bases with surveying meridians, have been brought into requisition to secure the certainty and brevity of description in the transfer of public lands to individual ownership. From the principal bases townships of six miles square are run out and established, with regular series of numbers counting north and south thereof, and from

* On page 55.

the surveying meridians a like series of ranges are numbered both east and west of the principal meridians.

During the period of ninety years since the organization of the system the following numerical and independent principal meridians and bases have been initiated, to wit:

The first principal meridian divides the States of Ohio and Indiana, having for its base the Ohio River, the meridian being coincident with 84° 51′ of longitude west from Greenwich. The meridian governs the surveys of public lands in the State of Ohio.

The second principal meridian coincides with 86° 28′ of longitude west from Greenwich, starts from the confluence of the Little Blue River with the Ohio, runs north to the northern boundary of Indiana, and governs the surveys in Indiana and a portion of those in Illinois.

The third principal meridian starts from the mouth of the Ohio River and extends to the northern boundary of the State of Illinois, and governs the surveys in said State *east* of the meridian, with the exception of those projected from the second meridian, and the surveys on the *west* to the Illinois River. This meridian coincides with 89° 10′ 30″ of longitude west from Greenwich.

The fourth principal meridian begins in the middle of the channel of the mouth of the Illinois River, in latitude 38° 58′ 12″ north and longitude 90° 29′ 56″ west from Greenwich, and governs the surveys in Illinois west of the Illinois River and west of the third principal meridian lying north of the river. It also extends due north through Wisconsin and northeastern Minnesota, governing all the surveys in the former and those in the latter State lying east of the Mississippi and the third guide meridian (west of the fifth principal meridian) north of the river.

The fifth principal meridian starts from the mouth of the Arkansas River, and, with a common base-line running due west from the mouth of the Saint Francis River, in Arkansas, governs the surveys in Arkansas, Missouri, Iowa, Minnesota west of the Mississippi, and the third guide meridian north of the river, and in Dakota Territory east of the Missouri River. This meridian is coincident with 90° 58′ longitude west from Greenwich.

The sixth principal meridian coincides with longitude 97° 22′ west from Greenwich, and, with the principal base line intersecting it on the 40th degree of north latitude, extends north to the intersection of the Missouri River and south to the 37th degree of north latitude, controlling the surveys in Kansas, Nebraska, that part of Dakota lying south and west of the Missouri River, Wyoming, and Colorado, excepting the valley of the Rio Grande del Norte, in southwestern Colorado, where the surveys are projected from the New Mexico meridian.

In addition to the foregoing six principal meridians and bases governing public surveys, there have been established the following meridians and bases, viz:

The Michigan meridian, in longitude 84° 19′ 09″ west from Greenwich, with a base-line on a parallel seven miles north of Detroit, governing the surveys in Michigan.

The Tallahassee meridian, in longitude 84° 18′ west from Greenwich, runs due north and south from the point of intersection with the base-line at Tallahassee, and governs the surveys in Florida.

The Saint Stephen's meridian, longitude 88° 02′ west from Greenwich, starts from Mobile, passes through Saint Stephen's, intersects the base line on the 31st degree of north latitude, and controls the surveys of

the southern district in Alabama and of the Pearl River district lying east of the river and south of township 10 north in the State of Mississippi.

The Huntsville meridian, longitude 86° 31′ west from Greenwich, extends from the northern boundary of Alabama as a base, passes through the town of Huntsville, and governs the surveys of the northern district in Alabama.

The Choctaw meridian, longitude 89° 10′ 30″ west from Greenwich, passes two miles west of the town of Jackson, in the State of Mississippi, starting from the base-line twenty-nine miles south of Jackson, and terminating on the south boundary of the Chickasaw cession, controlling the surveys east and west of the meridian and north of the base.

The Washington meridian, longitude 91° 05′ west from Greenwich, seven miles east of the town of Washington, in the State of Mississippi, with the base-line corresponding with the 31st degree of north latitude, governs the surveys in the southwestern angle of the State.

The Saint Helena meridian, 91° 11′ longitude west from Greenwich, extends from the 31st degree of north latitude, as a base, due south, and passing one mile east of Baton Rouge, controls the surveys in the Greensburgh and the southeastern districts of Louisiana, both lying east of the Mississippi.

The Louisiana meridian, longitude 92° 20′ west from Greenwich, intersects the 31st degree north latitude at a distance of forty-eight miles west of the eastern bank of the Mississippi River, and, with the base-line coincident with the said parallel of north latitude, governs the surveys in Louisiana west of the Mississippi.

The New Mexico meridian, longitude 106° 52′ 09″ west from Greenwich, intersects the principal base-line on the Rio Grande del Norte about ten miles below the mouth of the Puerco River, on the parallel of 34° 19′ north latitude, and controls the surveys in New Mexico, and in the valley of the Rio Grande del Norte, in Colorado.

The Great Salt Lake meridian, longitude 111° 53′ 47″ west from Greenwich, intersects the base-line at the corner of Temple Block, in Salt Lake City, Utah, on the parallel of 40° 46′ 04″ north latitude, and governs the surveys in the Territory of Utah.

The Boisé meridian, longitude 116° 20′ west from Greenwich, intersects the principal base between the Snake and Boisé Rivers, in latitude 43° 26′ north. The initial monument, at the intersection of the base and meridian, is nineteen miles distant from Boisé City, on a course of south 29° 30′ west. This meridian governs the surveys in the Territory of Idaho.

The Mount Diablo meridian, California, coincides with longitude 121° 54′ west from Greenwich, intersects the base-line on the summit of the mountain from which it takes its name, in latitude 37° 53′ north, and governs the surveys of all central and northeastern California and the entire State of Nevada.

The San Bernardino meridian, California, longitude 116° 56′ west from Greenwich, intersects the base-line at Mount San Bernardino, latitude 34° 06′ north, and governs the surveys in southern California lying east of the meridian and that part of the surveys situated west of it which are south of the eighth standard parallel south of the Mount Diablo base-line.

The Humboldt meridian, longitude 124° 11′ west from Greenwich, intersects the principal base-line on the summit of Mount Pierce, in latitude 40° 25′ 30″ north, and controls the surveys in the northwestern

corner of California lying west of the Coast range of mountains and north of township 5 south of the Humboldt base.

The Willamette meridian is coincident wite longitude 122° 44′ west from Greenwich, its intersection with the base-line is on the parallel of 45° 30′ north latitude, and it controls the public surveys in Oregon and Washington Territory.

The Montana meridian extends north and south from the initial monument established on the summit of a limestone hill, eight hundred feet high, longitude 111° 40′ 54″ west from Greenwich. The base line runs east and west from the monument on the parallel of 45° 46′ 27″ north latitude. The surveys for the entire Territory of Montana are governed by this meridian.

The Gila and Salt River meridian intersects the base-line on the south side of the Gila River, opposite the mouth of Salt River, in longitude 112° 15′ 46″ west from Greenwich, and latitude 33° 22′ 57″ north, and governs the public surveys in the Territory of Arizona.

The Indian meridian intersects the base-line at Fort Arbuckle, Indian Territory, in longitude 97° 15′ 56″ west from Greenwich, latitude 34° 31′ north, and governs the surveys in that Territory.

THE MAGNETIC DECLINATION OR VARIATION OF THE NEEDLE.

The following account of the geographical distribution and of the annual change of the magnetic declination or variation of the needle, with tables, explanations, and charts, presenting the latest information on the subject, were prepared by direction of the Superintendent of the U. S. Coast and Geodetic Survey, in accordance with a request of the Commissioner of the General Land Office.

DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE,
Washington, D. C., November 30, 1889.

For the following article with tables and their explanation, relating to the use of the compass in surveying, the Commissioner of the General Land Office is indebted to Prof. T. C. Mendenhall, Superintendent of the U. S. Coast and Geodetic Survey; it was furnished at the request of the Commissioner.

The paper originally written in January, 1878, by Assistant C. A. Schott, in charge of the computing division, has been revised and enlarged by him in order to present the latest information on the subject; it is also accompanied by two charts, taken from the Coast and Geodetic Survey Report for 1889 illustrating the present distribution of the magnetic declination.

This paper is designed to take the place of the chapter commencing at the foot of page 25 and ending in the middle of page 29 of the "Manual of Instructions to Surveyors-General of the United States," printed in 1871, part of which in the course of time had become obsolete. The article will be found of great interest and value as an aid in the prosecution of the surveys of the public lands.

AN ACCOUNT OF THE PRESENT GEOGRAPHICAL DISTRIBUTION AND OF THE ANNUAL CHANGE OF THE MAGNETIC DECLINATION (COMMONLY KNOWN AS THE VARIATION OF THE COMPASS NEEDLE) WITHIN THE LIMITS OF THE UNITED STATES.*

The magnetic declination at any place is the angle contained between two vertical planes, one being the astronomical or true meridian of the place and the other a plane in which the horizontal axis of a freely suspended magnetic needle lies at the time. The former is a fixed plane, the latter is variable since observation shows that the direction of a magnetic needle, when delicately suspended, is constantly changing, nor is it the same at different places. The magnetic declination, thus varying with respect to locality and time, it is necessary on the part of the observer to give with his statement of the declination the exact local time, year, month, day and hour, and fraction when the measure was taken, as well as the geographical position or the latitude and longitude of the place, which co-ordinates may be expressed in minutes of arc, and it generally suffices to give the nearest whole minute; longitudes are to be reckoned westward from Greenwich as the initial meridian.

The declination is called "west" when the north-seeking end of the magnet or needle points to the west of the true meridian, and is called "east" when the same end points to the east of the true meridian. The north end of the needle tends approximately toward the north and more particularly toward a region which surrounds the magnetic pole of dip; the magnetic declination within the limits of the United States presents, such great extremes as 18½° west at Eastport, Me., 3° east at Key West, Fla., 13¼° east at San Diego, Cal., 23° east in the Strait of Fuca, Washington Territory, and about 33° east at Fort Yukon, Alaska. The general distribution of the declination in the United States at the present time is shown on the accompanying charts, taken from the annual report of the Coast and Geodetic Survey for 1889 (as yet unpublished), the large MS. charts on two sheets having been greatly reduced to suit the present publication. These charts are for the epoch 1890 (January).

With regard to changes with the lapse of time the declinations, as observed, have undergone variations of several degrees. Thus at Boston, Mass., the declination changed from 10° west in 1700 to about 6½ west in 1778, and is now approaching 12° west and still increasing; at Monterey, Cal., the declination was 11½° east in 1780; it is now 16° east. On this subject the reader may consult the Coast and Geodetic Survey Report for 1888.†

The accuracy with which the declination may be determined depends chiefly upon the instrumental means at command, but also in a great measure upon the ability and care of the observer in using his instruments and in selecting the proper method and best time for observation. The instruments ordinarily in the hands of the observer are sufficiently described in works on surveying or in catalogues of instrument-makers; but for descriptions and illustrations of more refined instruments and for their adjustment and the methods of using them the reader may be

*In scientific treatises on terrestrial magnetism the term magnetic *declination* is always used in order to avoid any confusion which would arise when treating of such motions of the needle as the diurnal, annual, and secular variations.

†The Coast and Geodetic Survey Report for 1888, Appendix No. 7, it is expected, will soon pass through the press.

referred to Coast and Geodetic Survey Report for 1881, Appendix No. 8, entitled "Directions for Measurement of Terrestrial Magnetism."

It is a matter of observation that the needle, especially when light and delicately suspended, is seldom or never at rest; the principal laws of the angular changes have been made out; others and minor ones are known with more or less certainty and some are conjectural. These motions have, for convenience, been classified as regular and irregular variations, but we shall notice here only the principal ones.

To the former class belongs the solar variation depending upon the hour of the day, the time of the year, and the condition of the sun with respect to spot-activity; to the same class belongs the lunar variation depending on the moon's hour-angle and her position in the orbit, but this is of little interest to the practical surveyor on account of the small amplitude. In the same class is also included the secular variation, which is a systematic alteration in the earth's magnetism involving centuries to unfold itself, and as yet of unexplained origin. To the second class belong the so-called magnetic disturbances or storms, which frequently and simultaneously affect large parts and sometimes apparently the whole surface of the earth. On large averages these disturbances are found subject to complex laws, and they are noticed generally to accompany auroral displays and strong earth-currents.

They may be expected to occur at any time. Omitting any detailed notice of these disturbances and confining our attention to those more or less systematic changes which are of special interest to the surveyor as possibly affecting his work, we shall briefly review the effects of the principal regular variations as exhibited within the area of the United States.

The solar diurnal variation consists in a systematic movement of the direction of a magnet, having for its period the solar day; its character is the same for the greater part of the northern hemisphere. About the time of sunrise, or soon after it, the north-seeking end of the needle is generally found approaching to or near its easternmost position, *i. e.*, near or at its *eastern* elongation. This phase happens, for instance, at Philadelphia, Pa., on the yearly average about 8^h a. m., at Key West, Fla, about $8\frac{1}{4}^h$ a. m., and at Los Angeles, Cal., at $8\frac{1}{3}^h$ a. m.; it is subject to an annual variation, the time being earlier in summer and near $7\frac{1}{2}^h$ a. m. at Philadelphia, near $7\frac{1}{2}^h$ a. m. at Key West, near $7\frac{2}{3}^h$ at Los Angeles, near 8^h a. m. at Fort Steilacoom, Wash., and near $7\frac{3}{4}^h$ a. m. at Camp Date Creek, Arizona. In the winter, this phase is reached later—about $8\frac{3}{4}^h$ or 9^h a. m. at Philadelphia, about $9\frac{1}{2}^h$ a. m. at Key West and Los Angeles. The needle after remaining nearly stationary about this time, soon begins its principal daily motion toward the west, at first slowly, but after about $9\frac{1}{2}^h$ a. m. quite rapidly, and slackening again when nearing its western daily extreme, known as the *western* elongation, about $1\frac{1}{2}^h$ p. m. This phase is reached on the yearly average about $1\frac{1}{3}^h$ p. m. at Philadelphia, about $1\frac{3}{4}^h$ p. m. at Key West, and about $1\frac{1}{4}^h$ at Los Angeles, a few minutes earlier in summer and a few minutes later in winter, but it will generally fall between 1^h and 2^h p. m. After this second temporary stand the needle reverses its angular motion and gradually returns to the direction from which it had set out in the early morning. Not infrequently a small or secondary oscillation takes place during the night. The *average* daily direction of the needle is reached in summer about $10\frac{1}{4}^h$ a. m. and in winter about $10\frac{3}{4}^h$ a. m. at Philadelphia, about $10\frac{1}{4}^h$ a. m. and $11\frac{3}{4}^h$ a. m., at Key West, and about 10^h a. m. and $11\frac{1}{2}^h$ a. m., respectively, at Los Angeles.

The needle crosses a second time the average magnetic meridian about 7h p. m. at the former place, and about 8½h p. m. at the latter places, but these p. m. times are subject to considerable irregularity. The amount of displacement between the morning and afternoon elongations is called the diurnal range; it is about 8′ on the average during the year at Philadelphia, about 5½′ at Key West, and about 6⅓′ at Los Angeles. This range is greater for northern stations than for southern stations, and is also subject to an annual inequality, being more conspicuous in summer than in winter; thus, at Philadelphia, it reaches in August 12′, but in November only 5′, and at Key West it is in August 8′, and in November 3′; at Los Angeles, the ranges in these months are 8¾′ and 4′. This change from the maximum to the minimum and return is gradual. The solar diurnal variation is further subject to a periodic inequality related to the eleven-year cycle of the sun-spots. The diurnal range is least in years of minimum spots, as in 1878 or 1889, and is greatest in years of maximum sun spots, generally occurring about four years after the minima, as in 1883. In minimum years the range is about 0.8 and in maximum years about 1.3 of the average range. The daily variation appears at times intensified, at other times irregular and occasionally, and especially in the winter season, there are days when it is obscured or not recognizable.

The following table will be found useful for reducing observed declinations, taken at any time of the day between 6 a. m. and 6 p. m., on any day of the year, to the average value of the day, or that value which would have been obtained had hourly or continuous observations been made. The tabular values answer approximately to the middle epoch in the sun-spot cycle, and the nearest whole minute derived from them will give a degree of accuracy quite sufficient in view of the ordinary irregularities in the diurnal motion itself.

The tabular quantities give the average deviations of the direction of the needle at the respective hours of the day from the direction that would have been obtained had the mean been taken of twenty-four hourly observations. The letter W indicates that the needle points to the westward of the daily average, the letter E the reverse, whence the sign of the correction can be inferred whether the declination be westerly or easterly. Two sets of figures are given; the upper one is the mean from observations at Toronto, Canada; Philadelphia, Pa.; and Madison, Wis.; and answers, therefore, for northern stations; the lower one is the mean from observations at Key West, Fla., and Los Angeles, Cal., and answers, therefore, for southern stations.

Table for reducing an observed declination to the average declination of the day.

Mean local time.	6h a. m.	7h a. m.	8h a. m.	9h a. m.	10h a. m.	11h a. m.
	E. ′	E. ′	E. ′	E. ′	E. ′	W. ′
December, January, February:						
Northern stations	0.7	1.1	1.9	2.2	1.5	0.1
Southern stations	0.1	0.3	1.4	2.3	2.4	1.3*
March, April, May:						
Northern stations	2.6	3.8	4.4	3.5	1.2	1.6
Southern stations	1.4	2.7	3.2	2.6	1.2	0.4
June, July, August:						
Northern stations	4.0	5.6	5.7	4.5	1.7	1.6
Southern stations	2.1	3.5	3.6	2.4	0.3	1.5
September, October, November:						
Northern stations	1.8	2.6	3.1	2.5	1.0	1.5
Southern stations	0.6	2.1	2.5	1.9	0.6	0.9

* East.

Table for reducing an observed declination to the average declination of the day—Cont'd.

Mean local time.	Noon.	1h p. m.	2h p. m.	3h p. m.	4h p. m.	5h p. m.	6h p. m.
	W.	W.	W.	W.	W.	W.	W.
December, January, February:							
Northern stations	1.8	2.9	2.8	2.1	1.3	0.7	0.2
Southern stations	0.4	1.3	1.5	1.3	0.8	0.3*	0.0
March, April, May:							
Northern stations	3.8	4.8	4.6	3.8	2.5	1.4	0.7
Southern stations	1.6	2.3	2.0	2.2	1.5	0.8	0.4
June, July, August:							
Northern stations	4.1	5.6	5.6	4.6	3.0	1.4	0.6
Southern stations	2.6	3.1	2.9	2.4	1.5	0.0	0.5
September, October, November:							
Northern stations	3.3	4.0	3.4	2.3	1.2	0.6	0.1
Southern stations	1.9	2.1	1.7	1.2	0.8	0.7	0.4

*East.

The annual variation of the declination is so small that a mere mention here suffices; its amplitude is at most 1½ minutes of angular measure.

The lunar variations and inequalities.—These we likewise pass over briefly on account of their small amplitude or general minute effect. The principal inequality is the *lunar diurnal* variation, which exhibits the peculiarity of two maximum and two minimum values each lunar day. The range at Philadelphia is about 27″ and at Toronto about 38″. Other lunar inequalities are generally of smaller order.

The secular variation of the magnetic declination is, as has already been pointed out, a subject of great importance to the surveyor, especially when he is called upon to re-run old compass lines or to decide between conflicting claims as to the position of boundary lines marked out by compass many years ago, but the traces of which on the ground have become lost in the course of time. The most complete investigation of this remarkable change is contained in Coast and Geodetic Survey Report for 1888,* Appendix No. 7, and the tables here given of decennial values of the declination have been taken from this appendix. The variation in question is most probably of a periodic character, requiring centuries for its complete development, whence its specific name; it is undoubtedly of a highly complex nature. As yet at no station has a complete cycle been observed or completed, nor do we know whether the needle will ever trace out a similar one in period, in amplitude, or in other particulars; hence the necessity of continuing systematic observations at a number of stations specially selected for following up the inquiry.

These observations will enable us in time to introduce any needed change in the law as hitherto observed and improve the expression of the same, or gain a deeper insight into the secular variation. The motion may be compared to that of an oscillation of a pendulum, which alternately comes to rest at its extreme elongations and moves fastest midway between these extremes. Smaller oscillations within the period have also been discovered. About the times of maximum deflections the needle seems to fluctuate about an average position, apparently stationary for several years to ordinary or coarsely-divided instruments; but soon a perceptible change takes place, and the direction of motion is noticed to have slowly changed to one opposite to that followed before the stationary epoch. The annual change increases year by year, until the motion reaches a maximum speed, after which it

* Still in MS. in the hands of the printer.

gradually declines till the opposite stationary phase is attained, when it becomes once more zero.

This stately swing is gone through within our geographical limits in from about two hundred and fifty to about three hundred and fifty years. Thus, for example, at Baltimore and vicinity the needle was observed to be stationary about 1680, the north end of the needle pointing then nearly 6° west; in 1802 it had reached the opposite phase and was observed to point nearly ½° west; since that time the westerly motion has been kept up, and at present has already reached 4¾° west.

As might be expected the range varies greatly with geographical position, and so does the epoch of the elongations: thus the last easterly extreme occurred earliest in Maine; later in Florida, Texas, and Mexico, and has just reached but not yet touched all parts of the Pacific coast north of southern California; beyond the Straits of Fuca and for Alaska we have but little information. We have here at present a region or broad belt of no annual change or where the effect of secular variation is nil; it passes off and on the coast from the Strait of Fuca to near Point Conception, California, where it leaves the coast and stretches southward to the west of Lower California. On the other hand there is a region of no annual change but of opposite phase, and passing through Nova Scotia and New Brunswick. Between these two belts, and comprising the greater part of the United States, the effect of the secular variation is to *increase* west declination, or, what comes to the same thing, to decrease east declination, whereas on the Pacific coast there is still a narrow strip of land to the west of the belt first described, where the annual change is opposite, *i. e.*, easterly declination is still slightly increasing.

The following table gives the latitude and longitude as well as the annual change of the declination for each station, and the next table the computed decennial values of the declination (and after 1850 for every fifth year), at all places where the observations were sufficiently numerous and of sufficient range to admit of the recognition of the law of secular variation:

Geographical position of stations and annual change of declination for 1890 *and* 1895.

+ signifies increasing west or decreasing east declination.

Name of places.	Latitude.	Longitude west from Greenwich.	Annual change of declination.	
			For 1890.	For 1895.
Eastern group.				
	° ′	° ′	′	′
Eastport, Me	44 54.4	66 59.2	+0.8	+0.2
Bangor, Me	44 48.2	68 46.9	+2.4	+1.9
Portland, Me	43 38.8	70 16.6	+2.6	+2.2
Burlington, Vt	44 28.5	73 12.0	+5.0	+3.8
Hanover, N. H	43 42.3	72 17.1	+4.4	+3.9
Chesterfield, N. H	42 53.5	72 24.0	+4.3	+3.9
Rutland, Vt	43 36.5	72 55.5	+4.9	+4.4
Portsmouth, N. H	43 04.3	70 42.5	+3.2	+2.7
Newburyport, Mass	42 48.9	70 49.2	+2.6	+2.2
Salem, Mass	42 31.9	70 52.5	+3.6	+3.0
Boston, Mass	42 21.5	71 03.9	+2.2	+1.9
Cambridge, Mass	42 22.9	71 07.7	+1.5	+1.2
Provincetown, Mass	42 03.1	70 11.3	+1.9	+1.4
Nantucket, Mass	41 17.0	70 06.0	+1.2	+0.8
Providence, R. I	41 50.2	71 23.8	+4.4	+3.6

Geographical position of stations and annual change of declination, etc.—Continued.

Name of places.	Latitude.	Longitude west from Greenwich.	Annual change of declination.	
			For 1890.	For 1895.
Eastern group—Continued.				
	° ′	° ′	′	′
Williamstown, Mass	42 42.8	73 13.4	+3.4	+3.0
Hartford, Conn	41 45.9	72 40.4	+3.5	+3.3
New Haven, Conn	41 18.5	72 55.7	+3.8	+3.4
Albany, N. Y	42 39.2	73 45.8	+3.0	+2.5
Oxford, N. Y	42 26.5	75 40.5	+3.7	+3.4
Cold Spring Harbor, N. Y	40 52.0	73 28.0	+2.6	+2.3
New York City, N. Y	40 42.7	74 00.4	+3.8	+3.8
Bethlehem, Pa	40 36.4	75 22.9	+4.0	+4.3
New Brunswick, N. J	40 29.0	74 26.8	+2.2	+1.8
Jamesburgh, N. J	40 21.0	74 27.0	+3.6	+3.3
Hatboro, Pa	40 12.0	75 07.0	+4.4	+3.3
Philadelphia, Pa	39 58.9	75 09.0	+4.4	+4.4
Harrisburg, Pa	40 15.9	76 52.0	+2.3	+1.8
Huntington, Pa	40 31.0	78 02.0	+4.1	+3.9
Chambersburgh, Pa	39 55.0	77 40.0	+4.9	+4.8
Baltimore, Md	39 17.8	76 37.0	+3.1	+2.8
Washington, D. C	38 53.3	77 00.6	+1.5	+1.2
Cape Henlopen, Del	38 46.7	75 05.0	+4.0	+3.7
Williamsburgh, Va	37 16.2	76 42.4	+3.4	+3.2
Cape Henry, Va	36 55.0	76 00.4	+3.0	+2.8
New Berne, N. C	35 06.0	77 02.0	+3.0	+2.6
Charleston, S. C	32 46.6	79 55.8	+2.9	+2.5
Savannah, Ga	32 04.9	81 05.5	+3.0	+3.4
Milledgeville, Ga	33 04.2	83 12.0	+3.7	+3.7
Middle group.				
Sault de St. Marie, Mich	46 29.9	84 20.1	+4.1	+4.1
Duluth, Minn., and Superior City, Wis	46{45.5 / 39.0}	92{04.5 / 04.2}	+1.5 (?)	+1.0 (?)
Milwaukee, Wis	43 02.5	87 54.2	+5.4	+5.5
Pierrepont Manor, N. Y	43 44.5	76 03.0	+4.0	+4.2
Toronto, Canada	43 39.4	79 23.5	+3.8	+4.4
Grand Haven, Mich	43 05.2	86 12.6	+8.0 (?)	(?)
Ypsilanti, Mich	42 14.0	83 38.0	+3.1	+2.6
Michigan City, Ind	41 43.4	86 54.4	+3.5	+3.4
Buffalo, N. Y	42 52.8	78 53.5	+4.5	+4.2
Detroit, Mich	42 20.0	83 03.0	+2.5	+2.1
Erie, Pa	42 07.8	80 05.4	+3.5	+3.2
Beaver, Pa	40 44.0	80 20.0	+3.8	+3.7
Chicago, Ill	41 50.0	87 30.8	+3.8	+3.7
Cleveland, Ohio	41 30.4	81 41.5	+2.6	+2.4
Omaha, Nebr	41 15.7	95 56.5	+4.6	+4.5
Denver, Colo	39 45.3	104 59.5	+3.1	+3.4
Pittsburgh, Pa	40 27.0	80 00.8	+3.2	+3.0
Marietta, Ohio	39 25.0	81 28.0	+4.1	+3.9
Athens, Ohio	39 19.0	82 02.0	+3.3	+3.0
Cincinnati, Ohio	39 00.4	84 29.8	+3.4	+3.3
St. Louis, Mo	38 38.0	90 12.2	+4.4	+4.3
Nashville, Tenn	36 08.9	86 48.2	+4.6	+4.7
Florence, Ala	34 47.2	87 41.5	+3.2	+3.2
Mobile, Ala	30 41.4	88 02.5	+3.9	+4.0
New Orleans, La	29 57.2	90 03.0	+4.2	+4.3
San Antonio, Tex	29 25.4	98 29.3	+3.6	+3.8
Key West, Fla	24 33.5	81 48.5	+3.4	+3.2
Western group.				
El Paso, Tex	31 45.5	106 27.0	+2.6	+3.0
San Diego, Cal	32 42.1	117 14.3	+0.4	+0.8
Santa Barbara, Cal	34 24.2	119 43.0	+0.7	+1.1
Monterey, Cal	36 36.1	121 53.6	−0.0	−0.3
San Francisco, Cal	37 47.5	122 27.3	−0.2	+0.1

Geographical position of stations and annual change of declination, etc.—Continued.

Name of places.	Latitude.	Longitude west from Greenwich.	Annual change of declination.	
			For 1890.	For 1895.
Western group—Continued.	° ′	° ′	′	′
Salt Lake City, Utah	40 46.1	111 53.8	+2.5	+3.2
Cape Mendocino, Cal	40 26.3	124 24.3	+0.3	+0.6
Vancouver, Wash	45 37.5	122 39.7	+0.8	+1.3
Walla Walla, Wash	46 04.0	118 22.0	+1.0	+1.5
Cape Disappointment, Wash	46 10.7	124 02.8	−1.1	−0.7
Seattle, Wash	47 35.9	122 20.0	+0.8	+1.3
Port Townsend, Wash	48 07.0	122 44.9	+2.0	+2.5
Neah Bay, Wash	48 21.8	124 38.0	+0.3	+0.8
Sitka, Alaska	57 02.9	135 19.7	+2.7	+3.1
Port Mulgrave, Alaska	59 33.7	139 45.9	+8.8	+9.4
Port Etches, Alaska	60 20.7	146 37.6	+9.9	+10.5
St. Paul, Kodiak Island, Alaska	57 48.0	152 21.3	+6.9	+7.2
Captain's Harbor, Unalaska Island, Alaska	53 52.6	166 31.5	+2.4	+2.4
Port Clarence, Alaska	65 16.0	166 50.0	+10.4	+10.7
Chamisso Island, Alaska	66 13.0	161 49.0	+10.2	+10.4

RESULTS FOR EASTERN GROUP.

Computed magnetic declination at each station for every tenth year of the series, and after 1850 for every fifth year. A + sign signifies westerly declination, a − sign easterly declination. The *first* tabular result for any station indicates that the first observation made there falls between that tabular date and the next one following it.

Year (January 1).	Eastport, Me.	Bangor, Me.	Portland, Me.	Burlington, Vt.	Hanover, N. H.	Chesterfield, N. H.	Rutland, Vt.	Portsmouth, N. H.	Newburyport, Mass.	Salem, Mass.	Boston, Mass.	Cambridge, Mass.	Provincetown, Mass.	Nantucket, Mass.	Providence, R. I.	Williamstown, Mass.	Hartford, Conn.	New Haven, Conn.	Albany, N. Y.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1600	+19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	18.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+13	.....	.....	.....	.....	.....	.....
40	+18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13	.....	.....	.....	.....	.....	.....
1650	+17.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+12.5	.....	.....	.....	.....	.....	.....
60	17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	.....	.....	.....	.....	.....	.....
70	16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.5	.....	.....	.....	.....	.....	.....
80	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11	.....	.....	.....	.....	.....	.....
90	+14.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+10.5	.....	.....	.....	.....	.....	.....
1700	+13.7	.....	+12.1	.....	.....	.....	.....	.....	.....	.....	+10.1	+ 9.8	+10	+ 9.1	.....	.....	.....	.....	.....
10	13.0	.....	11.4	.....	.....	.....	.....	.....	.....	.....	9.4	9.2	9	8.4	+10.4	.....	.....	.....	.....
20	12.3	.....	10.6	.....	.....	.....	.....	.....	.....	.....	8.7	8.7	8.5	7.8	9.5	.....	.....	.....	.....
30	11.9	.....	9.9	.....	.....	.....	.....	.....	.....	.....	8.1	8.2	8	7.3	8.8	.....	.....	.....	.....
40	+11.6	.....	+ 9.3	.....	.....	.....	.....	.....	.....	.....	+ 7.6	+ 7.82	+ 7.4	+ 6.8	+ 8.4	.....	.....	.....	.....
1750	+11.4	.....	+ 8.8	.....	.....	.....	.....	.....	+ 8.0	+ 7.8	+ 7.1	+ 7.46	+ 7.0	+ 6.4	+ 7.8	+ 7.5	.....	+6.8	.....
60	11.4	.....	8.41	.....	+ 7.2	.....	.....	.....	7.5	7.1	6.8	7.17	6.8	6.2	7.0	6.8	.....	6.1	.....
70	11.6	.....	8.18	.....	6.6	.....	.....	+ 7.9	7.21	6.6	6.6	6.96	6.6	6.1	6.3	6.3	.....	5.6	.....
80	12.0	.....	8.12	.....	6.1	.....	+ 7.1	7.5	7.07	6.2	6.5	6.86	6.7	6.2	6.0	5.9	+5.4	5.1	.....
90	+12.6	.....	+ 8.23	+ 7.4	+ 5.8	.....	+ 6.6	+ 7.4	+ 7.07	+ 5.9	+ 6.65	+ 6.90	+ 6.9	+ 6.4	+ 6.2	+ 5.7	+5.2	+4.8	.....
1800	+13.2	+10.9	+ 8.50	+ 7.3	+ 5.8	.....	+ 6.3	+ 7.4	+ 7.26	+ 6.3	+ 6.90	+ 7.10	+ 7.2	+ 6.8	+ 6 46	+ 5.7	+5.16	+4.7	.....
10	14.0	11.4	8.92	7.2	6.0	+ 6.0	6.23	7.7	7.60	6.6	+ 7.29	7.46	7.7	7.2	6.51	5.9	5.24	4.7	+ 5.41
20	14.8	12.1	9.46	7.49	6.5	6.4	6.46	8.1	8.07	7.2	7.78	7.97	8.2	7.7	6.71	6.3	5.46	5.0	5.81
30	15.6	12.8	10.10	8.14	7.2	7.0	6.93	8.72	8.65	7.9	8.37	8.60	8.88	8.34	7.29	6.8	5.80	5.59	6.35
40	+16.4	+13.6	+10.82	+ 8.95	+ 7.9	+ 7.7	+ 7.61	+ 9.47	+ 9.31	+ 8.7	+ 9.01	+ 9.29	+ 9.56	+ 8.96	+ 8.24	+ 7.4	+6.24	+5.95	+ 7.00
1850	+17.1	+14.4	+11.56	+ 9.66	+ 8.82	+ 8.5	+ 8.46	+10.28	+10.02	+ 9.64	+ 9.67	+ 9.99	+10.25	+ 9.57	+ 9.18	+ 8.1	+6.77	+6.61	+ 7.74
55	17.5	14.8	11.92	9.96	9.31	9.0	8.03	10.70	10.37	10.11	10.00	10.33	10.59	9.87	9.53	8.5	7.06	6.97	8.12
60	17.79	15.2	12.29	10.26	9.80	9.4	9.41	11.12	10.72	10.58	10.33	10.63	10.91	10.15	9.78	8.8	7.36	7.35	8.49
65	18.08	15.5	12.64	10.60	10.28	9.9	9.91	11.53	11.06	11.04	10.64	10.92	11.21	10.40	10.00	9.2	7.68	7.72	8.86
70	+18.32	+15.9	+12.97	+10.98	+10.76	+10.3	+10.41	+11.94	+11.39	+11.48	+10.94	+11.17	+11.5	+10.64	+10.21	+ 9.6	+7.99	+8.10	+ 9.23

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Table of values of magnetic declinations—Continued.

RESULTS FOR EASTERN GROUP—Continued.

Year (January 1).	Oxford, N. Y.	Cold Spring Harbor, Long Island, N.Y.	New York City, N.Y.	Bethlehem, Pa.	New Brunswick, N.J.	Jamesburgh, N.J.	Hatboreugh, Pa.	Philadelphia, Pa.	Harrisburg, Pa.	Huntingdon, Pa.	Chambersburgh, Pa.	Baltimore, Md.	Washington, D.C.	Cape Henlopen, Del.	Williamsburgh, Va.	Cape Henry, Va.	New Berne, N.C.	Charleston, S.C.	Savannah, Ga.	Milledgeville, Ga.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1600	.....	.....	+8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	.....	.....	8.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	.....	.....	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	.....	.....	9.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
40	.....	.....	+9.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1660	.....	.....	+9.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
60	.....	.....	9.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
70	.....	.....	9.7	.....	.....	.....	.....	.....	.....	.....	.....	+5.7	.....	.....	.....	.....	.....	.....	.....	.....
80	.....	.....	9.6	.....	.....	.....	+8.3	.....	.....	.....	.....	5.8	.....	.....	.....	.....	.....	.....	.....	.....
90	.....	.....	+9.1	.....	.....	.....	+8.2	.....	.....	.....	.....	+5.7	.....	.....	+4.7	.....	.....	.....	.....	.....
1700	.....	.....	+8.5	.....	.....	.....	+7.9	+8.2	.....	.....	.....	+5.4	.....	+6.4	+4.6	+4.6	.....	+0.6	.....	.....
10	.....	.....	7.8	.....	.....	.....	7.5	7.8	.....	.....	.....	5.0	.....	5.8	4.4	4.3	.....	−0.5	.....	.....
20	.....	.....	7.3	.....	.....	.....	7.0	7.4	.....	.....	.....	4.5	.....	5.2	4.0	3.9	.....	1.2	.....	.....
30	.....	.....	6.8	.....	.....	.....	6.4	6.8	.....	.....	+4.45	3.9	.....	4.4	3.5	3.4	.....	1.8	.....	.....
40	.....	.....	+6.3	.....	.....	.....	+5.7	+6.2	.....	.....	+3.83	+3.2	.....	+3.7	+2.9	+2.9	.....	−2.5	.....	.....
1750	.....	+5.8	+5.6	+6.1	.....	.....	+4.8	+5.3	.....	+3.9	+3.18	+2.6	+2.1	+2.9	+2.3	+2.3	−0.1	−3.1	.....	.....
60	.....	5.4	5.0	5.3	.....	+4.49	3.9	4.4	.....	3.2	2.45	2.0	1.5	2.3	1.65	1.8	0.7	3.7	.....	.....
70	.....	5.0	4.6	4.5	.....	3.93	3.1	3.6	.....	2.5	1.64	1.46	1.0	1.7	1.05	1.2	1.2	4.1	.....	.....
80	.....	4.77	4.4	3.7	.....	3.49	2.4	2.8	.....	1.8	0.82	1.04	0.6	1.2	0.52	0.8	1.6	4.4	.....	.....
90	+3.01	+4.67	+4.4	+3.1	.....	+3.21	+2.0	+2.3	−0.1	+1.33	+0.12	+0.76	+0.3	+0.9	+0.10	+0.45	−1.8	−4.55	.....	.....
1800	+2.96	+4.72	+4.3	+2.6	+2.54	+3.09	+1.8	+2.1	+0.0	+0.99	−0.35	+0.64	+0.2	+0.8	−0.17	+0.24	−1.9	−4.55	.....	−5.0
10	3.10	4.90	4.5	2.3	2.93	3.15	2.0	2.16	0.3	0.84	−0.48	0.68	0.2	0.9	−0.28	0.17	1.9	4.37	−4.7	5.3
20	3.40	5.21	4.61	2.3	3.43	3.38	2.5	2.44	0.8	0.88	−0.28	0.88	0.4	1.1	−0.22	0.25	1.6	4.05	4.7	5.6
30	3.87	5.63	4.98	2.5	4.02	3.77	3.0	2.91	1.4	1.11	+0.17	1.23	0.75	1.6	+0.01	0.47	1.25	3.59	4.5	5.6
40	+4.46	+6.13	+5.66	+2.9	+4.66	+4.28	+3.7	+3.46	+2.2	+1.52	+0.75	+1.70	+1.08	+2.00	+0.38	+0.82	−0.75	−3.03	−4.2	−5.55
1850	+5.14	+6.69*	+6.31	+3.46	+5.32	+4.91	+4.35	+4.07	+2.94	+2.07	+1.38	+2.27	+1.84	+2.64	+0.88	+1.27	−0.17	−2.39	−3.78	−5.33
55	5.51	6.99	6.62	3.81	5.66	5.25	4.6	4.39	3.33	2.40	1.70	2.58	2.23	2.99	1.16	1.63	+0.14	2.06	3.54	5.17
60	5.89	7.28	6.91	4.19	5.98	5.60	5.0	4.73	3.71	2.74	2.02	2.90	2.50	3.36	1.47	1.80	0.46	1.73	3.27	4.98
65	6.26	7.58	7.16	4.58	6.29	5.96	5.3	5.08	4.08	3.10	2.35	3.23	2.68	3.73	1.78	2.08	0.79	1.39	2.68	4.76
70	+6.65	+7.87	+7.40	+5.00	+6.59	+6.32	+5.7	+5.44	+4.43	+3.48	+2.70	+3.55	+2.92	+4.11	+2.10	+2.37	+1.11	−1.07	−2.68	−4.61
1875	+7.02	+8.15	+7.64	+5.42	+6.87	+6.67	+6.2	+5.81	+4.75	+3.85	+3.06	+3.87	+3.30	+4.49	+2.43	+2.66	+1.42	−0.75	−2.37	−4.24
80	7.38	8.41	7.90	6.85	7.12	7.01	6.7	6.20	5.05	4.23	3.44	4.17	3.76	4.86	2.75	2.94	1.72	−0.45	2.06	3.96
85	7.72	8.66	8.18	6.26	7.35	7.35	7.1	6.59	5.30	4.60	3.84	4.47	4.12	5.2	3.06	3.22	2.61	−0.17	1.76	3.66
90	8.05	8.89	8.49	6.65	7.55	7.65	7 6	6.97	5.52	4.95	4.25	4.74	4.33	5.6	3.3	3.57	2.27	+0.09	1.45	3.36
95	+8.35	+9.1	+8.8	+7.03	+7.7	+7.9	+7.9	+7.4	+5.7	+5.3	+4.65	+5.01	+4.4	+5.9	+3.6	+ 3.7	+2.6	+0.3	−1.2	−3.0

RESULTS FOR MIDDLE GROUP.

Year (January 1).	Sanlt de Ste. Marie, Mich.	Dnlnth, Minn., and Superior City, Wis.	Milwaukee, Wis.	Pierrepont Manor, N. Y.	Toronto, Canada.	Grand Haven, Mich.	Ypsilanti, Mich.	Michigan City, Ind.	Buffalo, N. Y.	Detroit, Mich.	Erie, Pa.	Beaver, Pa.	Chicago, Ill.	Cleveland, Ohio.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1700	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
80	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+0.2	−0.42	.....	.....
90	+0.0	.....	.....	.....	.....	.....	.....	.....	+0.44	.....	−0.2	−0.85	.....	−1.9
1800	−0.5	.....	.....	.....	.....	.....	.....	.....	+0.22	−3.2	−0.46	−1.15	.....	−1.9
10	0.9	.....	.....	.....	.....	.....	−4.15	.....	0.21	3.11	0.52	1.30	.....	1.7
20	1.1	.....	.....	+2.6	.....	−5.0	3.65	.....	0.41	2.90	0.39	1.28	−6.2	1.5
30	1.16	.....	.....	3.05	+0.8	5.2	3.01	−5.6	0.79	2.55	−0.09	1.11	6.3	1.09
40	−1.04	.....	.....	+3.72	+1.32	−5.2	−2.25	−5.4	+1.35	−2.09	+0.36	−0.78	−6.2	−0.64
1850	−0.76	−9.8	−7.4	+4.52	+1.60	−4.95	−1.44	−5.0	+2.05	−1.56	+0.94	−0.32	−6.0	−0.14
55	0.57	9.9	7.2	4.96	1.85	4.74	1.03	4.8	2.43	1.26	1.26	−0.06	5.8	+0.13
60	0.34	10.02	6.9	5.41	2.17	4.45	0.62	4.6	2.84	0.99	1.60	+0.23	5.6	0.40
65	−0.07	10.08	6.6	6.87	2.39	4.11	−0.21	4.3	3.25	0.69	1.94	0.54	6.4	0.67
70	+0.21	−10.11	−6.2	+6.33	+2.66	−3.71	+0.18	−4 0	+3.67	−0.41	+2.30	+0.86	−5.14	+0.93
1875	+0.52	−10.10	−5.8	+6.79	+3.14	−3.25	+0.55	−3.8	+4.09	−0.13	+2.65	+1.19	−4.87	+1.20
80	0.84	10.06	5.4	7.23	3.62	2.73	0.89	3.6	4.51	+0.13	2.99	1.52	4.58	1.45
85	1.18	9.98	5.0	7.6	3.88	2.15	1.20	3.2	4.91	0.37	3.32	1.85	4.27	1.69
90	1.52	9.9	4.5	8.0	4.12	1.5	1.48	2.9	5.30	0.58	3.62	2.18	3.96	1.92
95	+1.9	−9.7	−4.1	+8.4	+4.5	−1.0	+1.7	−2.6	+5.66	+0.78	+3.9	+2.49	−3.6	+2.1

Tabular values of magnetic declinations—Continued.

RESULTS FOR MIDDLE GROUP.

Year (January 1).	Omaha, Nebr.	Denver, Colo.	Pittsburgh, Pa.	Marietta, Ohio.	Athens, Ohio.	Cincinnati, Ohio.	St. Louis, Mo.	Nashville, Tenn.	Florence, Ala.	Mobile, Ala.	New Orleans, La.	San Antonio, Tex.	Key West, Fla.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1700	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	−2.3	.....	.....
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.2	.....	.....
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.4	.....	.....
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.7	.....	.....
40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	−3.1	.....	.....
1750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	−3.7	.....	.....
60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.4	.....	.....
70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.1	.....	.....
80	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.8	.....	.....
90	.....	.....	.....	.....	−4.0	.....	.....	.....	.....	.....	−6.5	.....	.....
1800	.....	.....	.....	.....	−4.1	−4.89	.....	.....	.....	−5.81	−7.12	.....	.....
10	−12.5	.....	.....	−2.9	4.1	5.01	.....	.....	−6.50	6.30	7.62	.....	.....
20	12.6	.....	.....	2.8	3.9	4.99	.....	−6.7	6.58	6.71	7.96	− 9.8	−6.86
30	12.6	.....	.....	2.7	3.60	4.82	−8.9	6.0	6.54	6.97	8.15	10.1	6.50
40	−12.4	.....	+0.18	−2.33	−3.15	−4.51	−8.6	−6.9	−6.37	−7.07	−8.16	−10.3	−6.03
1850	−12.0	.....	+0.68	−1.86	−2.61	−4.08	−8.2	−6.7	−6.11	−6.99	−8.00	−10.2	−5.47
55	11.8	.....	0.96	1.57	2.31	3.83	8.0	6.5	5.93	6.90	7.86	10.2	5.17
60	11.5	−15.14	1.26	1.27	2.00	3.57	7.7	6.3	5.74	6.75	7.66	10.1	4.85
65	11.22	15.02	1.58	0.94	1.68	3.28	7.4	6.1	5.53	6.57	7.44	9.93	4.53
70	−10.90	−14.88	+1.87	−0.60	−1.36	−2.99	−7.1	−5.76	−5.30	−6.36	−7.18	− 9.75	4.21
1875	−10.56	−14.71	+2.18	−0.26	−1.04	−2.69	−6.7	−5.46	−5.08	−6.12	−6.90	− 9.64	−3.88
80	10.21	14.52	2.49	+0.10	0.73	2.39	6.4	6.13	4.81	5.84	6.69	9.30	3.57
85	9.83	14.30	2.78	0.45	0.43	2.09	6.0	4.78	4.55	5.54	6.26	9.03	3.26
90	9.46	14.06	3.06	0.79	−0.14	1.80	5.6	4.40	4.28	5.23	5.91	8.7	2.96
95	− 9.1	−13.8	+3.3	+1.1	+0.1	−1.5	−5.3	−4.0	−4.0	−4.9	−5.6	− 8.4	−2.7

Tabular values of magnetic declinations.

RESULTS FOR WESTERN GROUP.

Year (January 1).	El Paso, Tex.	San Diego, Cal.	Santa Barbara, Cal.	Monterey, Cal.	San Francisco, Cal.	Salt Lake City, Utah.	Cape Mendocino, Cal.	Vancouver, Wash. T.	Walla Walla, Wash. T.	Cape Disappointment, Wash. T.	Seattle, Duwamish Bay, Wash. T.	Port Townsend, Wash. T.	Nee-ah Bay, near Cape Flattery, Wash. T.	Sitka, Alaska.	Port Mulgrave, Yakutat Bay, Alaska.	Port Etches, Alaska.	St. Paul, Kadiak Island.	Captain's and Iliuliuk Harbors, Unalashka Island.	Port Clarence, Alaska.	Chamisso Island, Kotzebue Sound.
1700	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
10	......	—7.4	—8.2	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
20	......	7.4	8.2	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
30	......	7.4	8.3	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
40	......	—7.6	—8.5	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
60	......	—7.9	—8.9	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
60	......	8.2	9.3	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
70	......	8.7	9.8	......	......	......	......	......	......	......	......	......	......	—24.2	—22.7	—22.5	—22.2	......	......	......
80	......	9.2	10.4	—11.4	—12.6	......	—14.2	—15.6	......	—17.1	......	—16.8	—17.3	24.9	24.5	24.4	23.4	—18.6	......	......
90	......	—9.7	—11.0	—11.8	—13.1	......	—14.7	—16.1	......	—17.3	......	—17.4	—17.8	—25.7	—26.2	—26.16	—24.5	—19.0	......	......
1800	......	—10.3	—11.6	—12.33	—13.6	......	—15.1	—16.8	......	—17.7	......	—18.1	—18.3	—26.41	—27.82	—27.84	—25.54	—19.32	......	......
10	......	10.8	12.3	12.86	14.1	......	15.6	17.6	......	18.2	......	18.8	18.9	27.12	29.25	20.28	26.37	19.56	......	......
20	......	11.4	12.9	13.40	14.54	......	16.0	18.2	......	18.7	......	19.6	19.6	27.76	30.41	30.44	26.98	19.73	—26.6	—31.1
30	......	11.9	13.43	13.93	15.00	......	16.5	18.9	......	19.2	......	20.3	20.3	28.31	31.24	31.22	27.32	19.82	27.0	31.3
40	......	—12.35	—13.90	—14.45	—15.42	......	—16.9	—19.6	......	—19.8	......	—20.9	—21.0	—28.72	—31.71	—31.58	—27.38	—19.75	—26.9	—31.1
50	—12.31	—12.73	—14.30	—14.91	—15.79	—16.0	—17.2	—20.17	—20.4	—20.31	—21.3	—21.38	—21.64	—28.99	—31.78	—31.50	—27.15	—19.71	—26.4	—30.5
55	12.41	12.89	14.46	15.13	15.96	16.3	17.3	20.41	20.6	20.56	21.6	21.57	21.90	29.06	31.66	31.30	26.93	19.63	26.0	30.1
60	12 47	13.03	14.60	15.32	16.10	16.46	17.4	20.62	20.8	20.80	21.8	21.70	22.13	29.09	31.45	30.99	26.65	19.53	25.6	29.6
65	12.48	13.14	14.70	15.49	16.23	16 58	17.5	20.78	20.9	21.02	22.0	21.79	22.33	29.08	31.14	30.59	26.31	19.41	25.0	29.0
70	—12.45	—13.22	—14.78	—16.65	—16.34	—16.64	—17.6	—20.91	—21.0	—21.22	—22.13	—21.83	—22.60	—29.02	—30.74	—30.09	—25.90	—19.27	—24.4	—28.3
75	—12.38	—13.28	—14.82	—15.78	—16.44	—16.64	—17.6	—21.00	—21.1	—21.40	—22.23	—21.83	—22.62	—28.92	—30.26	—29.49	25.45	—19.11	—23.7	—27.6
80	12.26	13.31	14.84	15.89	16.51	16.58	17.69	21.04	21.1	21.56	22.28	21.78	22.70	28.79	29.69	28.8	24.96	18.94	22.9	26.8
85	12.11	13.32	14.82	15.98	16.56	16.46	17.70	21.05	21.1	21.69	22.29	21.68	22.74	28.6	29.06	28.1	24.4	18.75	22.1	26.0
90	11.91	13.29	14.8	16.04	16.58	16.3	17.69	21.0	21.0	21.79	22.25	21.54	22.73	28.4	28.4	27.3	23.9	18.56	21.2	25.2
1895	—11.7	—13.2	—14.7	—16.1	—16.6	—16.0	—17.7	—20.9	—21.0	—21.9	—22.2	—21.3	—22.7	—28.2	—27.6	—26.4	—23.3	—18.4	—20.4	—24.3

It will be observed that the character of the secular variation is the same over large areas, though each place has apparently minor features peculiar to itself. In consequence of our very imperfect data the deduced annual change (in minutes of arc) due to the action of the secular variation, can only claim to be a fair approximation for the several States and Territories at the present time.

In the following table the + sign indicates an increase of west declination, or its equivalent a decrease of east declination.

Table showing the annual change of the magnetic declination for the epoch 1890 *and referring to the central part of each State, Territory, or subdivision.*

Locality.	Annual change.	Locality.	Annual change.
	′		′
Alabama	+3.5	Mississippi	+3.7
Alaska:		Missouri	4.2
Dixon Entrance	1 (?)	Montana	2 (?)
Sitka Bay	3	Nebraska:	
Off Monot St. Elias	9 (?)	Western part	3 (?)
Arizona	2 (?)	Eastern part	4 (?)
Arkansas	3.3	Nevada	2 (?)
California:		New Hampshire	3.4
Northern part	0.5(?)	New Jersey	3.5
Southern part	0.7(?)	New Mexico	2.7
Colorado	2.9	New York:	
Connecticut	3.7	Long Island	3.3
Delaware	3.3	Main part	3.9
District of Columbia	3.1	North Carolina	3.4
Florida:		North Dakota	3 (?)
Northwestern part	3.6	Ohio	3.3
Peninsular	3.4	Oregon:	
Georgia	3.6	Western part	0.0
Idaho	2 (?)	Eastern part	1.5(?)
Illinois	4.0	Pennsylvania	3.9
Indiana	3.8	Rhode Island	3.4
Indian Territory	3.0	South Carolina	3.3
Iowa	4.4	South Dakota	4 (?)
Kansas	3.3	Tennessee	3.5
Kentucky	3.5	Texas:	
Louisiana	3.4	Northwest part	2.8
Maine:		Western part	2.6
Western part	2.5	Main part	3
Eastern part	1.0	Utah	2.5
Maryland	3.1	Vermont	4.3
Massachusetts:		Virginia	2.3
Western part	3.7	Washington:	
Eastern part	2.2	Western part	0.0
Michigan:		Eastern part	1.2
Southern part	4 (?)	West Virginia	3.3
Northwestern part	3 (?)	Wisconsin	3.5(?)
Minnesota	3.5(?)	Wyoming	3 (?)

It is to be hoped that before long we shall be in possession of sufficient material to render the above table more comprehensive and satisfactory. The numbers may be used for a few years (five) without serious error, but they certainly need recomputing after the lapse of a few years.

Isogonic charts.—If for any epoch we connect by curves all positions where the needle was observed to have the same declination, we trace out the so-called isogonic lines. On the accompanying charts they are laid down for equal differences of 1°, every fifth line, for greater distinction, being heavier. Such charts need reconstruction from time to time, not only for the purpose of improvements, but in consequence of the ever changing direction of the magnetic force. Thus, for instance, the line of no declination, or agonic line, as such lines are called, but which have no other distinction (beyond declination equal to zero), over any other isogonic line, is now seen to pass through the Strait of Mackinaw, Mich., Toledo, Ohio, and crossing the coast near Charleston, S. C.;

whereas about the years 1797 and 1803, when this same agonic line had its most northeasterly position on this coast, it passed near Buffalo, N. Y., Harrisburg, Pa., Annapolis, Md., to Cape Henry, Va. This and its neighboring lines will continue for some time to move southwestward on the Atlantic coast.

Magnetic disturbances.—These irregular motions of the needle may not infrequently be a source of annoyance to the surveyor; they may occur at any time, and are, when taken individually, beyond our power of prediction, but when averages are taken of many thousands they are nevertheless found to be subject to precise laws.

Their presence is generally indicated by sudden deflections and by rapid and great fluctuations in the direction of the needle, greatly exceeding all ordinary variations.

These deflections occur alternately on opposite sides of the normal position, and often take place simultaneously at distant regions of the globe; they may last from a few hours to a day, or even several days, and are frequently accompanied by auroral displays. These disturbances are found to be strictly under solar influence. Irrespective of direction of the disturbing force, the most disturbed hours of the day are frequently those between 7^h and 10^h a. m., and the least disturbed those between 2^h and 6^h p. m., but we can not here enter more fully into this subject. The greatest number of disturbances occur in the months of August, September, and October, the least number in January and June, and the disturbances are most active in years of sunspot maxima, and least so in years of minima. In the United States (excepting Alaska) deflections on either side of the normal of $\frac{1}{4}^\circ$ are common; deflections of $\frac{1}{2}^\circ$ may occasionally be noticed, but those exceeding 1° are rare, unless the place be near the northern boundary.—[C. A. S., AUGUST 26, 1889.]

METHOD OF ASCERTAINING THE MAGNETIC DECLINATION OR VARIATION OF THE COMPASS.

The following chapter, on the subject of the declination of the magnetic needle, is extracted from the revised edition of the work on surveying by Dr. Charles Davies, a graduate of the Military Academy at West Point. The work itself will be a valuable acquisition to the deputy surveyor, and his attention is particularly invited to the following chapter, which sets forth the usual easy modes by which the true meridian and magnetic declination may be approximately ascertained; his attention is also called to more complete statements on the subject given in the work "A treatise on land-surveying, etc.," by Dr. W. M. Gillespie, professor of engineering, Union College, in chapter treating of the declination of the magnetic needle. For more refined methods, he may consult Coast and Geodetic Survey Report for 1881, Appendix No. 8.

METHOD OF ASCERTAINING THE VARIATION.

"The best practical method of determining the true meridian of a place is by observing the north star. If this star were precisely at the point in which the axis of the earth, prolonged, pierces the heavens, then the intersection of the vertical plane passing through it and the place, with the surface of the earth, would be the true meridian. But the star being at a distance from the pole equal to $1^\circ\ 30'$ nearly,* it performs a revolution about the pole in a circle, the polar distance of which is $1^\circ\ 30'$;* the time of revolution is 23 hours and 56 minutes.

* $1^\circ\ 17'$ in 1890.

"To the eye of an observer this star is continually in motion and is due north but twice in 23 hours and 56 minutes; and is then said to be on the meridian. Now, when it departs from the meridian, it apparently moves east or west for 5 hours and 59* minutes, and then returns to the meridian again.

"When at its greatest distance from the meridian, east or west, it is said to be at its *eastern* or *western* elongation."

The following table† shows the times of the eastern and western elongations for 1889, computed for latitude 40° and for longitude 90° W. of Greenwich, also the times of culminations of Polaris; with directions for use for any year between 1889 and 1910; and for different latitudes.

Local mean (astronomical‡) time of the culminations and elongations of Polaris in the year 1889.

[Computed for latitude + 40° and longitude 6h west from Greenwich.]

Date.	Eastern elongation.	Upper culmination.	Western elongation.	Lower culmination.
1889.	h. m.	h. m.	h. m.	h. m.
Jan. 1	0 36.2	6 31.0	12 25.7	18 29.1
15	23 37.0	5 35.7	11 30.4	17 33.8
Feb. 1	22 20.0	4 28.6	10 23.3	16 26.7
15	21 34.6	3 33.3	9 28.1	15 31.4
Mar. 1	20 39.4	2 38.1	8 32.8	14 36.2
15	19 44.4	1 43.0	7 37.7	13 41.1
April 1	18 37.4	0 36.0	6 30.7	12 34.1
15	17 42.4	23 37.1	5 35.7	11 39.0
May 1	16 39.5	22 34.2	4 32.9	10 36.1
15	15 44.6	21 39.3	3 38.0	9 41.2
June 1	14 37.9	20 32.7	2 31.3	8 34.6
15	13 43.0	19 37.8	1 36.4	7 39.7
July 1	12 40.4	18 35.2	0 33.8	6 37.1
15	11 45.5	17 40.3	23 35.0	5 42.2
Aug. 1	10 39.0	16 33.8	22 28.4	4 35.7
15	9 44.1	15 38.9	21 33.5	3 40.8
Sept. 1	8 37.5	14 32.3	20 26.9	2 34.2
15	7 42.6	13 37.4	19 32.0	1 39.3
Oct. 1	6 39.7	12 34.5	18 29.1	0 36.4
15	5 44.7	11 39.5	17 34.1	23 37.6
Nov. 1	4 37.9	10 32.7	16 27.3	22 30.8
15	3 42.7	9 37.5	15 32.2	21 35.6
Dec. 1	2 39.7	8 34.5	14 29.2	20 32.6
15	1 44.4	7 39.3	13 34.0	19 37.3

It will be noted that for the tabular year two eastern elongations occur on January 10 and two western elongations on July 9; there are also two culminations on April 10 and on October 9.

The lower culmination either follows or precedes the upper culmination by 11 hours 58.1 minutes.

For other dates and positions than those implied by the table we need to apply the following corrections:

To refer the tabular times to any year subsequent to the tabular year (1889) add 0.33 minutes for every year. To refer the tabular times, corrected as above, to any year in a quadriennium observe that for first year after a leap year the table is correct; for second year after a leap year add 0.9 minutes to the tabular value; for third year after a leap year add 1.7 minutes to the tabular value; for leap year,

* In 1890 and latitude 40°, for about 5h 55m easterly and 6h 03m westerly.

† Computed at the Coast and Geodetic Survey Office, as was also the table of azimuths.

‡ Counted from noon and from zero to twenty-four hours.

and *before* March 1, add 2.6 minutes to the tabular value; for leap year *from* and *after* March 1, subtract 1.2 minutes from the tabular value.

To refer to any calendar day other than the first and fifteenth of each month, subtract 3.94 minutes for every day between it and the preceding tabular day, or add 3.94 minutes for every day between it and the succeeding tabular day. The longitude correction will amount to 0.16 minutes for each hour.

To refer to any other than the tabular latitude and between the limits of 25° and 50° north, add to the time of west elongation 0.13 minutes for every degree *south* of 40° and subtract from the time of west elongation 0.18 minutes for every degree *north* of 40°; reverse these signs for corrections to times of east elongation.

It will be important to direct attention to the fact that the year 1900 is *not* a leap year, and this must be kept in view when dealing with dates from and after March 1 of that year. The twentieth century begins after the expiration of December 31, 1900.

The deduced tabular times may generally be depended upon with no greater error than 0.3 minute.

The following table exhibits the angle which the meridian plane makes with the vertical plane passing through the pole-star when at its eastern or western elongation; this angle is called the azimuth of the star at elongation:

Azimuth of Polaris when at elongation for any year between 1889 *and* 1910, *and for any latitude between* +25° *and* +50°.

Lat.	1890.0	1891.0	1892.0	1893.0	1894.0	1895.0	1896.0	1897.0	1898.0	1899.0	1900.0	1901.0	1902.0	1903.0	1904.0	1905.0	1906.0	1907.0	1908.0	1909.0	1910.0	Lat.
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	°
+25	1 24.6	1 24.3	1 23.9	1 23.6	1 23.2	1 22.9	1 22.6	1 22.2	1 21.9	1 21.5	1 21.2	1 20.8	1 20.5	1 20.1	1 19.8	1 19.4	1 19.1	1 18.7	1 18.4	1 18.1	1 17.7	+25
26	25.3	25.0	24.6	24.3	23.9	23.6	23.2	22.9	22.5	22.2	21.8	21.5	21.1	20.8	20.5	20.1	19.8	19.4	19.1	18.7	18.4	26
27	26.0	25.7	25.4	25.1	24.7	24.3	24.0	23.6	23.3	22.9	22.5	22.2	21.9	21.5	21.2	20.8	20.5	20.1	19.8	19.4	19.1	27
28	26.8	26.5	26.2	25.8	25.4	25.1	24.7	24.4	24.0	23.7	23.3	23.0	22.6	22.2	21.9	21.6	21.3	20.9	20.5	20.1	19.8	28
29	27.6	27.3	27.0	26.6	26.3	25.9	25.5	25.2	24.8	24.5	24.1	23.8	23.4	23.0	22.7	22.4	22.1	21.7	21.3	20.9	20.5	29
30	28.5	28.2	27.8	27.5	27.1	26.8	26.4	26.0	25.7	25.3	24.9	24.6	24.2	23.9	23.5	23.1	22.8	22.4	22.1	21.7	21.3	30
31	29.4	29.1	28.8	28.4	28.0	27.6	27.3	26.9	26.5	26.2	25.8	25.6	25.1	24.7	24.4	24.0	23.8	23.2	22.9	22.5	22.2	31
32	30.4	30.1	29.7	29.3	29.0	28.6	28.2	27.8	27.5	27.1	26.7	26.4	26.0	25.6	25.3	24.9	24.5	24.1	23.8	23.4	23.1	32
33	31.4	31.1	30.7	30.3	30.0	29.6	29.2	28.8	28.5	28.1	27.7	27.3	27.0	26.6	26.2	25.9	25.6	25.1	24.7	24.3	24.0	33
34	32.5	32.1	31.8	31.4	31.0	30.6	30.3	29.9	29.5	29.1	28.7	28.4	28.0	27.6	27.2	26.9	26.5	26.1	25.7	25.3	25.0	34
35	33.6	33.2	32.9	32.5	32.1	31.7	31.3	31.0	30.6	30.2	29.8	29.4	29.0	28.7	28.3	27.9	27.5	27.1	26.8	26.4	26.0	35
36	34.8	34.4	34.0	33.6	33.2	32.9	32.5	32.1	31.7	31.3	30.9	30.5	30.1	29.8	29.4	29.0	28.6	28.2	27.9	27.5	27.1	36
37	36.0	35.6	35.2	34.8	34.5	34.1	33.7	33.3	32.9	32.5	32.1	31.7	31.3	30.9	30.5	30.1	29.7	29.3	29.0	28.6	28.2	37
38	37.3	36.9	36.5	36.1	35.7	35.3	34.9	34.5	34.1	33.7	33.3	33.0	32.6	32.2	31.8	31.4	31.0	30.6	30.2	29.8	29.4	38
39	38.7	38.3	37.9	37.5	37.1	36.7	36.3	35.9	35.5	35.1	34.7	34.3	33.9	33.5	33.1	32.7	32.3	31.8	31.4	31.0	30.6	39
40	40.1	39.7	39.3	38.9	38.5	38.1	37.7	37.3	36.8	36.4	36.0	35.6	35.2	34.8	34.4	34.0	33.6	33.2	32.8	32.4	32.0	40
41	41.6	41.2	40.8	40.4	40.0	39.6	39.2	38.8	38.3	37.9	37.5	37.1	36.7	36.2	35.8	35.4	35.0	34.6	34.2	33.8	33.4	41
42	43.2	42.8	42.4	42.0	41.5	41.1	40.7	40.3	39.8	39.4	39.0	38.6	38.2	37.7	37.3	36.9	36.5	36.0	35.6	35.2	34.8	42
43	44.9	44.4	44.0	43.6	43.2	42.7	42.3	41.9	41.5	41.0	40.6	40.2	39.8	39.3	38.9	38.5	38.1	37.6	37.2	36.8	36.3	43
44	46.6	46.2	45.8	45.3	44.9	44.4	44.0	43.6	43.1	42.7	42.3	41.8	41.4	41.0	40.5	40.1	39.7	39.2	38.8	38.4	37.9	44
45	48.5	48.1	47.6	47.1	46.7	46.2	45.8	45.4	44.9	44.5	44.0	43.6	43.2	42.7	42.3	41.8	41.4	40.9	40.5	40.1	39.6	45
46	50.5	50.0	49.5	49.0	48.6	48.2	47.7	47.3	46.8	46.4	45.9	45.5	45.0	44.6	44.2	43.7	43.2	42.7	42.3	41.8	41.4	46
47	52.5	52.0	51.5	51.0	50.6	50.2	49.7	49.3	48.8	48.3	47.9	47.4	46.9	46.5	46.0	45.6	45.1	44.6	44.2	43.7	43.3	47
48	54.6	54.2	53.7	53.2	52.8	52.3	51.9	51.4	50.9	50.4	49.9	49.5	49.0	48.6	48.1	47.7	47.2	46.7	46.3	45.8	45.3	48
49	56.9	56.5	56.0	55.5	55.0	54.5	54.1	53.6	53.1	52.6	52.1	51.7	51.2	50.7	50.2	49.8	49.3	48.8	48.4	47.9	47.4	49
50	1 59.3	1 58.8	1 58.4	1 57.9	1 57.4	1 56.9	1 56.4	1 55.9	1 55.4	1 54.9	1 54.5	1 54.0	1 53.5	1 53.0	1 52.5	1 52.0	1 51.5	1 51.0	1 50.6	1 50.1	1 49.6	50

The preceding table is computed with the mean declination of Polaris for each year; a closer result will be had by applying to the tabular values the following correction, which depends on the difference of the mean and the apparent place of the star:

For middle of—	Lat. 25°.	Lat. 40°.	Lat. 50°.	For middle of—	Lat. 25°.	Lat. 40°.	Lat. 50°.
	′	′	′		′	′	′
January	−0.3	−0.4	−0.4	July	+0.2	+0.3	+0.3
February	−0.3	−0.3	−0.4	August	+0.1	+0.1	+0.2
March	−0.1	−0.2	−0.2	September	0.0	−0.1	−0.1
April	0.0	0.0	0.0	October	−0.2	−0.3	−0.3
May	+0.2	+0.2	+0.2	November	−0.5	−0.6	−0.7
June	+0.2	+0.3	+0.3	December	−0.6	−0.8	−0.9

The deduced tabular azimuth (counted from the north) may generally be depended upon with no greater error than $\pm 0'.2$.

TO FIND THE TRUE MERIDIAN WITH THE ENGINEER'S OR SURVEYOR'S TRANSIT.

Take a board, of about one foot square, paste white paper upon it, and perforate it through the center, the diameter of the hole being somewhat larger than the diameter of the telescope of the transit. Let this board be so fixed to a vertical staff as to slide up and down freely, and let a small piece of board, about three inches square, be nailed to the lower edge of it, for the purpose of holding a candle.

About twenty-five minutes before the time of the greatest eastern or western elongation of the pole-star, as shown by the tables of elongations, let the transit be placed at a convenient point and leveled. Let the board be placed about one foot in front of the instrument, a lamp or candle placed on the shelf at its lower edge; and let the board be slipped up or down, until the pole-star can be seen through the hole. The light reflected from the paper will show the cross hairs in the telescope.

Then, let the vertical spider's line be brought exactly upon the pole-star, and if it is an eastern elongation that is to be observed, and the star has not yet reached the most easterly point, it will move from the line toward the east, and the reverse when the elongation is west.

At the time the star attains its greatest elongation, it will appear to coincide with the vertical spider's line for some time, and then leave it, in the direction contrary to its former motion.

As the star moves toward the point of greatest elongation, the telescope must be continually directed to it, by means of the tangent screw of the vernier plate; and when the star has attained its greatest elongation, great care should be taken that the instrument be not afterward moved.

Now, if it be not convenient to leave the instrument in its place until daylight, let a staff, with a candle or small lamp upon its upper extremity, be arranged at thirty or forty yards from the instrument, and in the same vertical plane with the axis of the telescope. This is easily effected, by revolving the vertical limb about its horizontal axis without moving the vernier plate, and aligning the staff to coincide with the vertical hair. Then mark the point directly under the transit; the line pass-

ing through this point and the staff, makes an angle with the true meridian equal to the azimuth of the pole-star.

From the table of azimuths, page 70, take the azimuth corresponding to the year and nearest latitude. If the observed elongation was east, the true meridian lies on the west of the line which has been found, and makes with it an angle equal to the azimuth. If the elongation was west, the true meridian lies on the east of the line; and, in either case, laying off the azimuth angle with the transit, gives the true meridian.

TO FIND THE TRUE MERIDIAN WITH THE COMPASS.

1. Drive two posts firmly into the ground, in a line nearly east and west; the uppermost ends after the posts are driven, being about three feet above the surface, and the posts about four feet apart; then lay a plank, or piece of timber three or four inches in width, and smooth on the upper side, upon the posts, and let it be pinned or nailed, to hold it firmly.

2. Prepare a piece of board four or five inches square, and smooth on the under side. Let one of the compass sights be placed at right angles to the upper surface of the board, and let a nail be driven through the board, so that it can be tacked to the timber resting on the posts.

3. At about twelve feet from the stakes, and in the direction of the pole-star, let a plumb be suspended from the top of an inclined stake or pole. The top of the pole should be of such a height that the pole-star will appear about six inches below it; and the plumb should be swung in a vessel of water to prevent it from vibrating.

This being done, about twenty minutesbefore the time of elongation place the board to which the compass sight is fastened on the horizontal plank, and slide it east or west until the aperture of the compass sight, the plumb line, and the star are brought into the same range. Then if the star depart from the plumb line move the compass sight east or west along the timber, as the case may be, until the star shall attain its greatest elongation, when it will continue behind the plumb line for several minutes, and will then recede from it in the direction contrary to its motion before it became stationary. Let the compass sight be now fastened to the horizontal plank. During this observation it will be necessary to have the plumb line lighted; this may be done by an assistant holding a candle near it.

Let now a staff, with a candle or lamp upon it, be placed at a distance of thirty or forty yards from the plumb line, and in the same direction with it and the compass sight. The line so determined makes, with the true meridian, an angle equal to the azimuth of the pole-star; and from this line the variation of the needle is readily determined, even without tracing the true meridian on the ground.

Place the compass upon this line, turn the sights in the direction of it, and note the angle shown by the needle. Now, if the elongation at the time of observation was west, and the north end of the needle is on the west side of the line, the azimuth, plus the angle shown by the needle, is the true variation. But should the north end of the needle be found on the east side of the line, the elongation being west, the difference between the azimuth and the angle would show the variation, and the reverse when the elongation is east.

EXAMPLES.

1. Elongation west, azimuth	1° 35′	
North end of the needle on the west, angle	4° 35′	
The *sum* is the variation	6° 10′	west.
2. Elongation west, azimuth	1° 59′	
North end of the needle on the east, angle	4° 50′	
The *difference* is the variation	2° 51′	east.
3. Elongation east, azimuth	1° 42′	
North end of the needle on the west, angle	8° 07′	
The *difference* is the variation	6° 25′	west.
4. Elongation east, azimuth	1° 57′	
North end of the needle on the east, angle	8° 40′	
The *sum* is the variation	10° 37′	east.

It may be stated that for magnetic purposes a moderate degree of accuracy suffices in the determination of the meridian, and a correct knowledge of it within 1′ will in general fully suffice. It is difficult, even in our middle latitudes, to determine the *magnetic* meridian within the limit of 1′ on account of the continuous fluctuations; hence any greater accuracy than this in the astronomic meridian would be useless.

A very near approximation to a true meridian, and consequently to a variation, may be had, by remembering that the pole-star very nearly reaches the true meridian when it is in the same vertical plane with the star Delta (δ) in the constellation Cassiopeia. Using the apparatus just described, place the "sight-board" in line with the plumb-line and the pole-star, and move it to the *west* as the pole star moves *east*,* until Polaris and Delta both appear upon the plumb-line together; the line through the point of sight and the plumb-line will be, very nearly and with sufficient accuracy, the true meridian. This method is practicable only when the star Delta is *below* the pole-star during the night; when it passes the meridian above the pole, it is too near the zenith to be of service, in which case the star Zeta (ζ), the last star but one in the tail of the Great Bear, may be used instead.

Delta (δ) Cassiopeia is on the meridian below the pole-star at midnight about April 10, and is, therefore, the proper star to use at that date and for some two or three months before and after.

Six months later, the star Zeta (ζ), in the tail of the Great Bear, will supply its place, and is to be used in precisely the same manner.

The diagram† gives a representation, drawn to scale, of North Pole, Polaris, and the constellations Cassiopeia and Great Bear; and the line drawn through the star Delta (δ), of Cassiopeia, and Zeta (ζ) of the Great Bear represents those stars on the meridian with the pole-star.

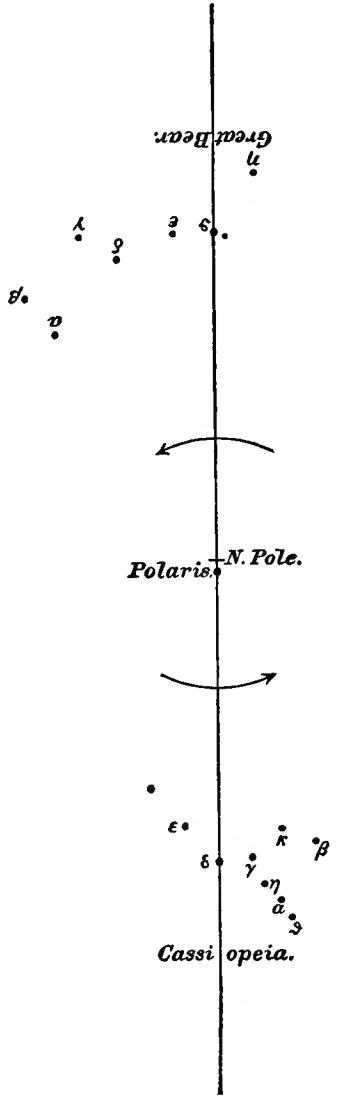
The method given in this article for finding the true meridian can not be used with advantage, on account of the haziness of the amosphere near the horizon at places below about 38° north latitude.

The foregoing methods for the determination of the true meridian and variation of the compass are excellent in themselves when available, as they answer the requirements of the surveyor and give results with all desirable precision. They do not require an accurate knowledge of the time, which is their principal advantage. The relative mo-

*At its lower culmination. †See next page.

tion of the stars employed, when near the meridian and the unchangeable azimuth of Polaris at elongation (so far as the surveyor is concerned), indicate with sufficient exactness the moment when the ob-

This method is given in LaLande's Astronomy and was practiced by A. Ellicott, in 1785, on the Ohio and Peunsylvania boundary.



The diagram held vertically, with the right hand side of the page uppermost (the reader facing north) will represent the configuration of the constellations with Polaris near *eastern* elongation at midnight about July 10—*inverted*, it will show Zeta (ζ) of the Great Bear and Polaris on the meridian (the former *below* and the latter *above* the pole) at midnight about October 10; and held with left hand side uppermost the diagram will indicate relative situations for midnight about January 10, with Polaris near *western* elongation. The arrows indicate the direction of apparent motion. Zeta (ζ) of the Great Bear (also sometimes called the Great Dipper) was called *Mizar* by the ancient Arabians, and the small star near it *Alcor*. *Mizar* is the second star from the end of the handle of the dipper.

servation is to be made. Stormy weather, a hazy atmosphere, or the presence of clouds may interfere with or entirely prevent observation when the star is either at elongation or on the meridian, and both events sometimes occur in broad daylight or at a late or otherwise inconvenient hour. Under such circumstances a simple method, for use at any time (Polaris being visible), may be acceptable, and can often be used by the surveyor when other methods fail.

DETERMINATION OF THE AZIMUTH OF POLARIS, TRUE MERIDIAN AND VARIATION OF THE COMPASS, AT ANY HOUR, THE CORRECT LOCAL MEAN TIME BEING KNOWN.

Many years ago a table was published giving azimuths of Polaris at stated times during one year, but as it was arranged for a kind of time with which surveyors are generally unacquainted and was explained in unfamiliar astronomical terms and required the use of tables and data not always accessible, it met with little favor and never came into general use.

In this article it is proposed to simplify the work, omit all technicalities requiring a knowledge of astronomy, and present the method, with two new and compact tables* adapted to common clock time, with directions for use so plain that any person of ordinary intelligence can understand and apply them.

As the surveyor should have a perfectly clear idea of what is meant by *Astronomical Time* (used to simplify computations), and the *Hour Angle of Polaris*, these terms will now be explained.

The *Civil Day*, according to the customs of society, commences at midnight and comprises twenty-four hours from 1 midnight to the next following. The hours are counted from 0 to 12 from midnight to noon, after which they are again reckoned from 0 to 12 from noon to midnight. Thus the day is divided into two periods of 12 hours each; the first of which is marked a. m., the last p. m.

The *Astronomical Day*, commences at noon on the Civil day of the same date. It also comprises twenty-four hours; but they are reckoned from 0 to 24, and from the noon of one day to that of the next following.

The Civil day begins twelve hours before the astronomical day; therefore the first period of the civil day answers to the last part of the preceding Astronomical day, and the last part of the Civil day corresponds to the first part of the Astronomical day. Thus, January 9, 2 o'clock p. m., Civil time, is also January 9, 2^h, Astronomical time; and January 9, 2 o'clock a. m., Civil time is January 8, 14^h Astronomical time.

The rule, then, for the transformation of Civil time into Astronomical time is this: *If the civil time is marked p. m., take away the designation p. m., and the astronomical time is had without further change; if the civil time is marked a. m., take one from the day and add twelve to the hours, remove the designation a. m., and the result is the astronomical time wanted.*

The substance of the above rule may be otherwise stated as follows. When the surveyor takes an observation during p. m. hours, civil time, he can say; the *astronomical time* is the hours and minutes *passed* since the noon of *this* day, and when observing in the a. m. hours he can say the astronomical time is the hours and minutes *elapsed* since the noon of *yesterday*, in either case omitting the designation a. m. or p. m., and writing for the day of the month that civil date on which the noon falls from which the time is reckoned. Finally, *the astronomical time may be called the hours and minutes elapsed since the* NOON LAST PASSED, *the astronomical* DATE *being that of the civil day to which the noon belongs.* Thus, April 23, 4.15 p. m., civil time, is April 23 4^h 15^m, astronomical time, and April 23, 4.15 a. m., civil time, is April 22 16^h 15^m astronomical time.

* Computed and arranged in the General Land Office, by J. B. Shinn, of the Surveying Division.

The surveyor should thoroughly master this transformation* of the civil time into astronomical time, as it will be the first duty he will have to perform after observing Polaris out of the meridian.

Hour Angle of Polaris.—In Fig. 2, Diagram A, the full vertical line represents a portion of the meridian passing through the zenith Z (the point directly overhead), and intersecting the northern horizon at the north point N, from which, for surveying purposes, the azimuths are reckoned east or west. The meridian is pointed out by the plumb line when it is in the same plane with the eye of the observer and Polaris on the meridian, and a visual representation is also seen in the vertical wire of the transit when it bisects the star on the meridian.

When Polaris crosses the meridian it is said to culminate; above the poles (at S), the passage is called the *Upper Culmination*, abbreviated U. C., in contradistinction to its *Lower Culmination* (at S′), for which L. C. may be written. In this article h stands for *hours* and m for *minutes*.

In the diagram,—which the surveyor may better understand by holding it up perpendicular to the line of sight when he looks towards the pole,—Polaris is supposed to be at S, where it is about *noon* on April 10th of each year, and it appears to revolve around the pole, in the direction of the arrows, once in every $23^h\ 56^m.1$† of *mean solar time;* it consequently comes to and crosses the meridian, or *culminates*, nearly four minutes *earlier* each successive day. The apparent motion of the star being uniform, one quarter of the circle will (omitting fractions), be described in $5^h\ 59^m$, one half in $11^h\ 58^m$, and three quarters in $17^h\ 57^m$. For the positions s_1, s_2, s_3, etc., the angles SPs_1, SPs_2, SPs_3, etc., are called *Hour Angles of Polaris* for the instant the star is at s_1, s_2, or s_3, etc., and they are measured by the arcs Ss_1, Ss_2, Ss_3, etc., expressed (in these instructions) in *mean solar* (common clock) time, and are always counted from the *upper* culmination (at S) to the *west*, around the circle from $0^h\ 0^m$ to $23^h\ 56^m.1$, and may have any value between the limits named. The hour angles, measured by the arcs Ss_1, Ss_2, Ss_3, Ss_4, and Ss_5, are approximately $1^h\ 8^m$, $5^h\ 55^m$, $9^h\ 4^m$, $14^h\ 52^m$, and $22^h\ 48^m$ respectively; their extent is also indicated by broken fractional circles about the poles. If the star is observed at any one of these points (or at any other point), and the local mean time noted, and from it the time of upper culmination be taken, the remainder will be the hour angle of Polaris as above defined. Therefore, in general: *From the correct local mean time of observation subtract the time of upper culmination, the remainder will be the hour angle required.*

Table I.

The time to be subtracted, mentioned in the preceding rule, may be taken from Table I, which gives to the nearest tenth of a minute the local mean time of the upper culmination of Polaris, for the 1st and 15th of each month, for several years to come,‡ with the necessary direction at the bottom of the tables for deducing the time for intermediate dates. The tabular *times* decrease, but not with entire uniformity

* The change can always be made mentally, no written work being required. Table I might be easily altered to give the times by the civil count marked A. M., and P. M., but such an arrangement would greatly extend and complicate the following rules and examples, and correspondingly increase the chances for making mistakes.

† The exact time is 23 hours, 56 minutes, 4.09 seconds.

‡ The surveyor can extend the table to the year 1910 by following directions in article on "Magnetic Declination, page 68." The values for 1893 were so computed.

from January 1st until they become zero on the 10th of April; then, commencing at $23^h\ 56^m.1$, the times again decrease until the following April, and so on, continuously. The quantity in the column following 1889, marked "Diff. for 1 day," is the decrease *per day* for the interval in which it is placed, and applies to *all the years* marked in the table. For any intermediate date the "Diff. for 1 day" is to be multiplied by the days elapsed since the preceding *tabular date*, and the product *subtracted* from the corresponding *tabular time*, to obtain the required time of culmination for the date under consideration. The table answers directly for 90° west longitude. For places east or west of the tabular meridian a small correction, dependent on the longitude, should be applied to the tabular time of culmination. This correction may be taken from the last line of Part III, and, with sufficient accuracy, for the tabular longitude which is *nearest* that of the station. Use the correction according to the direction placed over it. A few examples will illustrate the use of the table.

1. Required the time of Upper Culmination of Polaris for a station in longitude 116° west, for March 3, 1892.

	h.	m.
Tabular time U. C. of Polaris, 1892, March 1	2	37.8
Reduction for 2 days is $3^m.94\times2=7^m.9$ (Part I.) } Correction for 116° long is $0^m.3$ (Part III.) } *Subtract*		8.2
Local mean time U. C. of Polaris, March 3	2	29.6

The required time may also be obtained by using the table in the opposite direction; by taking the tabular time for March 15 and *adding* the reduction, as follows:

	h.	m.
Tabular time U. C. of Polaris, 1892, March 15	1	42.6
Reduction for 12 days is $3^m.94\times12=47^m.3$ *add*		47.3
	2	29.9
Correction for longitude 116°, (Part III), *subtract*		0.3
Local mean time U. C. of Polaris, 1892, March 3	2	29.6

In this case the two results are identical; generally, the derived value will be true to the nearest tenth of a minute. If the computation is made both ways the results will check each other.

The reduction for intermediate dates has been made for any number of days from 1 to 16, and the results inserted in Part II of the table, by the use of which the surveyor will be saved even the little work of making the above multiplication. The correction for longitude may be subtracted (or added) mentally. When working from a *preceding* tabular date, and for a station *west* of longitude 90°, as both corrections are then *subtractive*, they may be added together mentally and their *sum* written down at once, and the whole work of the surveyor be thus reduced to a single subtraction. Thus, for the above example, look in PART II, under the proper tabular differences ($3^m.94$), and opposite 2 days is the correction $7^m.9$; also, in PART III, is the correction for 116° longitude, $0^m.3$, the sum being $8.^m2$. The work is put down as follows:

	h.	m.
Tabular time U. C. of Polaris, March 1, 1892, (PART I.)	2	37.8
Reduction, (PART II), and correction for long, (Part III), *subtract*		8.2
Local mean time U. C. of Polaris, March 3, 1892	2	29.6

The longitude correction being small may generally be omitted, and it will not be considered in the following examples.

Computing from a *preceding* date for days between April 11 and 15 of any year, the reduction in PART II will be *greater* than the tabular time of culmination, in which case $23^h\ 56^m.1$ must be *added* to the tabular time to make the subtraction possible.

2. Required for a station in long. 90° west the time of upper culmination of polaris for April 14, 1889:

	h.	m.
Tabular time U. C. of Polaris, 1889, April 1 (PART I)	0	36.0
Add	23	56.1
Sum	24	32.1
Reduction for 13 days (tab. diff. $3^m.93$, PART II), *subtract*		51.1
Local mean time, U. C. of Polaris, April 14th	23	41.0

Working from a *following* tabular date for days between 9th and 15th of April, the *sum* will exceed $23^h\ 56^m.1$, and when this occurs *subtract* $23^h\ 56^m.1$ from the sum, and the *remainder* will be the required time.

3. Required, for a station in longitude 90° west, the time of U. C. of Polaris for April 10, 1889:

	h.	m.
Tabular time U. C. of Polaris, 1889, April 15th (PART I)	23	37.1
Reduction for 5 days (PART II), *add*		19.6
Sum	23	56.7
Subtract	23	56.1
Local mean time U. C. of Polaris, 1889, April 10	0	0.6

This example, worked like the last one, from the *preceding* date (April 1st) will give precisely the result above written. (See example in specimen field-notes, No. 4.) If to the above time of culmination we add $23^h\ 56^m.1$ and then subtract 3.9^m, we receive $23^h\ 52^m.8$, the time of the *second* culmination on April 10th, since both occur within 24 hours of noon and, consequently, on the *same day*. This fact has been already mentioned. The U. C., to be used at any time, must always be the *last* one that occurs *before* the observation. In this instance it is, of course, the first one that occurs on the 10th.*

When the time of observation is *less* than the tabular time of culmination, the latter must be taken from the table for a date *one day earlier*. (See specimen field-notes Nos. 2 and 5 for examples.) The surveyor can determine when to take the time one day earlier by comparing his *astronomical* time of observation with the tabular times. Thus, for another example, suppose his time of observation is 1889, November 7th, $8^h\ 24^m.0$. Looking at the table he will see the time given for either November 1st or 15th is greater than $8^h\ 24^m.0$, and he will have to take out the time for November 6th, and thus obtain:

	h.	m.
4. Time of U. C. of Polaris, ($10^h\ 32^m.7$, *less* $19^m.7$ from PART II) } 1889, November 6th	10	13.0
which, being *earlier* than 1889, November 7th	8	24.0
may be subtracted from it.		

* The *second* culmination occurs $7^m.2$ *before* noon of April 11th, and consequently in broad daylight.

TABLE I.

LOCAL MEAN (ASTRONOMICAL) TIME OF THE UPPER CULMINATION OF POLARIS, COMPUTED FOR LONGITUDE 6 HOURS (90°) WEST OF GREENWICH.

[The tabular quantity for any date is the hours and minutes elapsed (measured by a common clock or watch) since the preceding noon.]

Part I.

Date.	1889.	Diff. for 1 day.	1890.	1891.	1892.	1893.
	h. m.	m.	h. m.	h. m.	h. m.	h. m.
Jan. 1	6 31.0	3.95	6 32.2	6 33.4	6 34.6	6 32.3
15	5 35.7	3.95	5 36.9	5 38.1	5 39.3	5 37.0
Feb. 1	4 28.6	3.95	4 29.8	4 31.0	4 32.2	4 29.9
15	3 33.3	3.95	3 34.5	3 35.7	3 37.0	3 34.6
Mar. 1	2 38.1	3.94	2 39.3	2 40.5	2 37.8	2 39.4
15	1 43.0	3.94	1 44.2	1 45.4	1 42.6	1 44.3
Apr. 1	0 36.0	3.94	0 37.2	0 38.4	0 35.7	0 37.3
15	23 37.1	3.93	23 38.3	23 39.5	23 36.8	23 38.4
May 1	22 34.2	3.93	22 35.3	22 36.6	22 34.0	22 35.5
15	21 39.3	3.92	21 40.4	21 41.7	21 39.0	21 40.6
June 1	20 32.7	3.92	20 33.9	20 35.1	20 32.4	20 34.0
15	19 37.8	3.92	19 39.0	19 40.2	19 37.5	19 39.1
July 1	18 35.2	3.92	18 36.4	18 37.6	18 34.9	18 36.5
15	17 40.3	3.91	17 41.5	17 42.7	17 40.1	17 41.6
Aug. 1	16 33.8	3.92	16 35.0	16 36.2	16 33.5	16 35.1
15	15 38.9	3.92	15 40.1	15 41.1	15 38.7	15 40.2
Sept. 1	14 32.3	3.92	14 33.5	14 34.7	14 32.0	14 33.6
15	13 37.4	3.93	13 38.6	13 39.8	13 37.1	13 38.7
Oct. 1	12 34.6	3.93	12 35.7	12 37.0	12 34.3	12 35.9
15	11 39.5	3.93	11 40.7	11 42.0	11 39.3	11 40.8
Nov. 1	10 32.7	3.94	10 33.9	10 35.1	10 32.4	10 34.0
15	9 37.6	3.94	9 38.8	9 40.0	9 37.3	9 38.9
Dec. 1	8 34.5	3.94	8 35.6	8 36.9	8 34.3	8 35.8
15	7 39.3	3.95	7 40.5	7 41.7	7 39.1	7 40.6

Part II.

Reduction of tabular times to *intermediate dates.*

The reduction is to be *subtracted* from a *preceding* or *added* to a *following* tabular time

Arguments, tabular difference, and No. of days between tabular date and date of observation.

No. of days.	Tabular difference.				
	m. 3.91.	m. 3.92.	m. 3.93.	m. 3.94.	m. 3.95.
	m.	m.	m.	m.	m.
1	3.9	3.9	3.9	3.9	3.9
2	7.8	7.8	7.9	7.9	7.9
3	11.7	11.8	11.8	11.8	11.8
4	15.6	15.7	15.7	15.8	15.8
5	19.5	19.6	19.6	19.7	19.7
6	23.5	23.5	23.6	23 6	23.7
7	27.4	27.4	27.5	27.6	27.6
8	31.3	31.4	31.4	31.5	31.6
9	35.2	35.3	35.4	35.5	35.5
10	39.1	39.2	39.3	39.4	39.5
11	43.0	43.1	43.2	43.3	43.4
12	47.0	47.0	47.2	47.3	47.4
13	50.8	51.0	51.1	51.2	51.3
14	54.7	54.9	55.0	55.2	55.3
15	58.6	58.8	58.9	59.1	59.2
16	62.6	62.7	62.9	63.0	63.2

For any other than the tabular day *subtract* from the tabular time of culmination the product of the "Diff. for 1 day" by the number of days elapsed.

Part III.—Correction of the tabular time for longitude.

Longitude.	63°	72°	81°	90°	99°	108°	117°	127°
	Add	Add	Add	Add	Subtract	Subtract	Subtract	Subtract
Correction.....	m. 0.3	m. 0.2	m. 0.1	m. 0.0	m. 0.1	m. 0.2	m. 0.3	m. 0.4

The foregoing examples embrace all cases which can occur in the use of Table I, and will be a sufficient guide for its application.

The vertical diameter SS′, Fig. 2, Diagram A, divides the apparent path of Polaris into two equal parts, and for the star at any point s_5 on the *east* side there is a corresponding point s_1 on the *west* side of the meridian, for which the azimuth Nw is eqnal to the azimuth Ne. The arc $Ss_1S's_5$, taken from the entire circle (or $23^h\ 56^m$) leaves the arc Ss_5, and its equal, Ss_1, may be used to find the azimuth Ne, which is equal to Nw.

The hour angles entered in the following table include only those of the *west half* of the circle ending at S′, and when an hour angle *grcater* than $11^h\ 58^m$ results from observation it is to be *subtracted* from $23^h\ 56^m$ and the *remainder* used as one of the arguments* for the table. The surveyor must not confound these two quantities. The *hour angle itself* always decides the *direction* of the azimuth and defines the place of the star with reference to the pole and meridiau, as noted at top of Table II.

Table II.

This table gives for various hour angles, expressed in *mean solar time*, and for even degrees of latitude from 30 to 50 degrees, the *azimuths of Polaris* during the remainder of this century, computed for average values of the north polar distance of the star—the arguments (reference numbers) being the *hour angle* (or $23^h\ 56^m$ *minus* the hour angle, when the latter exceeds $11^h\ 58^m$) and the *latitude* of the place of observation. The table is so extended that azimuths can be taken out by mere inspection and all interpolation avoided, except what can be performed mentally.

The *hours* of the hour angles are placed in the columns headed "Hours," on left of each page. The *minutes* of hour angles will be found in the columns marked "m.," and under the years for which they are computed, and they are included between the same heavy zigzag lines which enclose the hours to which they belong.

The hour angles are given to the nearest half minute of time. The occurrence of a period after the *minutes* of any hour angle indicates that its value is 0.5^m greater than printed, the table being so arranged to economize space.

The table is to be used as follows: *Find the* HOURS *of the hour angle*† *in the left hand column of either page; then, between the heavy lines which enclose the hours, find the* MINUTES *of the hour angle in the column marked at the top with the current ycar. On the same horizontal line with the* MINUTES, *the azimuth will be found under the given latitude, which is marked at the top of the right hand half of cach page.* Thus, for 1892, hour angle $0^h\ 40^m$, latitude 42°; find 0^h on left hand page and under 1892 find 40^m, on tenth line from the top, and on same line with the *minutes*, under latitude 42°, is the azimuth 0° 18′. For 1896, hour angle $7^h\ 58^m$, lat. 36°, the azimuth is 1° 19′, found on 9th line from bottom of right hand page.

For the year 1889, the hour angles for 1890 may be used and this has been done in the specimen field notes for the purpose of illustration. If the *exact* hour angle is not found in the table, the azimuth should be proportioned to the difference between the given and tabular values of the hour angle. Thus, if the hour angle, in the first of the above examples (for 1892), was $0^h\ 42^m$ instead of $0^h\ 40^m$, the azimuth would be the mean between 0° 18′ and 0° 20′, or 0° 19′. In a similar manner

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* A term used to designate reference numbers.

† See rule on page 76, above "Table I."

if the *latitude* is nearer an *odd* than an *even* degree the mean of the azimuth for the next greater and next less latitude will be used; thus, if in the above example for 1896, the given latitude was 37°, then the mean between 1° 19′ and 1° 21′, or 1° 20′, would be the azimuth for latitude 37°. The table has been arranged to give the azimuths as above, by simple inspection, and it requires no written arithmetical work, all being done mentally. It will always be sufficient to take the nearest *whole* degree of latitude and use it as above directed, except for a few values near the end of the table, where the difference of azimuths, for 2° difference of latitude, amounts to 4 or 5 minutes of arc; as for instance for 1890, hour angle $7^h\ 29^m$, lat. 46° 40′. Here, the latitude may be taken to the nearest *half* degree, (46½°) and the corresponding azimuth is at once found to be 1° 42′. See another example in Specimen Field Notes, No. 4.

The attention of the surveyor is here called to the fact that he must always use *one day* of *twenty-four hours*, as the unit, when he subtracts the time of culmination from the time of observation. To illustrate, resume example 4.* The time of observation was found to be November 7th, $8^h\ 24.0^m$. One day is taken from the days and its equivalent, *twenty-four hours* added to the hours, making Nov. 6th $32^h\ 24^m.0$, without altering the time, and then the substraction is performed as usual. The resulting hour angle being *greater* than $11^h\ 58^m$, must be taken from $23^h\ 56^m$,† in order to use it in Table II, but it is the *hour angle itself* which decides the direction of the azimuth as before mentioned. The work may be set down as follows:

	h.	*m.*
Local mean time of observation, 1889, Nov. 7	8	24.0
Local mean time of U. C. of Polaris, 1889, Nov. 6	10	13.0
Hour angle† of Polaris	22	11
Subtract from	23	56
Argument for Table II	1	45

The azimuth from Table II, for latitude 43°, is 0° 47′ *east*, the *tabular* hour angle $1^h\ 44^m.5$ for 1890, being used. For two similar examples, see Specimen Field Notes Nos. 2 and 5.

If an hour angle comes out within *one minute* of either $0^h\ 0^m$ or $23^h\ 56^m$, the observation may be regarded as having been taken with the star on the meridian *above* the pole, if within one minute of $11^h\ 58^m$, Polaris may be considered on the meridian *below* the pole at the time of observation.

At *elongation*, Polaris is nearly $5^h\ 55^m$ west (or east) of its position at upper culmination, and consequently if the hour angle for *any* observation comes out within *five minutes* of $5^h\ 55^m$ or $18^h\ 1^m$, the star may be assumed to be *at elongation, west* for the first and *east* for the second hour angle, and its azimuth may be taken from a preceding table, which gives its value at elongation from 1890 to 1910,‡ inclusive.

Should the surveyor wish the time of *Lower Culmination*, for use with the plumb line method, described on page 73, or for any other purpose, he will first determine the time of *upper* culmination for the date (Table I), and then *subtract* $11^h\ 58^m$ for the *preceding* lower culmination, or *add* $11^h\ 58^m$ for the lower culmination *following* the derived time for upper culmination, attending to the addition or subtraction of $23^h\ 56^m.1$, as directed on page 78.

* Page 78.

† See page 80, second paragraph.

‡ See table prepared in office of U. S. Coast and Geodetic Survey; article on Magnetic Declination, page 70.

The time to be used in making observations on Polaris out of the meridian should be as accurate as can be obtained. Looking at Table II, near the top, the surveyor will observe that for a difference of *four* minutes in the hour angle there is a change of about *two* minutes in the azimuth, and consequently to obtain the azimuth to the *nearest whole minute* the true local time, upon which all depends, should be known *within two minutes.* If the surveyor uses a solar instrument, he can readily determine the time for himself during the afternoon *before* observing Polaris, or during the morning *after* observation, and, without moving the hands of his watch, apply the necessary correction to his *observed* watch time, as exemplified in Specimen Field Notes Nos. 2 and 4. If the surveyor uses *standard railroad time,* he must correct the same for the difference of longitude between his station and the standard meridian for which the time is given at the rate of *four minutes* of time *for each degree* of the difference in arc. Thus, if the difference of longitude is 6° 45′, the equivalent in time will be 27 minutes. The difference of longitude may be taken from a good map. If the surveyor knows how many ranges (of 6 miles each) are included between his station and the standard meridian, the number of seconds taken from the 5th column of Table IX (opposite his latitude), multiplied by the number of ranges, will give the correction for longitude in *seconds* of time.* The correction is to be *subtracted* from the standard railroad time of observation when the surveyor's station is *west* of the standard meridian, and *added* when the station occupied is *east* of the standard meridian, to obtain *local* time. It makes no difference *where* the surveyor obtains the standard time, provided he gets it right.

Generally the surveyor will have only two or three simple additions or substractions to make, and ten minutes will be ample time in which to make the observation and perform the little computation required.

The foregoing examples, with those in the Specimen Field Notes and some attention to these directions, will enable the surveyor, after a little practice, to take out an azimuth from Table II in less time than he can derive a latitude and departure from a Traverse Table.

NOTE.—The *azimuths* entered in the following table were calculated with the mean North Polar Distance of Polaris for July 1, 1890, the assumed latitudes of the table and the *hour angles* for the year. These values having been tabulated, the process was reversed, and with the mean N. P. D. of the star, for the 1st of July of each of the remaining ten years of the series, the *latitudes* named and *azimuths* already determined, the corresponding *hour angles* were found. By this artifice the table (which, if computed for the *same* hour angles for each year, would cover twenty-two pages of this book), is here confined to two pages, and this without any sacrifice of precision, and with the additional advantage of presenting all the *azimuths for eleven years* at one opening of the book, an arrangement which will be appreciated by those surveyors who may have occasion to use it in the discharge of their professional duties.

[J. B. S.]

* See example, page 99.

TABLE II.—*Azimuths of Polaris*

[The hour angles are expressed in *mean solar* time. The occurrence of a period

[General Land Office, Sept., 1889.]

STAR AND AZIMUTH.

W. of N. when hour angle is *less* than 11h 58m.
E. of N. when hour angle is *greater* than 11h 58m.

Argument, the star's hour angle (or 23h 56m *minus* the star's hour angle), for the year—

POLARIS *above* THE POLE:

To determine the true meridian the azimuth must be laid off to the *east* when the hour angle is *less* than 11h 58m, and to the *west* when *greater* than 11h 58m.

Hours.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	Azimuths for latitude— 30°	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°
h.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	4	4	4	4	4	4	4	4	4	4	4	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2
	8	8	8	8	8	8	8	8	8.	8.	8.	3	3	3	3	3	4	4	4	4	4	4
	12	12	12	12	12	12	12.	12	12.	12.	12.	5	5	5	5	5	5	6	6	6	6	6
	16	16	16	16	16.	16.	16.	16.	16.	16.	16.	6	6	6	7	7	7	7	8	8	8	8
	20	20	20	20.	20.	20.	20.	20.	20.	21	21	8	8	8	8	9	9	9	9	10	10	11
	24	24	24	24.	24.	24.	24.	24.	24.	25	25	9	10	10	10	10	11	11	11	12	12	13
	28	28	28	28.	28.	28.	28.	28.	29	29	29	11	11	11	12	12	12	13	13	14	14	15
	32	32	32	32.	32.	32.	33	33	33.	33.	33.	12	13	13	13	14	14	15	15	16	16	17
	36	36	36	36.	36.	36.	37	37	37	37.	37.	14	14	15	15	15	16	16	17	16	18	19
	40	40	40	40.	40.	41	41	41	41.	41.	41.	15	16	16	17	17	18	18	19	20	20	21
	44	44	44.	44.	44.	45	45	45.	45.	45.	46	17	17	18	18	19	19	20	21	21	23	23
	48	48	48.	48.	49	49	49	49.	49.	50	50	19	19	19	20	21	22	22	23	23	24	25
	52	52	52.	52.	53	53	53.	53.	53.	54	54	20	21	21	22	22	23	24	24	25	26	27
0	56	56	56.	56.	57	57	57.	57.	58	58	58.	22	22	23	23	24	25	25	26	27	28	29
1	0	0	0.	0.	1	1.	1.	2	2	2.	2.	23	24	24	25	26	26	27	28	29	30	32
	6	5	5.	6	6	6.	6.	7	7	7.	7.	25	26	26	27	28	28	29	30	31	33	34
	10	10.	10.	11	11	11.	11.	12	12.	13	13	27	27	28	29	30	31	32	33	34	35	37
	15	15.	15.	16	16	16.	17	17.	17.	18	18	29	29	30	31	32	33	34	35	36	38	39
	20	20.	20.	21	21.	21.	22	22.	22.	23	23.	31	31	32	33	34	35	36	37	38	40	42
	25	25.	25.	26	26.	27	27	28	28.	28.	28.	32	33	34	35	36	37	38	39	41	42	44
	30	30.	31	31.	31.	32	32	33	33.	34	34	34	35	36	37	38	39	40	42	43	45	47
	34.	35	35.	36.	36.	37	37.	38	38	38.	39	36	37	38	39	40	41	42	44	45	47	49
	39.	40	40.	41	41.	42	42.	43	43.	44	44.	38	39	40	41	42	43	44	46	47	49	51
	44.	45	45.	46	46.	47	47.	48	48.	49	49.	39	40	41	42	44	45	46	48	50	52	54
	49.	50	50.	51	52	52.	53	53.	54	54.	55	41	42	43	44	46	47	48	50	52	54	56
	54.	55	55.	56.	57	57	58	58.	59	59.	0	43	44	45	46	47	49	50	52	54	56 0	59
1	59.	0.	1	1.	2	2.	3	3.	4.	5	6.	45	46	47	48	49	51	52	54	50 0	58 1	1
2	4.	5.	6	6.	7.	8	8.	9	9.	10	10.	46	47	49	50	51	53	54	56 0	58 1	1	3
	9.	10	11	11.	12	12.	13.	14	14.	15	16	48	49	50	51	53	54	56 0	58 1	0	3	5
	14.	15	16	16.	17.	18	18.	19	20	20.	21.	50	51	52	53	55	56 0	58 1	0	2	5	8
	19.	20.	21	21.	22.	23	24	24.	25	26	26.	51	52	54	55	57 0	58 1	0	2	4	7	10
	24.	25.	26	26.	27.	28	29	30	30.	31	32	53	54	55	57 0	58 1	0	2	4	6	9	12
	29.	30.	31	31.	32.	33.	34.	35	35.	36.	37	54	55	57 0	58 1	0	2	4	6	8	11	14
	34	35.	36	37	38	38.	39.	40	41	41.	42.	56	57 0	58 1	0	2	3	6	8	10	13	16
	39.	40.	41	42	43	43.	44.	45.	46.	47	48	57 0	59 1	0	2	3	5	7	9	12	15	18
	44.	45.	46	47	48	49	49.	50.	51.	53	53	0 59 1	0	2	3	5	7	9	11	14	17	20
	49.	50.	51	52	53.	54	55	56	57	57	58.	1 0	2	3	5	7	8	11	13	16	19	22
	54.	55.	56.	57	58.	59	0	1	2	3	4	2	3	5	6	8	10	12	15	17	20	24
2	59.	1.	1.	2.	3.	4.	5.	6.	7.	8.	9.	3	4	6	8	10	12	14	16	19	22	26
3	6.	6.	7.	8.	10	10.	12	13	14	15	16	5	6	8	10	12	13	16	18	21	24	28
	11.	12.	13.	14.	16	17	18	19.	20.	21.	23	6	8	9	11	13	15	18	20	23	27	30
	17.	18.	19.	21	23	23	24.	16.	27	28	29.	8	9	11	13	16	17	19	22	25	28	32
	23.	24.	26	27	29	29.	31	32.	33.	35	30	9	11	13	14	16	19	21	24	27	30	34
	29.	30.	32	33	35	36	37.	39	40	41.	43	11	13	14	16	18	20	23	25	29	32	36
	36.	38	39	40.	42	43.	45	46.	48	49.	51	12	14	16	17	20	22	25	27	31	34	38
	43.	46	46.	47.	49.	51	52.	54	55.	57.	60	14	15	17	19	21	24	26	29	32	36	40
	50.	62	53.	56	57	58.	0	2	3.	5	7	15	17	19	21	23	25	28	31	34	38	42
3	59.	1	2.	4	6.	8	10	12	13.	15.	17.	17	19	21	23	25	27	30	33	36	40	44
4	9.	4	13	15	17.	19	21.	23.	26.	28	30	19	21	23	24	27	29	32	35	39	43	47
	19.	21.	23.	25.	28.	30.	33	35.	38	40.	43	20	22	24	26	29	31	34	37	41	45	49
	29.	32	34	36.	40	42	45	48	50.	54	57.	22	24	26	28	30	33	36	39	42	47	51
	44	47.	50	53	57.	0.	4.	8.	12.	17.	23	24	26	28	30	33	35	38	41	45	49	54
4	59	3	7	11	17	20.	29	37	50.	.....	.....	20	27	30	32	34	37	40	43	47	51	56
5	19	25.	32	41.	.....	.....	.....	.....	.....	.....	.....	27	26	31	33	36	39	42	45	49	58	58
5	59	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1 29	1 30	1 32	1 35	1 37	1 40	1 43	1 47	1 50	1 55	1 59

(*For the use of land surveyors*).

after minutes of an hour angle indicates that its value is $0^m.5$ greater than printed.]

[Arranged and computed by J. B. S.]

STAR AND AZIMUTH.

W. of N. when hour angle is *less* than $11^h\ 58^m$.
E. of N. when hour angle is *greater* than $11^h\ 58^m$.

Argument, the star's hour angle (or $23^h\ 56^m$ *minus* the star's hour angle), for the year—

POLARIS *below* THE POLE.

To determine the true meridian the azimuth must be laid off to the *east* when the hour angle is *less* than $11^h\ 58^m$ and to the *west* when *greater* than $11^h\ 58^m$.

Hours.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	Azimuths for latitude— 30°	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°
h.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
11	54	54	54	54	54	54	54	54	54	54	54	0 1	0 1	0 1	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2
	50	50	50	50	50	50	50	50	50	50	50	3	3	3	3	3	3	3	4	4	4	4
	46	46	46	46	46	46	46	45.	45.	45.	45.	5	5	5	5	5	5	5	6	6	6	6
	42	42	42	42	42	42	41.	41.	41.	41.	41.	6	6	6	6	7	7	7	7	8	8	8
	38	38	38	37.	37.	37.	37.	37.	37.	37.	37.	8	8	8	8	8	8	9	9	9	10	10
	34	34	34	33.	33.	33.	33.	33.	33.	33	33	9	9	9	10	10	10	11	11	11	12	12
	30	30	30	29.	29.	29.	29.	29	29	29	29	11	11	11	11	12	12	12	13	13	14	14
	26	26	26	25.	25.	25.	25.	25	25	25	26	12	12	13	13	13	14	14	14	15	15	16
	22	22	22	21.	21.	21	21	21	21	21	21	14	14	14	15	15	15	16	16	17	17	18
	18	18	18	17.	17.	17.	17	17	17	16.	16.	15	15	16	16	17	17	18	18	19	19	20
	14	14	14	13.	13.	13.	13	13	12.	12.	12.	17	17	17	18	18	19	19	20	21	21	22
	10	10	10	9.	9.	9.	9	8.	8.	8.	8	18	18	19	19	20	20	21	22	22	23	25
	6	6	6	5.	5.	5.	5	4.	4.	4.	4	20	20	20	21	22	22	23	23	24	25	20
11	2	2	2	1.	1.	1	1	1	0.	0.	0	21	21	22	23	23	24	24	25	26	27	28
10	58	57.	57.	57	57	56.	56.	56.	56.	55.	55.	23	23	24	24	25	25	26	27	28	29	30
	53	52.	52.	52.	52	51.	51.	51	51	50.	50.	24	25	25	26	27	27	28	29	30	31	32
	48	47.	47.	47.	47	46.	46.	46	46	45.	45	26	27	27	28	29	29	30	31	32	34	35
	43	42.	42.	42.	42.	41.	41.	41	40.	40.	40	28	29	29	30	31	31	32	33	35	36	37
	38.	38	37.	37.	37	36.	36	35.	35.	35	35	30	30	31	22	33	34	35	36	37	38	40
	33.	33	32.	32.	32	31.	31	30.	30.	30	29.	32	32	33	34	35	36	37	38	39	41	42
	28.	28	27.	27	26.	26	26	25.	25	24.	24.	33	34	35	36	37	38	39	40	41	43	44
	23.	23	22.	22	21.	21	21	20.	20	19.	19	35	36	37	37	39	40	41	42	43	45	47
	18.	18	17.	17	16.	16	15.	15.	15	14.	14	37	38	39	39	40	41	43	44	46	47	49
	13.	13	12.	12	11.	11	10.	10	9.	9	8.	39	39	40	41	42	43	45	46	48	49	51
	8.	8	7.	7	6.	6	5.	5	4.	4	3.	40	41	42	43	44	45	47	48	50	52	54
10	3.	3	2.	2	1.	1	0	59.	59	58.	58	42	43	44	45	46	47	49	50	52	54	56
9	58.	58	57.	57	56	55.	55.	54.	54	53	53	44	45	46	47	48	49	51	52	54	56 0	58
	53.	53	52.	52	51	50.	50.	49	49	48	47.	45	46	47	48	50	51	53	54	56 0	58 1	0
	48.	48	47.	46.	46	45.	44.	44	43.	43	42	47	48	49	50	51	53	54	56 0	58 1	0	2
	43.	43	42	41.	40.	40.	39.	39	38.	37.	37	49	50	51	52	53	55	56 0	58 1	0	2	5
	38.	38	37	36.	35.	35	34.	33.	33	32	31.	50	51	52	53	55	56 0	58 1	0	2	4	7
	33.	32.	32	31.	30.	30	29	28.	28	27	26.	51	53	54	55	57 0	58 1	0	2	4	6	9
	28.	28	27	26.	25.	25	24	23	22.	21.	21	53	54	56	57 0	58 1	0	2	4	6	8	11
	23.	23	22	21.	20.	19.	19	18	17.	16.	16.	55	56	57 0	58 1	0	2	4	6	8	10	13
	18.	17.	17	16	15	14.	13.	12.	12	11	10	56	57 0	59 1	0	2	3	5	7	10	12	15
	13.	12.	12	11	10	9.	8.	7.	6.	5.	5	58 0	59 1	0	2	3	5	7	9	11	14	17
	8.	7.	7	6	5	4	3	2	1.	0.	59.	0 59	1 0	2	3	5	7	9	11	13	16	19
9	3.	2.	2	1	50.	58	58	57	56	55	54	1 0	2	3	5	6	8	10	12	15	18	21
8	58.	57.	56.	55.	54.	54	52.	52	51	49.	49	2	3	5	6	8	10	12	14	17	20	23
	52.	51.	50.	49.	48.	47.	46.	45.	44.	43	42.	3	5	6	8	10	12	14	16	19	22	25
	46.	45.	44.	43.	42.	41.	40	39.	38	36.	35.	5	6	8	9	11	13	16	18	21	24	27
	40.	39.	38.	37.	36	35	33.	32.	31.	30	29	7	8	10	11	13	15	17	20	22	26	29
	34.	33.	32.	31	29.	28.	27	27	25	23.	23.	8	9	11	13	15	17	19	22	24	28	31
	28.	27.	26	25	23	21.	21	19.	17.	17	15.	10	11	13	14	16	18	21	23	26	29	33
	21.	20.	19	18	16	15	13.	12	10.	9	7.	11	13	14	16	18	20	23	25	28	31	35
	14.	13	12	10.	8.	7.	5.	4	2.	1	59.	13	14	16	18	20	22	25	27	30	33	37
8	7.	6	5	3.	1	0	58	56.	55	53	51.	14	16	18	19	21	24	26	29	32	35	39
7	58.	57	55	54	51.	50	48	46.	44.	42.	40.	16	18	19	21	24	26	28	31	34	38	42
	48.	47	45	43.	40.	39	37	35	33	30.	28.	18	19	21	23	26	28	31	33	37	40	44
	38.	36.	34.	32.	29.	28	25	23	20.	18	15.	20	21	23	25	27	30	33	35	39	43	47
	29	26.	24	22	18.	16.	13.	10.	7.	4.	1.	21	23	25	27	29	32	35	37	41	45	49
7	14	11	8	5	1	58	54	50	45.	41	35.	23	25	27	29	32	34	37	40	43	47	52
6	59	55	51.	47.	41	37.	30	22.	11	....	....	25	27	29	31	34	36	39	42	46	50	54
6	39	62.	26	16.	....	....	....	....	....	....	....	27	29	31	33	36	38	41	44	48	52	57
5	59	....	....	....	....	....	....	....	....	....	....	1 29	1 30	1 32	1 35	1 37	1 40	1 43	1 47	1 50	1 55	1 59

TABLE III.

AZIMUTHS OF THE TANGENT TO THE PARALLEL.

[The azimuth is the *smallest* angle the tangent makes with the true meridian and always measured from the *north* and towards the tangential points.]

Latitude.	1 mile.	2 miles.	3 miles.	4 miles.	5 miles.	6 miles.
°	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
30	89 59 30	89 58 59.9	89 58 29.9	89 57 59.9	89 57 29.9	89 56 59.8
31	89 59 28.8	89 58 57.5	89 58 26.3	89 57 55.9	89 57 23.8	89 56 52.5
32	89 59 27.5	89 58 55.0	89 58 22.5	89 57 56.0	89 57 17.6	89 56 45.0
33	89 59 26.2	89 58 52.5	89 58 18.7	89 57 44.9	89 57 11.2	89 56 37.4
34	89 59 24.9	89 58 49.9	89 58 14.8	89 57 39.7	89 57 04.6	89 56 29.6
35	89 59 23.6	89 58 47.2	89 58 16.8	89 57 34.4	89 56 58.0	89 56 21.6
36	89 59 22.2	89 58 44.4	89 58 06.8	89 57 28.9	89 56 51.1	89 56 13.4
37	89 59 20.8	89 58 41.6	89 58 02.5	89 57 23.3	89 56 44.1	89 56 05.0
38	89 59 19.4	89 58 38.8	89 57 58.2	89 57 17.5	89 56 36.9	89 55 56.3
39	89 59 17.9	89 58 35.8	89 57 53.7	89 57 11.6	89 56 29.6	89 55 47.5
40	89 59 16.4	89 58 32.8	89 57 49.2	89 57 05.5	89 56 21.9	89 55 38.3
41	89 59 14.8	89 58 29.6	89 57 44.4	89 56 59.3	89 56 14.1	89 55 28.9
42	89 59 13.2	89 58 26.4	89 57 39.6	89 56 52.8	89 56 06.0	89 55 19.2
43	89 59 11.5	89 58 23.1	89 57 34.6	89 56 46.2	89 55 57.7	89 55 09.2
44	89 59 09.8	89 58 19.6	89 57 29.5	89 56 39.3	89 55 49.1	89 54 58.9
45	89 59 08.0	89 58 16.1	89 57 24.1	89 56 32.1	89 55 40.2	89 54 48.2
46	89 59 06.2	89 58 12.4	89 57 18.6	89 56 24.8	89 55 31.0	89 54 37.2
47	89 59 •04.3	89 58 08.6	89 57 12.9	89 56 17.1	89 55 21.4	89 54 25.7
48	89 59 02.3	89 58 04.6	89 57 06.9	89 56 09.2	89 55 11.5	89 54 13.8
49	89 59 00.2	89 58 00.5	89 57 00.7	89 56 00.9	89 55 01.2	89 54 01.4
50	89 58 58.1	89 57 56.2	89 56 54.3	89 55 52.6	89 54 50.5	89 53 48.5

Latitude.	7 miles.	8 miles.	9 miles.	10 miles.	11 miles.	12 miles.
°	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
30	89 56 29.8	89 55 59.8	89 55 29.8	89 54 59.7	89 54 29.7	89 53 59.7
31	89 56 21.3	89 55 50.0	89 55 18.8	89 54 47.6	89 54 16.3	89 53 45.1
32	89 56 12.5	89 55 40.6	89 55 07.6	89 54 35.1	89 54 02.6	89 53 30.1
33	89 56 03.6	89 55 29.9	89 54 56.1	89 54 22.3	89 53 48.5	89 53 14.8
34	89 55 54.5	89 55 19.4	89 54 44.4	89 54 09.3	89 53 34.2	89 52 59.1
35	89 55 45.2	89 55 08.8	89 54 32.3	89 53 55.9	89 53 19.5	89 52 43.1
36	89 55 35.6	89 54 57.8	89 54 20.0	89 53 42.3	89 53 04.5	89 52 26.7
37	89 55 25.8	89 54 46.6	89 54 07.4	89 53 28.2	89 52 49.1	89 52 09.9
38	89 55 15.7	89 54 35.1	89 53 54.5	89 53 13.9	89 52 33.2	89 51 52.6
39	89 55 05.4	89 54 23.3	89 53 41.2	89 52 59.1	89 52 17.0	89 51 34.9
40	89 54 54.7	89 54 11.1	89 53 27.6	89 52 43.8	89 52 00.2	89 51 16.6
41	89 54 43.7	89 53 58.6	89 53 13.4	89 52 28.2	89 51 43.0	89 50 57.8
42	89 54 32.4	89 53 45.6	89 52 58.8	89 52 12.0	89 51 25.2	89 50 38.4
43	89 54 20.8	89 53 32.3	89 52 43.8	89 51 55.4	89 51 06.9	89 50 18.5
44	89 54 08.7	89 53 18.5	89 52 28.4	89 51 38.2	89 50 48.0	89 49 57.8
45	89 53 56.3	89 53 04.3	89 52 12.3	89 51 20.4	89 50 28.4	89 49 36.4
46	89 53 43.4	89 52 49.5	89 51 55.7	89 51 01.9	89 50 08.1	89 49 14.3
47	89 53 30.0	89 52 34.3	89 51 38.6	89 50 42.9	89 49 47.2	89 48 51.4
48	89 53 16.1	89 52 18.4	89 51 20.7	89 50 23.0	89 49 25.3	89 48 27.6
49	89 53 01.7	89 52 01.9	89 51 02.1	89 50 02.4	89 49 02.6	89 48 02.8
50	89 52 46.6	89 51 44.7	89 50 42.8	89 49 40.9	89 48 39.0	89 47 37.1

TABLE III, *Azimuths of the tangent to the parallel*, gives for each degree of latitude from 30° to 50°, the angle which the tangent makes with the true meridian at distances of 1, 2, 3, etc., miles from the tangential point.

Diagram A, Fig. 1, shows a base line, or standard parallel (supposed to be in Latitude 43° N.), and one township north of the parallel, the lines of which are purposely thrown out of their true positions in order to more clearly exhibit the effect of convergency of meridians in modifying the dimensions and shape of townships when surveyed in accordance with present practice.

If run with a transit, the direction of the tangent at right angles to the *true meridian* at the starting point, T, should be accurately determined by a sufficient number of observations on Polaris at elongation, and carefully prolonged, by back and foresights, in a *straight* line. At the half mile and mile points the offsets are measured in the proper direction and correct length, the azimuths being taken from Table III and the offsets from Table IV (or Table V, which is more convenient for the surveyor when off-sets are long),—and the corner should be established on the *parallel of latitude* B—T, passing through the point of beginning.

The *bearing* of the tangent continually decreases, and at any mile point its azimuth taken from 90° leaves a quantity which is called the *convergency of the meridians*, which, for the six-mile point, is the angle marked K O F on the diagram between the true meridian O—F and the perpendicular K—O, which is, of course parallel to the true meridian T—E through the tangential point.

One-half of the convergency, K O F, taken from 90°, leaves the angle (given under "3 miles" in Table III), which the *straight* line, connecting the township corners, supposed to be in the same latitude, makes with the true meridian, and its bearing is always north of west (or east); thus the line E—F bears N. 89° 57′ W. from E, and the return course is N. 89° 57′ E. To call the last-named bearing *south* 89° 57′ east is manifestly incorrect.

When standard parallels or E. and W. township lines are run with a solar compass, or a transit with solar attachment, and the instrument is in perfect adjustment (as it always should be), and the stations are at *equal* distances, the line will have nearly the curvature of the parallel and almost coincide with it, but it will always have a tendency to run to the south to the amount of the off-set between stations (Table IV), repeated *as many times as the instrument is set*, unless correction for departure from the parallel of latitude is made at every station occupied. If the distances between the stations are *unequal*, the line will approximate to the form of the parallel, and generally with sufficient accuracy to be considered as having the same curvature as the parallel of latitude itself.

TABLE IV.

OFF-SETS FROM TANGENT TO PARALLEL.

[*Off-sets in feet.*]

Latitude.	1 mile.	2 miles.	3 miles.	4 miles.	5 miles.	6 miles.
°	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
30	0.39	1.54	3.47	6.17	9.64	13.88
31	0.40	1.60	3.61	6.42	10.03	14.44
32	0.42	1.67	3.76	6.67	10.42	15.02
33	0.43	1.73	3.90	6.93	10.82	15.60
34	0.45	1.80	4.05	7.20	11.25	16.20
35	0.47	1.87	4.20	7.47	11.68	16.81
36	0.48	1.94	4.36	7.75	12.11	17.41
37	0.50	2.01	4.52	8.04	12.57	18.09
38	0.52	2.08	4.69	8.33	13.02	18.75
39	0.54	2.16	4.86	8.63	13.49	19.43
40	0.56	2.24	5.03	8.95	13.98	20.11
41	0.58	2.32	5.21	9.27	14.48	20.85
42	0.60	2.40	5.40	9.59	14.99	21.59
43	0.62	2.48	5.59	9.93	15.52	22.35
44	0.64	2.57	5.79	10.29	16.07	23.14
45	0.67	2.66	5.99	10.65	16.64	23.96
46	0.69	2.76	6.20	11.02	17.21	24.80
47	0.71	2.85	6.42	11.41	17.83	25.68
48	0.74	2.95	6.65	11.82	18.47	26.58
49	0.76	3.06	6.88	12.24	19.12	27.54
50	0.79	3.17	7.12	12.68	19.80	28.52

Latitude.	7 miles.	8 miles.	9 miles.	10 miles.	11 miles.	12 miles.
°	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
30	18.89	24.67	31.23	38.55	46.65	55.52
31	19.66	25.68	32.49	40.12	48.54	57.77
32	20.44	26.69	33.78	41.71	50.47	60.06
33	21.23	27.74	35.10	43.34	52.44	62.41
34	22.05	28.80	36.45	45.00	54.45	64.80
35	22.89	29.89	37.83	46.71	56.62	67.26
36	23.74	31.01	39.25	48.45	58.63	69.77
37	24.62	32.16	40.70	50.24	60.79	72.35
38	25.52	33.33	42.19	52.08	63.02	75.00
39	26.44	34.54	43.71	53.97	65.30	77.71
40	27.40	35.78	45.29	55.91	67.65	80.51
41	28.37	37.06	46.90	57.91	70.07	83.39
42	29.38	38.38	48.57	59.97	72.56	86.35
43	30.42	39.74	50.29	62.09	75.13	89.41
44	31.50	41.14	52.07	64.28	77.78	92.57
45	32.61	42.59	53.91	66.55	80.53	95.84
46	33.76	44.10	55.81	68.90	83.37	98.22
47	34.95	45.65	57.78	71.34	86.32	102.72
48	36.19	47.27	59.83	73.86	89 37	106.36
49	37.48	48.95	61.96	76.49	92.55	110.15
50	38.82	50.70	64.17	79.22	95.86	114.08

For the purpose of illustration, the south boundary of the township represented by Diagram C is supposed to be a *straight* line, and this is done in order to provide a variety of bearings to illustrate the application of Table VI, and to give emphasis to the requirement *that all* RANDOM *section lines running approximately east and west must be run* PARALLEL *to the south boundary of the tier of sections to which they belong, and that* TRUE *lines, for fractional sections, must be run in the same manner and not necessarily east (or west) as heretofore directed.* Random lines will be run east (or west) when the south boundary is so run.

For various reasons the boundaries on the north and south of townships are not always truly east and west lines; many are run *crooked* and *some* of them may, by accident, be run *straight.* Consequently, there seems to be no impropriety in assuming the south boundary of the township, Diagram C, to be a *straight line* with the *bearings* indi-

TABLE V.

OFF-SETS FROM TANGENT TO PARALLEL.

[*Off-sets in chains.*]

Latitude.	1 mile.	2 miles.	3 miles.	4 miles.	5 miles.	6 miles.
°	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*
30	0.006	0.023	0.053	0.09	0.14	0.21
31	0.006	0.024	0.055	0.10	0.15	0.22
32	0.006	0.025	0.057	0.10	0.16	0.23
33	0.007	0.026	0.059	0.10	0.16	0.24
34	0.007	0.027	0.061	0.11	0.17	0.25
35	0.007	0.028	0.064	0.11	0.18	0.25
36	0.007	0.029	0.066	0.12	0.18	0.26
37	0.008	0.031	0.068	0.12	0.19	0.27
38	0.008	0.032	0.071	0.13	0.20	0.28
39	0.008	0.033	0.074	0.13	0.20	0.29
40	0.008	0.034	0.076	0.13	0.21	0.30
41	0.009	0.035	0.079	0.14	0.22	0.32
42	0.009	0.036	0.082	0.14	0.23	0.33
43	0.009	0.038	0.085	0.15	0.24	0.34
44	0.010	0.039	0.088	0.16	0.24	0.35
45	0.010	0.040	0.091	0.16	0.25	0.36
46	0.010	0.042	0.094	0.17	0.26	0.37
47	0.011	0.044	0.097	0.17	0.27	0.39
48	0.011	0.045	0.101	0.18	0.28	0.40
49	0.012	0.046	0.104	0.19	0.29	0.42
50	0.012	0.048	0.108	0.19	0.30	0.43

Latitude.	7 miles.	8 miles.	9 miles.	10 miles.	11 miles.	12 miles.
°	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*
30	0.29	0.37	0.47	0.58	0.71	0.84
31	0.30	0.39	0.49	0.60	0.74	0.88
32	0.31	0.40	0.51	0.63	0.76	0.91
33	0.32	0.42	0.53	0.65	0.79	0.95
34	0.33	0.43	0.55	0.68	0.82	0.98
35	0.35	0.45	0.57	0.70	0.86	1.02
36	0.36	0.47	0.59	0.73	0.89	1.06
37	0.37	0.48	0.61	0.75	0.91	1.10
38	0.38	0.50	0.64	0.78	0.95	1.14
39	0.40	0.52	0.66	0.81	0.99	1.18
40	0.41	0.54	0.68	0.84	1.02	1.22
41	0.43	0.56	0.70	0.87	1.06	1.26
42	0.44	0.58	0.73	0.90	1.09	1.31
43	0.46	0.60	0.75	0.93	1.14	1.35
44	0.48	0.62	0.79	0.97	1.18	1.40
45	0.49	0.64	0.81	1.00	1.22	1.45
46	0.51	0.66	0.84	1.04	1.26	1.50
47	0.53	0.68	0.87	1.07	1.31	1.56
48	0.55	0.71	0.91	1.12	1.35	1.61
49	0.57	0.74	0.93	1.16	1.40	1.67
50	0.59	0.77	0.97	1.20	1.45	1.73

cated on the line E—F, and north of it, as represented on Diagram A, Fig. 1.

If the south boundary is a true east and west line, as it should be, then of course all the random lines will be run east (or west) as indicated in T. 1 N. of Diagram A.

The above assumption of a straight line for a township boundary, *merely for the purpose of illustration*, is not to be construed as authority for so running the north or south boundaries, or as in any manner changing present practice in the survey of township exteriors, but it *is* the purpose of Diagram C, and Specimen Field-Notes, No. 5, to so amend directions for *subdividing* as to secure a record of the survey which will *truly represent the work upon the ground*, and give the bearings of lines, *governed by the true meridian*, as required by law.

TABLE VI.

Table showing the difference in latitude and departure in running 80 *chains at any course from* 1 *to* 60 *minutes.*

VI. A.

Minutes.	Links.	Minutes.	Links.
1	2⅛	31	72⅛
2	4⅜	32	74⅜
3	7	33	77
4	9⅛	34	79⅛
5	11⅜	35	81⅜
6	14	36	84
7	16⅛	37	86⅛
8	18⅜	38	88⅜
9	21	39	91
10	23⅛	40	93⅛
11	25⅜	41	95⅜
12	28	42	98
13	30⅛	43	100⅛
14	32⅜	44	102⅜
15	35	45	105
16	37⅛	46	107⅛
17	39⅜	47	109⅜
18	42	48	112
19	44⅛	49	114⅛
20	46⅜	50	116⅜
21	49	51	119
22	51⅛	52	121⅛
23	53⅜	53	123⅜
24	56	54	126
25	58⅛	55	128⅛
26	60⅜	56	130⅜
27	63	57	133
28	65⅛	58	135⅛
29	67⅜	59	137⅜
30	70	60	140

VI. B.

Links.	Minutes.	Links.	Minutes.
2⅛	1	72⅛	31
4⅜	2	74⅜	32
7	3	77	33
9⅛	4	79⅛	34
11⅜	5	81⅜	35
14	6	84	36
16⅛	7	86⅛	37
18⅜	8	88⅜	38
21	9	91	39
23⅛	10	93⅛	40
25⅜	11	95⅜	41
28	12	98	42
30⅛	13	100⅛	43
32⅜	14	102⅜	44
35	15	105	45
37⅛	16	107⅛	46
39⅜	17	109⅜	47
42	18	112	48
44⅛	19	114⅛	49
46⅜	20	116⅜	50
49	21	119	51
51⅛	22	121⅛	52
53⅜	23	123⅜	53
56	24	126	54
58⅛	25	128⅛	55
60⅜	26	130⅜	56
63	27	133	57
65⅛	28	135⅛	58
67⅜	29	137⅜	59
70	30	140	60

Random bearings, determined as above directed, are actually the *true* bearings of the lines and are so used for running fractional *true lines.* Any deviation from random bearings, derived from the application of the falling [Table VI], changes the random bearing by an amount due to unavoidable errors, and should give for a final result a bearing *as near the true bearing* as the field work will permit. A *true* bearing means the angular deviation from the *true meridian* in contradistinction to the *magnetic* bearing, or angle made with the *magnetic meridian.* A true line is to be understood to refer to *the line upon which the corners are established.*

Table VI [A and B] is used to determine the *return* from the *random* course by the following rules, the meridians being regarded as *parallel.*

I.—If the random line is run *east or west,* subtract the falling [in minutes of arc] from 90°, reverse the departure letter, and name the meridianal letter N. or S., like the falling.

II.—When the random course is nearly east and west, take the **sum** of the random course and closing error [in minutes of arc], if they are of the **same** name—that is, both north or both south—but their **difference** when of **different** names; in either case changing the meridional and departure letters of the random line. [This is easily remembered by bearing in mind the initial letters of Sum and Same and Difference and Different].

III.—In any case when the sum exceeds 90°, the return course is found by subtracting said sum from 180° and retaining the meridional letter of the random course unchanged. If the sum is exactly 90°, the return course is evidently west [or east] to the starting point.

THE RANDOM AND TRUE LINE AND USE OF THE VARIATION.

In the article entitled "METHOD OF SUBDIVIDING," directions have been given to run east and west *random* lines *parallel* to the south boundary of the tier of sections to which they belong, instead of *due east* as given in former editions of these instructions. In many instances the south boundary of townships to be subdivided are found to depart, sometimes considerably, from the true east and west line, or parallel of latitude, which they are supposed to follow. The present instructions are intended to reduce the falling of the random to the smallest practicable amount and to show at once how much the *random* line departs from the *true* line, instead of complicating its departure with the deviation of the south boundary. When the south boundary makes a comparatively large angle with the parallel, the *random* line, if run *due east*, necessarily falls at a considerable distance north or south of the objective corner, and it appears to have been the practice of some surveyors to turn around the compass box until the north end of the needle points to the north mark, and to call the resulting reading of the vernier the *variation*. Thus, many old plats give the *variation* on east and west lines *one value* throughout, and on the north and south lines another *uniform variation*, the two differing by ten or fifteen minutes, or even more. In other instances two lines, making an angle of one or two degrees with each other, will be run, for example, *north*, and the *variation* recorded as differing by the angle between them. By this practice neither the *magnetic* nor the *true* bearing is given, and what is called the *variation* is simply an *arbitrary* angle, which may in some cases be the variation by accident, but oftener something else. The bearing of the south boundary will be the same from one end to the other if correctly run, and its bearing is of course the *true* bearing of *east and west section lines* if the corners are at the proper distance from said boundary. Therefore, for the sake of uniformity, it necessarily follows that the bearing of *random* lines should be *the same as that of the south boundary of the tier of sections to which they belong and the lines are to be so run.*

When the lines are run as above directed, that portion of the falling due to deviation of the south boundary no longer enters into consideration and the limit for the closing error may be consistently reduced to the limit allowed on exterior lines, or *fifty links per mile*, and this change has been made in the prescribed limits (on page 40), which are, even after this reduction, much greater than good work will ever require.

The variation, when once properly determined, is to be set off on the variation arc, which should then be clamped and not again moved until natural causes—such as diurnal change or local attraction—require it to be corrected. Whenever any change in the variation is made on

the instrument, all particulars relating thereto must be recorded, as illustrated in Specimen Field Notes.

The compass used as above directed will always give the bearing from the *true meridian* or the *true bearing* of any point, or of any line upon which the compass is directed.

Tables VII and VIII.

These tables, which require no special description, are useful for converting linear into angular, and angular into linear, measures, as well as for determining the convergencies and divergencies of the meridians, on the speroidal surface of the earth. As the tabular values are given in *chains*, the tables will be found convenient for the surveyor's use. The following rules and examples will illustrate their application :

1. *Given the latitudes of any two places on the same meridian, to find the distance between them.*

Rule.—Find from Table VII the length of a degree of the meridian at each latitude, and take half their sum for the mean length of a degree. Then say, as 60 minutes is to the difference of latitude, so is the mean length of a degree to the distance required.

The latitude of the north boundary of Wyoming is 45° N., and that of the 1st Standard Parallel South, Montana, 45° 26′ 4″.08; what is the meridional distance between them ?

Chains. Chains.
As 60′ : 26′ 4″.08 :: 5524.02 : 2400, the distance required.

2. *Given the distance between any two places on the same meridian, and the latitude of one of them, to find the difference of latitude.*

Rule.—Find from Table VII the length of a degree of the meridian, in the given latitude, and also in that differing from it, by the meridional distance, converted into arc at the rate of 52 seconds per mile, and take half their sum for the mean length of a degree. Then say, as the mean length of a degree is to the meridional distance, so is 60 minutes to the difference of latitude required.

The latitude of the north boundary of Wyoming is 45° N.; what is the latitude of the 1st Standard Parallel South, Montana, the meridional distance being 30 miles ?

Chains. Chains.
As 5524.02 : 2400 :: 60′ : 26′ 4″.08, the difference of latitude required.

3. *Given the longitudes of any two places, on the same parallel, in a given latitude, to find the distance between them.*

Rule.—Find from Table VIII the length of a degree of longitude in the given latitude; and say, as 60 minutes is to the difference of longitude, so is the length of a degree of longitude to the distance required.

The longitude of the Willamette Meridian is 122° 44′, and that of east boundary of Range 6 east, 121° 59′ 31″; what is the distance between them, on the Base Line, in latitude 45° 30′ ?

Chains. Chains.
As 60′ : 44′ 29″ : : 3884.81 : 2880, the distance required.

4. *Given the distance between any two places on the same parallel, in a given latitude, to find their difference of longitude.*

Rule.—Find from Table VIII the length of a degree of longitude in the given latitude; and say, as the length of the degree of longitude is to the given distance, so is 60 minutes to the difference of longitude.

The longitude of the Willamette Meridian is 122° 44′; what is the difference of longitude to east boundary of Range 6 east, the distance on the Base Line, in latitude 45° 30′, being 36 miles?

Chains. Chains.
As 3884. 81 : 2880 :: 60′ : 44° 29′, the difference of longitude required.

5. *Given the distance between two meridians, on any parallel, in a given latitude, to find the convergency of the meridians for any distance north of that parallel.*

RULE.—Find the length of a degree of longitude, at each latitude, by the foregoing rules; and say, as the *greater* of the two lengths is to their difference, so is the given distance to the *convergency* required.

The distance between the Principal Meridian and first Range Line west is 6 miles, in latitude 42° 39′ 12″; what is the convergency of the two range lines at the Base Line, the meridional distance being 24 miles?

Chains. Chains. Chains. Chains.
As 4075. 67 : 2. 71 :: 480 : 2.67, the convergency required.

6. *Given the distance between two meridians, on any parallel in a given latitude, to find the divergency of the meridians for any distance south of that parallel.*

RULE.—Find the length of a degree of longitude, at each latitude, by the foregoing rules; and say, as the *less* of the two lengths is to their difference, so is the given distance to the *divergency* required.

The distance between the Principal Meridian and first Range Line on the Base Line in latitude 43°, is 5 miles 77.33 chains; what is the divergency of the two range lines at the parallel 42° 39′ 12″, the meridional distance being 24 miles?

Chains. Chains. Chains. Chains.
As 4052. 96 : 22. 71 :: 477. 33 : 2. 67, the divergency required.

TABLE VII.

LENGTH OF A DEGREE OF LATITUDE.

Lat.	29°	30°	31°	32°	33°	34°	35°	36°	37°	38°	Lat.
′	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	′
0	5509.15	5509.97	5510.82	5511.67	5512.55	5513.44	5514.34	5515.25	5516.18	5517.11	0
1	09.16	09.99	10.83	11.69	12.56	13.45	14.35	15.27	16.19	17.13	1
2	09.17	10.00	10.84	11.70	12.58	13.47	14.37	15.28	16.21	17.14	2
3	09.19	10.01	10.86	11.72	12.59	13.48	14.38	15.30	16.22	17.16	3
4	09.20	10.03	10.87	11.73	12.61	13.50	14.40	15.31	16.24	17.17	4
5	09.21	10.04	10.89	11.75	12.62	13.61	14.42	15.33	16.25	17.19	5
6	09.23	10.06	10.90	11.76	12.64	13.63	14.43	15.34	16.27	17.20	6
7	09.24	10.07	10.91	11.78	12.65	13.54	14.45	15.36	16.28	17.22	7
8	09.25	10.08	10.93	11.79	12.67	13.56	14.46	15.38	16.30	17.23	8
9	09.27	10.10	10.94	11.81	12.68	13.67	14.48	15.39	16.32	17.25	9
10	09.28	10.11	10.96	11.82	12.70	13.59	14.49	15.41	16.33	17.27	10
11	09.30	10.13	10.97	11.83	12.71	13.60	14.51	15.42	16.35	17.28	11
12	09.31	10.14	10.99	11.85	12.73	13.62	14.52	15.44	16.36	17.30	12
13	09.32	10.15	11.00	11.86	12.74	13.63	14.54	15.45	16.38	17.31	13
14	09.34	10.17	11.01	11.88	12.76	13.65	14.55	15.47	16.39	17.33	14
15	09.35	10.18	11.03	11.89	12.77	13.66	14.57	15.48	16.41	17.34	15
16	09.36	10.19	11.04	11.91	12.79	13.68	14.58	15.50	16.42	17.36	16
17	09.38	10.21	11.06	11.92	12.80	13.69	14.60	15.51	16.44	17.38	17
18	09.39	10.22	11.07	11.94	12.81	13.71	14.61	15.53	16.46	17.39	18
19	09.41	10.24	11.09	11.95	12.83	13.72	14.63	15.54	16.47	17.41	19
20	09.42	10.25	11.10	11.96	12.84	13.74	14.64	15.66	16.49	17.42	20
21	09.43	10.26	11.11	11.98	12.86	13.75	14.66	15.57	16.50	17.44	21
22	09.45	10.28	11.13	11.99	12.87	13.77	14.67	15.59	16.52	17.45	22
23	09.46	10.29	11.14	12.01	12.89	13.78	14.69	15.61	16.53	17.47	23
24	09.47	10.31	11.16	12.02	12.90	13.80	14.70	15.62	16.55	17.49	24
25	09.49	10.32	11.17	12.04	12.92	13.81	14.72	15.64	16.56	17.50	25
26	09.50	10.33	11.19	12.05	12.93	13.83	14.73	15.65	16.58	17.52	26
27	09.51	10.35	11.20	12.07	12.95	13.84	14.75	15.67	16.60	17.53	27
28	09.53	10.36	11.21	12.08	12.96	13.86	14.76	16.68	16.61	17.55	28
29	09.54	10.38	11.23	12.10	12.98	13.87	14.78	15.70	16.63	17.56	29
30	09.56	10.39	11.24	12.11	12.99	13.89	14.79	15.71	16.64	17.58	30
31	09.57	10.41	11.26	12.12	13.01	13.90	14.81	15.73	16.66	17.60	31
32	09.58	10.42	11.27	12.14	13.02	13.92	14.82	15.74	16.67	17.61	32
33	09.60	10.44	11.29	12.15	13.04	13.93	14.84	15.76	16.69	17.63	33
34	09.61	10.45	11.30	12.17	13.05	13.95	14.86	15.77	16.70	17.64	34
35	09.63	10.46	11.31	12.18	13.07	13.96	14.87	15.79	16.72	17.66	35
36	09.64	10.48	11.33	12.20	13.08	13.98	14.89	15.81	16.74	17.67	36
37	09.65	10.49	11.34	12.21	13.10	13.99	14.90	15.82	16.75	17.69	37
38	09.67	10.50	11.36	12.22	13.11	14.01	14.92	15.84	16.77	17.71	38
39	09.68	10.52	11.37	12.24	13.13	14.02	14.93	15.85	16.78	17.72	39
40	09.69	10.53	11.39	12.26	13.14	14.04	14.95	15.87	16.80	17.74	40
41	09.71	10.55	11.40	12.27	13.16	14.05	14.96	15.88	16.81	17.75	41
42	09.72	10.56	11.42	12.29	13.17	14.07	14.98	16.90	16.83	17.77	42
43	09.74	10.57	11.43	12.30	13.18	14.08	14.99	15.91	16.84	17.78	43
44	09.75	10.59	11.44	12.31	13.20	14.10	15.01	15.93	16.86	17.80	44
45	09.76	10.60	11.46	12.33	13.21	14.11	15.02	15.94	16.88	17.82	45
46	09.78	10.62	11.47	12.34	13.23	14.13	15.04	15.96	16.89	17.83	46
47	09.79	10.63	11.49	12.36	13.24	14.14	15.05	15.98	16.91	17.85	47
48	09.80	10.65	11.50	12.37	13.26	14.16	16.07	15.99	16.92	17.86	48
49	09.82	10.66	11.52	12.39	13.27	14.17	15.08	16.01	16.94	17.88	49
50	09.83	10.67	11.53	12.40	13.29	14.19	15.10	16.02	16.95	17.89	50
51	09.85	10.69	11.54	12.42	13.30	14.20	15.11	16.04	16.97	17.91	51
52	09.86	10.70	11.56	12.43	13.32	14.22	15.13	16.05	16.98	17.93	52
53	09.87	10.72	11.57	12.45	13.33	14.23	15.15	16.07	17.00	17.94	53
54	09.89	10.73	11.59	12.46	13.35	14.25	15.16	16.08	17.02	17.96	54
55	09.90	10.74	11.60	12.48	13.36	14.26	15.18	16.10	17.03	17.97	55
56	09.92	10.76	11.62	12.49	13.38	14.28	15.19	16.11	17.05	17.99	56
57	09.93	10.77	11.63	12.51	13.39	14.29	15.21	16.13	17.06	18.00	57
58	09.94	10.79	11.65	12.52	13.41	14.31	15.22	16.15	17.08	18.02	58
59	09.96	10.80	11.66	12.53	13.42	14.32	16.24	16.16	17.09	18.04	59
60	5509.97	5510.82	5511.67	5512.55	5513.44	5514.34	5515.25	5516.18	5517.11	5518.05	60

TABLE VII.

LENGTH OF A DEGREE OF LATITUDE.

Lat.	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	Lat.
′	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	′
0	5518.05	5519.00	5519.96	5520.92	5521.88	5522.85	5523.81	5524.78	5525.75	5526.72	0
1	18.07	19.02	19.97	20.93	21.90	22.86	23.83	24.80	25.77	26.73	1
2	18.08	19.03	19.99	20.95	21.91	22.88	23.85	24.82	25.78	26.75	2
3	18.10	19.05	20.00	20.96	21.93	22.89	23.80	24.83	25.80	26.76	3
4	18.11	19.06	20.02	20.98	21.94	22.91	23.88	24.85	25.82	26.78	4
5	18.13	19.08	20.04	21.00	21.96	22.93	23.90	24.86	25.83	26.80	5
6	18.15	19.10	20.05	21.01	21.98	22.94	23.91	24.88	25.85	26.81	6
7	18.16	19.11	20.07	21.03	21.99	22.96	23.93	24.90	25.86	26.83	7
8	18.18	19.13	20.08	21.04	22.01	22.98	23.94	24.91	25.88	26.84	8
9	18.19	19.14	20.10	21.06	22.02	22.99	23.96	24.93	25.90	26.86	9
10	18.21	19.16	20.12	21.08	22.04	23.01	23.98	24.94	25.91	26.88	10
11	18.22	19.18	20.13	21.09	22.06	23.02	23.99	24.96	25.93	26.89	11
12	18.24	19.19	20.15	21.11	22.07	23.04	24.01	24.98	25.94	26.91	12
13	18.26	19.21	20 16	21.12	22.09	23.06	24.02	24.99	25.96	26.92	13
14	18.27	19.22	20.18	21.14	22.11	23.07	24.04	25.01	25.98	26.94	14
15	18.29	19.24	20.20	21.16	22.12	23.09	24.06	25.03	25.99	26.96	15
16	18.30	19.25	20.21	21.17	22.14	23.10	24.07	25.04	26.01	26.97	16
17	18.32	19.27	20.23	21.19	22.15	23.12	24.09	25.06	26.02	26.99	17
18	18.34	19.29	20.24	21.20	22.17	23.14	24.11	25.07	26.04	27.00	18
19	18.35	19.30	20.26	21.22	22.19	23.15	24.12	25.09	26.06	27.02	19
20	18.37	19.32	20.28	21.24	22.20	23.17	24.14	25.11	26.07	27.04	20
21	18.38	19.33	20.29	21.25	22.22	23.19	24.15	25.12	26.09	27.05	21
22	18.40	19.35	20.31	21.27	22.23	23.20	24.17	25.14	26.10	27.07	22
23	18.41	19.37	20.32	21.29	22.25	23.22	24.19	25.15	26.12	27.09	23
24	18.43	19.38	20.34	21.30	22.27	23.23	24.20	25.17	26.14	27.10	24
25	18.45	19.40	20.36	21.32	22.28	23.25	24.22	25.19	26.15	27.12	25
26	18.46	19.41	20.37	21.33	22.30	23.27	24.23	25.20	26.17	27.13	26
27	18.48	19.43	20.39	21.35	22.31	23.28	24.25	25.22	26.19	27.15	27
28	18.49	19.45	20.40	21.36	22.33	23.30	24.27	25.23	26.20	27.17	28
29	18.51	19.46	20.42	21.38	22.35	23.31	24.28	25.25	26.22	27.18	29
30	18.53	19.48	20.44	21.40	22.36	23.33	24.30	25.27	26.23	27.20	30
31	18.54	19.49	20.45	21.41	22.38	23.35	24.32	25.28	26.25	27.21	31
32	18.56	19.51	20.47	21.43	22.40	23.36	24.33	25.30	26.27	27.23	32
33	18.57	19.53	20.48	21.45	22.41	23 38	24.35	25.32	26.28	27.25	33
34	18.59	19.54	20.50	21.46	22.43	23.40	24.36	25.33	26.30	27.26	34
35	18.60	19.56	20.52	21.48	22.44	23.41	24.38	25.35	26.31	27.28	35
36	18.62	19.57	20.53	21.49	22.46	23.43	24.40	25.36	26.33	27.29	36
37	18.64	19.59	20.55	21.51	22.48	23.44	24.41	25.38	26.35	27.31	37
38	18.65	19.60	20.56	21.53	22.49	23.46	24.43	25.40	26.36	27.33	38
39	18.67	19.62	20.58	21.54	22.51	23.48	24.44	25.41	26.38	27.34	39
40	18.68	19.64	20.60	21.56	22.52	23.49	24.46	25.43	26.39	27.36	40
41	18.70	19.65	20.61	21.57	22.54	23.51	24.48	25.44	26.41	27.37	41
42	18.72	19.67	20.63	21.59	22.56	23.52	24.49	25.46	26.43	27.39	42
43	18.73	19.68	20.64	21.61	22.57	23.54	24.61	26.48	26.44	27.41	43
44	18.75	19.70	20.66	21.62	22.59	23.56	24.52	25.49	26.46	27.42	44
45	18.76	19.72	20.68	21.64	22.60	23.57	24.54	25.61	26.47	27.44	45
46	18.78	19.73	20.69	21.65	22.62	23.59	24.56	25.52	26.49	27.45	46
47	18.79	19.75	20.71	21.67	22.64	23.60	24.57	25.54	26.51	27.47	47
48	18.81	19.76	20.72	21.69	22.65	23.62	24.59	25.56	26.52	27.49	48
49	18.83	19.78	20.74	21.70	22.67	23.64	24.61	25.57	26.54	27.50	49
50	18.81	19.80	20.76	21.72	22.69	23.65	24.62	25.59	26.56	27.52	50
51	18.86	19.81	20.77	21.74	22.70	23.67	24.64	25.61	26.57	27.63	51
52	18.87	19.83	20.79	21.75	22.72	23.69	24.65	25.62	26.59	27.55	52
53	18.89	19.84	20.80	21.77	22.73	23.70	24.67	25.64	26.60	27.57	53
54	18.91	19.86	20.82	21.78	22.75	23.72	24.69	25.65	26.62	27.58	54
55	18.92	19.88	20.84	21.80	22.77	23.73	24.70	25.67	26.64	27.60	55
56	18.94	19.89	20.85	21.82	22.78	23.75	24.72	25.69	26.65	27.61	56
57	18.95	19.91	20.87	21.83	22.80	23.77	24.73	25.70	26.67	27.63	57
58	18.97	19.92	20.88	21.85	22.81	23.78	24.75	25.72	26.68	27.65	58
59	18.98	19.94	20.90	21.86	22.83	23.80	24.77	25.73	26.70	27.66	59
60	5519.00	5519.96	5520.92	5521.88	5522.85	5523.81	5524.78	5525.75	5526.72	5527.68	60

TABLE VIII.

LENGTH OF A DEGREE OF LONGITUDE.

Lat.	29°	30°	31°	32°	33°	34°	35°	36°	37°	38°	Lat.
′	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	′
0	4843.17	4795.82	4747.01	4696.75	4645.06	4591.96	4537.45	4481.56	4424.29	4365.68	0
1	42.40	95.62	46.19	95.90	44.19	91.06	36.53	80.61	23.33	04.69	1
2	41.62	94.22	45.36	95.05	43.32	90.16	35.61	79.67	22.36	03.76	2
3	40.84	93.42	44.53	94.20	42.44	89.26	34.69	78.73	21.40	02.72	3
4	40.06	92.61	43.71	93.35	41.57	88.37	33.77	77.78	20.43	01.73	4
5	39.28	91.81	42.88	92.60	40.69	87.47	32.84	76.84	19.46	00.74	5
6	38.50	91.01	42.06	91.65	39.82	86.57	31.92	75.89	18.49	59.75	6
7	37.72	90.20	41.22	90.86	38.94	85.67	31.00	74.95	17.53	58.76	7
8	36.94	89.40	40.39	89.94	38.06	84.77	30.08	74.00	16.66	57.77	8
9	36.16	88.59	39.56	89.09	37.19	83.87	29.15	73.05	15.69	56.77	9
10	35.38	87.79	38.73	88.24	36.31	82.97	28.23	72.11	14.62	55.78	10
11	34.60	86.98	37.90	87.38	35.43	82.07	27.30	71.16	13.65	54.79	11
12	33.82	86.18	37.07	86.53	34.55	81.17	26.38	70.21	12.08	53.80	12
13	33.04	85.37	36.24	85.67	33.68	80.26	25.40	69.26	11.71	52.81	13
14	32.26	84.56	35.41	84.82	32.80	79.36	24.53	68.32	10.74	51.81	14
15	31.47	83.76	34.58	83.96	31.92	78.46	23.60	67.37	09.77	50.82	15
16	30.69	82.95	33.75	83.11	31.04	77.56	22.68	66.42	08.80	49.83	16
17	29.91	82.14	32.92	82.25	30.16	76.65	21.76	65.47	07.82	48.83	17
18	29.12	81.33	32.08	81.40	29.28	75.75	20.83	64.52	06.85	47.84	18
19	28.34	80.52	31.25	80.54	28.40	74.85	19.90	63.57	05.88	46.84	19
20	27.56	79.71	30.42	79.68	27.52	73.94	18.97	62.62	04.91	45.85	20
21	26.77	78.90	29.58	78.82	26.64	73.04	18.64	61.67	03.93	44.85	21
22	25.98	78.09	28.75	77.97	25.75	72.13	17.11	60.72	02.96	43.85	22
23	25.20	77.28	27.92	77.11	24.87	71.23	16.19	59.77	01.98	42.86	23
24	24.41	76.47	27.08	76.26	23.99	76.32	16.26	58.81	01.01	41.86	24
25	23.62	75.66	26.25	75.39	23.11	69.41	14.33	67.86	4400.04	40.86	25
26	22.83	74.85	25.41	74.53	22.22	68.51	13.40	66.91	4399.06	39.87	26
27	22.05	74.04	24.57	73.67	21.34	67.60	12.47	65.96	98.08	38.87	27
28	21.26	73.22	23.74	72.81	20.45	66.69	11.54	65.00	97.11	37.87	28
29	20.47	72.41	22.90	71.95	19.57	65.78	10.61	54.05	96.13	36.87	29
30	19.68	71.60	22.06	71.09	18.69	64.88	09.67	63.09	95.16	36.87	30
31	18.89	70.78	21.22	70.22	17.80	63.97	08.74	52.14	94.18	34.87	31
32	18.16	69.97	20.39	69.36	16.91	63.06	07.81	51.19	93.20	33.87	32
33	17.31	69.16	19.55	68.50	16.03	62.15	66.88	50.23	92.22	32.87	33
34	16.52	68.34	18.71	67.64	15.14	61.24	05.94	49.27	91.25	31.87	34
35	15.73	67.53	17.87	66.77	14.26	60.33	05.01	48.32	90.27	30.87	35
36	14.94	66.71	17.03	65.91	13.37	59.42	04.08	47.36	89.29	29.87	36
37	14.15	65.80	16.19	65.05	12.48	58.51	03.14	46.41	88.31	28.87	37
38	13.35	65.68	16.35	64.18	11.60	57.60	02.21	46.45	87.33	27.87	38
39	12.56	64.26	14.61	63.32	10.70	56.68	61.28	44.49	86.35	26.87	39
40	11.77	63.44	13.67	62.45	09.81	55.77	4500.34	43.53	85.37	25.86	40
41	10.98	62.52	12.82	61.59	08.93	64.80	4499.46	42.57	84.39	24.86	41
42	10.18	61.81	11.98	60.72	08.04	53.95	98.47	41.62	83.41	23.86	42
43	09.39	60.99	11.14	59.85	07.15	53.03	97.53	40.66	82.42	22.85	43
44	08.59	60.17	10.30	58.99	06.26	52.12	96.59	39.70	81.44	21.85	44
45	07.80	59.35	09.45	58.12	05.36	61.21	95.66	38.74	80.46	20.85	45
46	07.00	58.53	08.61	57.25	04.47	50.29	94.72	37.78	79.48	19.84	46
47	06.21	57.71	07.76	56.38	03.58	49.38	93.78	36.82	78.49	18.84	47
48	05.41	56.80	06.92	55.51	02.69	48.46	92.84	35.86	77.51	17.83	48
49	04.61	56.07	06.07	54.65	01.80	47.56	91.91	34.80	76.53	16.82	49
50	03.82	55.25	05.23	53.78	00.90	46.63	90.97	33.93	75.54	15.82	50
51	03.02	54.43	04.38	52.91	4600.01	45.71	90.03	32.97	74.56	14.81	51
52	02.22	53.66	03.54	52.04	4599.12	44.80	89.09	32.01	73.57	13.80	52
53	01.42	52.78	02.69	51.17	98.22	43.88	88.16	31.04	72.59	12.80	53
54	4800.62	51.96	01.84	50.30	97.33	42.96	87.21	30.08	71.60	11.79	54
55	4799.82	51.13	01.00	49.42	96.44	42.04	86.27	29.12	70.62	10.78	55
56	99.02	50.31	4700.15	48.55	95.54	41.13	85.32	28.15	69.63	09.77	56
57	98.22	49.49	4699.30	47.68	94.64	40.21	84.38	27.19	68.64	08.76	57
58	97.42	48.66	98.45	46.81	93.75	39.29	83.44	26.22	67.66	07.75	58
59	96.62	47.84	97.60	45.94	92.85	38.37	82.50	25.26	66.67	06.74	59
60	4795.82	4747.01	4696.75	4645.06	4591.96	4637.46	4481.56	4424.29	4365.68	4306.73	60

TABLE VIII.

LENGTH OF A DEGREE OF LONGITUDE.

Lat.	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	Lat.
′	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	*Chains.*	′
0	4305.73	4244.47	4181.91	4118.06	4052.96	3986.62	3919.05	3850.28	3780.33	3709.22	0
1	04.72	43.44	80.85	16.99	51.87	85.50	17.91	49.12	79.15	08.03	1
2	03.71	42.41	79.80	15.91	60.77	84.38	16.78	47.97	77.98	06.83	2
3	02.70	41.37	78.75	14.84	49.67	83.27	15.64	46.81	76.80	05.63	3
4	01.69	40.34	77.69	13.76	48.58	82.15	14.50	45.65	75.63	04.44	4
5	4300.68	39.31	76.64	12.69	47.48	81.03	13.36	44.50	74.45	03.24	5
6	4299.67	38.27	75.58	11.61	46.38	79.91	12.23	43.34	73.27	02.05	6
7	98.65	37.24	74.52	10.53	45.28	78.79	11.09	42.18	72.00	3700.85	7
8	97.64	36.20	73.47	09.46	44.19	77.68	09.95	41.02	70.92	3699.65	8
9	96.63	35.17	72.41	08.38	43.09	76.56	08.81	39.86	69.74	98.46	9
10	95.61	34.13	71.36	07.30	41.99	75.44	07.67	38.70	68.56	97.26	10
11	94.60	33.10	70.30	06.22	40.89	74.32	06.53	37.54	67.38	96.06	11
12	93.59	32.06	69.24	05.14	39.79	73.20	05.39	36.38	66.20	94.86	12
13	92.57	31.02	68.18	04.07	38.69	72.08	04.25	35.22	65.02	93.66	13
14	91.56	29.99	67.12	02.99	37.59	70.96	03.11	34.06	63.84	92.46	14
15	90.54	28.95	66.07	01.91	36.49	69.84	01.97	32.90	62.66	91.26	15
16	89.52	27.91	65.01	4100.83	35.39	68.72	3900.83	31.74	61.48	90.06	16
17	88.51	26.87	63.95	4099.75	34.29	67.59	3899.69	30.58	60.30	88.86	17
18	87.49	25.84	62.89	98.67	33.19	66.47	98.54	29.42	59.12	87.66	18
19	86.48	24.80	61.83	97.58	32.09	65.35	97.40	28.26	57.94	86.46	19
20	85.46	23.76	60.77	96.50	30.98	64.23	96.26	27.09	66.76	85.26	20
21	84.44	22.72	59.71	95.42	29.88	63.11	95.12	25.93	55.57	84.06	21
22	83.42	21.68	58.65	94.34	28.78	61.98	93.97	24.77	54.39	82.86	22
23	82.40	20.64	57.58	93.26	27.67	60.86	92.83	23.60	63.21	81.66	23
24	81.39	19.60	56.52	92.17	26.57	59.73	91.68	22.44	52.02	80.46	4
25	80.37	18.56	55.46	91.09	25.47	68.61	90.54	21.28	50.84	79.25	25
26	79.35	17.62	64.40	90.01	24.36	57.49	89.40	20.11	49.66	78.05	26
27	78.33	16.48	53.44	88.92	23.26	56.36	88.25	18.95	48.47	76.85	27
28	77.31	15.43	52.27	87.84	22.15	55.24	87.11	17.78	47.29	75.64	28
29	76.29	14.39	51.21	86.75	21.05	54.11	85.96	16.62	46.10	74.44	29
30	75.27	13.35	50.14	85.67	19.94	52.98	84.81	15.45	44.92	73.24	30
31	74.24	12.31	49.08	84.58	18.84	51.86	83.67	14.29	43.73	72.03	31
32	73.22	11.26	48.02	83.50	17.73	50.73	82.52	13.12	42.55	70.83	32
33	72.20	10.22	46.95	82.41	16.62	49.60	81.37	11.95	41.30	69.62	33
34	71.18	09.18	45.89	81.33	15.52	48.48	80.23	10.79	40.18	68.42	34
35	70.16	08.13	44.82	80.24	14.41	47.35	79.08	09.62	38.99	67.21	35
36	69.13	07.09	43.75	79.15	13.30	46.22	77.93	08.45	37.80	66.01	36
37	68.11	06.04	42.69	78.07	12.19	45.09	76.78	07.28	36.62	64.80	37
38	67.09	05.00	41.62	76.98	11.09	43.96	75.63	06.11	35.43	63.59	38
39	66.06	03.95	40.55	75.89	09.98	42.83	74.48	04.95	34.24	62.39	39
40	65.04	02.90	39.49	74.80	08.87	41.71	73.34	03.78	33.05	61.18	40
41	64.01	01.86	38.42	73.71	07.76	40.58	72.19	02.61	31.86	59.97	41
42	62.99	4200.81	37.35	72.62	06.65	39.45	71.04	01.44	30.67	58.76	42
43	61.96	4199.76	36.28	71.53	05.54	38.32	69.89	3800.27	29.48	57.56	43
44	60.93	98.72	35.21	70.44	04.43	37.18	68.74	3799.10	28.30	56.35	44
45	59.91	97.67	34.14	69.35	03.32	36.05	67.58	97.93	27.11	55.14	45
46	58.88	96.62	33.08	68.26	02.21	34.92	66.43	96.76	25.92	53.93	46
47	57.85	95.57	32.01	67.17	4001.10	33.79	65.28	95.59	24.73	52.72	47
48	56.83	94.52	30.93	66.08	3999.98	32.66	64.13	94.41	23.53	51.51	48
49	55.80	93.47	29.86	64.99	98.87	31.53	62.98	93.24	22.34	50.30	49
50	54.77	92.42	28.79	63.90	97.76	30.39	61.82	92.07	21.15	49.09	50
51	53.74	91.37	27.72	62.81	96.65	29.26	60.67	90.90	19.96	47.88	51
52	52.71	90.32	26.65	61.71	95.53	28.13	59.52	89.72	18.77	46.67	52
53	51.68	89.27	25.58	60.62	94.42	26.99	58.36	88.55	17.58	45.46	53
54	50.66	88.22	24.51	59.53	93.31	25.86	57.21	87.38	16.38	44.25	54
55	49.63	87.17	23.43	58.43	92.19	24.73	56.06	86.20	15.19	43.03	55
56	48.59	86.12	22.36	57.34	91.08	23.59	54.90	85.03	14.00	41.82	56
57	47.56	85.07	21.29	56.25	89.96	22.46	53.75	83.86	12.80	40.61	57
58	46.53	84.02	20.21	55.15	88.85	21.32	52.59	82.68	11.61	39.40	58
59	45.50	82.96	19.14	54.06	87.73	20.19	51.44	81.51	10.41	38.18	59
60	4244.47	4181.91	4118.06	4052.96	3986.62	3919.05	3850.28	3780.33	3709.22	3636.97	60

TABLE IX.

Convergency of meridians. The second column contains the convergency, measured on the parallel, for two meridians *six miles long and six miles apart*, for the latitude of their *middle* points which is given in the first column. For other than the tabular latitudes the distance may be obtained by simple proportion. The third column contains the angle of convergency. See Diagram A, Fig. 1.

The convergency between any two meridians *whose lengths are equal to their mean distances apart* may be found by the following proportion:

The square of the tabular meridional length (six miles) is to the square of the given length of meridians as the tabular *convergency* is to the convergency required.

Thus, for two meridians three miles long and three miles apart, in latitude 44°, we have: As $6^2 : 3^2 :: 70.1$ links : 17.52 links, the convergency.

The convergency of equal length of meridians in the same latitude are proportional to their distance apart; thus, the convergency for five ranges (meridians 6 mls. long) in latitude 38° is, 56.8 lks. × 5 = 2.84 chains.

TABLE IX.

Convergency of meridians six miles long and six miles apart. Also, difference of longitude for one range.

Latitude.	Convergency.		Difference of longitude per range.	
	On the parallel.	Angle.	In arc.	In time.
°	*Links.*	′ ″	′ ″	*Seconds.*
30	41.9	3 0	6 0.36	24.02
31	43.6	3 7	6 4.02	24.27
32	45.4	3 15	6 7.93	24.53
33	47.2	3 23	6 12.00	24.80
34	49.1	3 30	6 16.31	25.09
35	50.9	3 38	6 20.95	25.40
36	52.7	3 46	6 25.60	25.71
37	54.7	3 55	6 30.59	26.04
38	56.8	4 4	6 35.81	26.39
39	58.8	4 13	6 41.34	26.76
40	60.9	4 22	6 47.13	27.14
41	63.1	4 31	6 53.22	27.55
42	65.4	4 41	6 59.62	27.97
43	67.7	4 51	7 6.27	28.42
44	70.1	5 1	7 13.44	28.90
45	72.6	5 12	7 20.93	29.39
46	75.2	5 23	7 28.81	29.92
47	77.8	5 34	7 37.10	30.47
48	80.6	5 46	7 45.79	31.05
49	83.5	5 59	7 55.12	31.67
50	86.5	6 12	8 4.90	32.33

The above rules may be used to find the convergency for lengths of meridians more than 6 miles long. Take the preceding example, 5. Find from Table IX the tabular convergency for latitude 42° 49′ 36″,—equal to 67.3 links, and from the proportion, $6^2 : 24^2 :: 67.3$ links : 1076.8 links, the convergency for *two meridians* 24 *miles long and* 24 *miles apart.* Then for two meridians *six* miles apart divide 1076.8 links by 4, the quotient, 2.69 chains, is the convergency required, which agrees closely with the result obtained by the preceding rule.

Another proportion for finding the convergency is this: The cosines of the latitudes are to each other as the lengths of the intercepted parallels.

Thus, for example 5, we have cos. 42° 39′ 12″ : cos. 43° : : 480 chs. : 477.32 chs., which proportion may be computed with natural cosines, or more expeditiously, by logarithms, as follows:

Log. cos. 42° 39′ 12″	a. c. 0.133437
Log. cos. 43°	9.864127
Log. 480 chains	2.681241
Log. 477.32 chs.	2.678805

The difference 2.68 chs., is the convergency required.

This method does not take into account the *spheroidal* shape of the earth, but regards it as a perfect sphere and is sufficiently exact for surveying purposes.

Columns 4 and 5 contain differences of longitude for one range in arc and time. The tabular value in last column multiplied by the number of ranges between any two points in the same latitude, gives the difference of their *local* times. Thus, for a station 20 ranges west of the *standard meridian for mountain time* (105° longitude), in latitude 47°, the difference in time is $30^{s}.47 \times 20 = 10^{m}\ 9^{s}.4$.

SPECIMEN FIELD NOTES.

No. 1.

TITLE PAGE.

(See Diagram B.)

FIELD NOTES

OF THE SURVEY OF THE

THIRD STANDARD PARALLEL NORTH

THROUGH

Range No. 21 East

OF THE

PRINCIPAL BASE AND MERIDIAN

IN THE

TERRITORY OF MONTANA,

AS SURVEYED BY

RICHARD ROODS,

U. S. DEPUTY SURVEYOR,

UNDER HIS CONTRACT No. 97,

DATED JULY 10, 1889.

Survey commenced August 22, 1889.

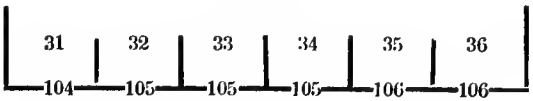
Survey completed August 24, 1889.

[Second Page.]

NAMES AND DUTIES OF ASSISTANTS.

PETER LONG.....Chainman.
JOHN SHORT.....Chainman.
ELI MARKER.....Chainman.
WILLIAM TALLY.....Chainman.
GEORGE SHARP.....Axeman.
ADAM DULL.....Axeman.
JAMES BANNER.....Flagman.

INDEX.



PRELIMINARY OATHS OF ASSISTANTS.

We, Peter Long, John Short, Eli Marker, and William Tally, do solemnly swear that we will well and faithfully execute the duties of chain carriers; that we will level the chain upon even and uneven ground, and plumb the tally pins, either by sticking or dropping the same; that we will report the true distance to all notable objects, and the true lengths of all lines that we assist in measuring, to the best of our skill and ability, and in accordance with instructions given us, in the survey of the third standard parallel north, through range No. 21 east, of the principal base and meridian, in the Territory of Montana.

PETER LONG, *Chainman.*
JOHN SHORT, *Chainman.*
ELI MARKER, *Chainman.*
WILLIAM TALLY, *Chainman.*

Subscribed and sworn to before me this 2d day of August, 1889.
[SEAL.] WILLIAM MARTIN,
Notary Public.

We, George Sharp and Adam Dull, do solemnly swear that we will well and truly perform the duties of axemen, in the establishment of corners and other duties, according to instructions given us, and to the best of our skill and ability, in the survey of the third standard parallel north, through range No. 21 east, of the principal base and meridian, in the Territory of Montana.

GEORGE SHARP, *Axeman.*
ADAM DULL, *Axeman.*

Subscribed and sworn to before me this 2d day of August, 1889.
[SEAL.] WILLIAM MARTIN,
Notary Public.

I, James Banner, do solemnly swear that I will well and truly perform the duties of flagman, according to instructions given me, to the best of my skill and ability, in the survey of the third standard parallel north, through range No. 21 east, of the principal base and meridian, in the Territory of Montana.

JAMES BANNER, *Flagman.*

Subscribed and sworn to before me this 2d day of August, 1889.
[SEAL.] WILLIAM MARTIN,
Notary Public.

Third standard parallel north, through range No. 21 east.

Chains.

Survey commenced August 22nd, 1889, with a W. & L. E. Gurley light mountain transit, with solar attachment.

At the standard corner to township 13 north, ranges 20 and 21 east, in latitude 46° 50′ N., long. 109° W., at 4h 43m a. m., by my watch, which is 2 minutes slow of local mean time, I take an observation on Polaris, in accordance with instruction in the Manual, and find the *magnetic* bearing of the star to be N. 19° 57′ W.

I drive a picket on the line thus found three chains north of the corner.

	h.	m.
Astronomical time* by watch Aug. 21st	16	43.0
Watch slow ..... *add*		2.0
Correct local mean time of observation, Aug. 21st	16	45.0
Tabular time U. C. of Polaris, 1889, Aug. 15 (Table I)	15	38.9
Reduction for six days, $3.92^m \times 6 = 23.5^m$ ..... *subtract.*		23.5
Local mean time U. C. of Polaris, Aug. 21st,	15	15.4
Which, taken from time of observation, leaves *hour angle* of Polaris	1	29.6

Azimuth of Polaris for lat. 47° (Table II)	0° 44′	*west.*
North end of needle	19 57	*east.*
The *difference* is the variation	19° 13′	*east.*

At 7 a. m. I take the *magnetic* bearing of the line established this morning, and find it to be N. 19° 59′ W., and the variation 19° 15′ east. The *mean* variation is 19° 9′ east.†

NOTE.—For the purpose of illustration the hour angle is taken from Table II for the year 1890. The deputy is not required to use the above method to determine the variation. He can observe at elongation of Polaris if he wishes to do so, but must determine the true meridian at beginning of survey, and record the *time* of his observation and the *magnetic* bearing of the star.

I begin at the standard cor. to townships 13 north, ranges 20 and 21 east, which is a post, 4 inches square, marked—
S. C., T. 13 N., on N.;
R. 21 E., S. 31, on E., and
R. 20 E., S. 36, on W. faces, with 6 notches on N., E., & W. faces, and pits 24 × 18 × 12 ins. crosswise on each line, N., E., and W. of post, 6 ft. dist., and mound of earth around post. Thence I run east, on S. boundary sec. 31.
Va. 19° 15′ E.

Ascend

18.00 A point about 200 ft. above township cor., top of ridge.

40.00 Set a sandstone 18 × 8 × 5 ins. 12 ins. in the ground, for standard ¼ sec. cor., marked S. C. ¼ on N. face, dug pits 18 × 18 × 12 ins. E. and W. of stone, 5½ ft. dist., and raised a mound of earth 1½ ft. high, 3½ ft. base alongside; thence over high, rolling prairie.

57.00 Enter pine timber.

80.00 Set a sandstone, 24 × 10 × 7 ins., 18 ins. in the ground, for standard cor. to secs. 31 and 32, marked S. C., with 5 notches on E and 1 notch on W. edges; from which
A pine, 12 ins. diam., bears N. 77° E., 41 lks. dist., marked T. 13 N., R. 21 E., S. 32, B. T.;
A pine, 18 ins. diam., bears N. 50° W., 20 lks. dist., marked T. 13 N., R. 21 E., S. 31, B. T.;
A pine, 7 ins. diam., bears S. 30° W., 119 lks. dist., marked T. 13 N., R. 21 E., S. C., S. 31 & 32, B. T.

* See page 75 and foot-note on page 76. † Reduce by table, page 55.

Third standard parallel north, through range No. 21 east—Continued.

Chains.	
	Land high, mountainous, 38 chs. hilly, and rolling, 42 chs. Soil sandy, gravel, and rocky; 4th rate. Timber, pine, 23 chs.; mostly dead and fallen.
	At 10 a. m. the variation has decreased 1′ by diurnal change.*
	East, on S. boundary sec. 32.
	Through timber,
	Va. 19° 11′ E.
3.75	Ravine, course S., about 30 ft. deep.
21.85	Ravine, course S. 20° E., about 20 ft. deep.
40.00	Set a sandstone, 18 × 14 × 5 ins., 12 ins. in the ground, for standard ¼ sec. cor., marked S. C., ¼ on N. face, and raised a mound of stone,† 1½ ft. high, 2 ft. base, alongside. Pits impracticable.
59.00	Top of ridge, about 100 ft. high.
68.90	Ravine, course S., about 40 ft. deep.
80.00	Set a post, 4½ ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for standard cor. to secs. 32 and 33, marked— S. C., T. 13 N., R. 21 E., on N.; S. 33 on E., and S. 32 on W. faces, with 4 notches on E. and 2 notches on W. faces, and raised a mound of earth 2 ft. high, 4½ ft. base, around post.
	Land, high and mountainous, 48 chs.
	Soil, sandy, gravelly, and rocky; 4th rate.
	Timber, pine and fir, 80 chs.; mostly dead and fallen; some thick undergrowth same.
	August 22, 1889.
	East, on S. boundary sec. 33.
	Through timber.
	Va. 19° 15′ E.
3.50	Old Indian trail, course N. 10° W.
6.00	Leave scattering and enter heavy timber.
13.50	Leave heavy timber, enter high, open prairie.
21.40	Old Indian trail, course S. 70° W.
30.00	Ascend.
40.00	Set a sandstone 14 × 10 × 5 ins., 10 ins. in the ground, for standard ¼ sec. cor., marked S. C., ¼ on N. face, and raised a mound of stone 1½ ft. high, 2½ ft. base, alongside. Pits impracticable.
45.10	Old Indian trail, course N. 70° W.
53.00	Top of ridge, about 300 ft. high, course N. 30° E.
69.00	Leave prairie, enter timber.
80.00	Set a sandstone, 20 × 15 × 3 ins., 15 ins. in the ground, for standard cor. to secs. 33 & 34, marked S. C., with 3 notches on E. and W. edges; from which A pine, 8 ins. diam., bears N. 89¼° E., 88 lks. dist., marked T. 13 N., R. 21 E., S. 34, B. T.; A pine, 7 ins. diam., bears N. 74° W., 6 lks. dist.; marked T. 13 N., R. 21 E., S. 33, B. T.; A pine, 9 ins. diam., bears S. 4¾° W., 62 lks. dist.; marked T. 13 N., R. 21 E., S. C., S. 33 & 34, B. T.
	Land, high and mountainous, 20 chs.
	Soil, sandy and rocky; 4th rate.
	Timber, pine and fir, 24.50 chs., with some thick undergrowth of same, 9 chs.
	East, on S. boundary sec. 34.
	Through timber.
	Va. 19° 15′ E.
9.40	Enter aspen thicket.
13.80	Ravine, about 12 ft. deep, and leave thicket. Ascend.
23.84	A pine 12 ins. diam. on line, marked with two notches on E. and W. sides.

* The reason for change of va. to be stated. See table page 55.
† See foot-note, p. 22.

chs.	
40.00	Set a sandstone, 16 × 12 × 5 ins., 11 ins. in the ground, for standard ¼ sec. cor., marked S. C. ¼ on N. face; from which A pine, 11 ins. diam., bears N. 54½° E., 39 lks. dist., marked S. C. ¼ S. B. T.; A pine, 10 ins. diam., bears S. 56° W., 17 lks. dist., marked S. C. ¼ S. B. T.
53.55	A pine, 6 ins. diam. on line, marked with 2 notches on E. and W. sides.
80.00	Top of monntain. Set a post, 4½ ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for standard cor. to secs. 34 and 35, marked— S. C., T. 13 N., R. 21 E., on N.; S. 35, on E., and S. 34, on W. faces, with two notches on E. and 4 notches on W. faces; from which A pine, 12 ins. diam., bears N. 45° E., 15 lks. dist., marked T. 13 N., R. 21 E., S. 35 B. T.; A pine, 15 ins. diam., bears S. 48° W., 54 lks. dist., marked T. 13 N., R. 21 E., S. C. S. 34 & 35 B. T. No other trees within limits; raised a mound of stone 1½ ft. high, 2 ft. base, around post. Land, high, mountainous, and rolling. Soil, sandy and rocky; 4th rate. Timber, pine and fir—some good quality—thick under-growth of same and aspen; 80 chs.

August 23, 1889.

East, on S. boundary sec. 35.
Va. 19° 15′ E.
Descend through timber.

37.50	A point about 300 ft. below last sec. cor. on top of mountain; ravine, course N. 10° E. and ascend.
40.00	Set a sandstone 14 × 12 × 5 ins., 10 ins. in the ground, for standard ¼ sec. cor., marked S. C. ¼ on N. face; from which A pine, 12 ins. diam., bears N. 79° E., 140 lks. dist., marked S. C. ¼ S. B. T. No other tree within limits; raised a mound of stone 1½ ft. high, 2 ft. base, alongside the corner.
47.00	Top of ridge, about 150 ft. above ravine, and descend over broken, rolling ground.
80.00	Set a sandstone, 24 × 18 × 5 ins., 18 ins. in the ground, for standard cor. to secs. 35 and 36, marked S. C. on N., with 1 notch on E. and 5 notches on W. edges, and raised a mound of stone 1½ ft. high, 2 ft. base, alongside. Pits impracticable. Land, high and broken. Soil, sandy and gravelly; 4th rate. Timber, pine and fir, mostly dead and fallen. Some thick undergrowth of same; 80 chs.

At 11.30 a. m. the variation has decreased 3′ by diurnal change.
East, on S. boundary sec 36.
Va. 19° 12′ E.
Ascend, through timber.

7.50	Top of ridge, course N. 2° E., about 100 ft. high, and descend.
22.00	A pine, 10 ins. diam. on line, marked with 2 notches on E. and W. sides.
40.00	Set a sandstone 16 × 10 × 6 ins., 11 ins. in the ground, for standard ¼ sec. cor., marked S. C. ¼ on N. face; from which A pine, 12 ins. diam., bears N. 58° W., 12 lks. dist., marked S. C. ¼ S. B. T.; A pine, 11 ins. diam., bears S. 33° E., 36 lks. dist., marked S. C. ¼ S. B. T.
47.42	A pine, 12 ins. diam. on line, marked with 2 notches on E. and W. sides.
72.38	A pine, 10 ins. diam. on line, marked with 2 notches on E. and W. sides.
79.40	A point about 450 feet below top of ridge. Small ravine, course N. 65° E. and ascend.

Third standard parallel north through range No. 21 east—Continued.

Chains.	
80.00	Set a post, 4½ ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for standard cor. to Tps. 13 N., Rs. 21 and 22 E., marked— S. C., T. 13 N., on N.; R. 22 E., S. 31, on E., and R. 21 E., S. 36, on W. faces; with 6 notches on N., E., and W. faces; and raised a mound of earth 2½ ft. high, 5 ft. base, around post. Land, high, mountainous, and rolling. Soil, sandy and rocky; 4th rate. Timber, pine; thick undergrowth same; 80 chs. *August* 24, 1889.

GENERAL DESCRIPTION.

This line runs over the east slope of the Little Snowy Mountains. The townships on each side are rough and broken, but contain large groves of pine and fir timber of fair quality, and some springs and small streams of pure clear water.

RICHARD ROODS.
United States Deputy Surveyor.

FINAL OATHS FOR SURVEYORS.

LIST OF NAMES.

A list of the names of the individuals employed by Richard Roods, U. S. deputy surveyor, to assist in running, measuring, and marking the lines and corners described in the foregoing field notes of the survey of the third standard parallel north, through range No. 21 east of the principal base and meridian, in the Territory of Montana, showing the respective capacities in which they acted.

PETER LONG ..... Chainman.
JOHN SHORT ..... Chainman.
ELI MARKER ..... Chainman.
WILLIAM TALLY ..... Chainman.
GEORGE SHARP ..... Axeman.
ADAM DULL ..... Axeman.
JAMES BANNER ..... Flagman.

FINAL OATHS OF ASSISTANTS.

We hereby certify that we assisted Richard Roods, United States deputy surveyor, in surveying all those parts or portions of the third standard parallel north through range No. 21 east of the principal base and meridian in the Territory of Montana, as are represented in the foregoing field-notes as having been surveyed by him and under his direction; and that said survey has been in all respects, to the best of our knowledge and belief, well and faithfully surveyed, and the corner monuments established according to the instructions furnished by the United States surveyor-general for Montana.

PETER LONG, *Chainman.*
JOHN SHORT, *Chainman.*
ELI MARKER, *Chainman.*
WILLIAM TALLY, *Chainman.*
GEORGE SHARP, *Axeman.*
ADAM DULL, *Axeman.*
JAMES BANNER, *Flagman.*

Subscribed and sworn to before me this 1st day of September, 1889.
[SEAL.] WILLIAM MARTIN, *Notary Public.*

FINAL OATH OF UNITED STATES DEPUTY SURVEYOR.

I, Richard Roods, United States deputy surveyor, do solemnly swear that in pursuance of a contract received from A—— B——, United States surveyor-general for Montana, bearing date of the tenth day of July, 1889, I have well, faithfully, and truly, in my own proper person, and in strict conformity with the instructions furnished by the United States surveyor-general for Montana, the Manual of Surveying Instructions, and the laws of the United States, surveyed all those parts or portions of the third standard parallel north through range No. 21 east of the principal base and meridian in the State of Montana, as are represented in the foregoing field-notes as having been surveyed by me and under my direction; and I do further solemnly swear that all the corners of said surveys have been established and perpetuated in strict accordance with the manual of printed instructions, the special instructions of the United States surveyor-general for Montana, and in the specific manner described in the field-notes, and that the foregoing are the *true* field-notes of such survey; and should any fraud be detected I will suffer the penalty of perjury under the provisions of an act of Congress approved August 8, 1846.

RICHARD ROODS,
U. S. Deputy Surveyor.

Subscribed by said Richard Roods and sworn to before me this 1st day of September, 1889.

[SEAL.]

A—— B——,
U. S. Surveyor-General for Montana.

SPECIMEN FIELD NOTES.—No. 2.

(See diagram B.)

NOTE.—This specimen shows only the body of the field-notes of the survey of the sixth guide meridian east, through township No. 16 north of the base line in the State of Montana. The oaths and other portions omitted would be of like nature to those shown in Specimen Field Notes, No. 1.

Sixth guide meridian east through township No. 16 north.

Chains.	
	Survey commenced September 2, 1889, with a Burt's improved solar compass with telescopic attachment. At the corner to townships 15 and 16 N., ranges 24 and 25 E., in lat. 47° 6′ N., long. 108° 32′ W., on the night of September 2, 1889, I take an observation on Polaris, in accordance with instructions contained in the Manual, and at $6^h\ 34^m$ p. m. (my watch being $4\frac{1}{2}^m$ fast of local mean time), I find the *magnetic* bearing of the star to be N. 17° 24′ W. I drive a picket on the line thus established 4 chs. N. of the corner.
	Astronomical local mean time by watch, September 2 ..... h. 6 m. 34
	Watch fast ..... *subtract* 4.5
	Correct local mean time of observation, September 2 ..... 6 29.5
	Local mean time of U. C. of Polaris (Table I), September 1 ... 14 32.3
	Which, taken from time of obs.,* leaves the *hour angle* of Polaris 15 57.2
	Subtract from 23 56.0
	Argument† for Table II 7 58.8
	Azimuth of Polaris for lat. 47° (Table II) ..... 1° 36′ *east.*
	North end of needle ..... 17 24 *east.*
	The *sum* is the *variation* ..... 19° 0′ *east.*
	Which is also the *mean* declination by table in the Manual (page 56). I lay off the azimuth 1° 36′ to the *west*‡ and mark the *true meridian* so found.
	September 2, 1889.
	At 7 a. m., September 3, I take the *magnetic* bearing of the true meridian established last night, and find the variation to be 19° 6′ east at the corner above mentioned, which is a post 4 ins. square, marked— T. 16 N., S. 31, on N. E.; R. 25 E., S. 6, on S. E.; T. 15 N., S. 1, on S. W., and R. 24 E., S. 36, on N. W. faces, with 6 notches on each edge, and pits N., S., E., and W. of post, 6 ft. dist., and mound of earth around post. Thence I run
	North, bet. secs. 31 and 36. Va. 19° 6′ E.
10.00	Dry channel, 10 lks. wide, course E.
40.00	Set a sandstone 18 × 10 × 3 ins. 12 ins. in the ground for ¼ sec. cor. marked ¼ on W. face; dug pits 18 × 18 × 12 ins. N. and S. of stone, 5½ ft. dist., and raised a mound of earth 1½ ft. high, 3½ ft. base, alongside.
42.60	Stream 6 lks. wide, course N. 70° W.
55.50	Enter timber.
56.45	Ravine about 30 ft. deep, course S. 80° W., and ascend.
60.70	Top of ridge about 50 ft. above ravine, and descend.
72.40	Foot of ridge about 50 ft. below top, course E. and W.

* Take one day from September 2 and add its equivalent, 24 hrs., to the time, making September 1, $30^h\ 29^m\ .5$, then substract. See page 78, example 4, also page 81.

† See foot note page 80.

‡ See precepts at top of Table II.

Sixth guide meridian east, through township No. 16 north—Continued.

Chains.	
80.00	Set a sandstone 18 × 11 × 3 ins. 12 ins. in the ground for cor. to secs. 25, 30, 31, and 36, marked with 5 notches on N. and 1 notch on S. edges; from which A pine, 6 ins. diam. bears N. 62° E., 41 lks. dist., marked T. 16 N., R. 25 E., S. 30 B. T.; A pine, 18 ins. diam., bears S. 41½° E., 93 lks. dist., marked T. 16 N., R. 25 E., S. 31 B. T.; A pine, 12 ins. diam., bears S. 83½° W., 109 lks., dist., marked T. 16 N., R. 24 E., S. 36 B. T.; A pine, 11 ins. diam., bears N. 47° W., 45 lks. dist., marked T. 16 N., R. 24 E., S. 25 B. T. Land, rolling. Soil, sandy and clay—2d and 3d rate. Timber, pine; large and good quality, with some thick undergrowth of same; 24.50 chs.
	North, bet. secs. 25 and 30. Va. 19° 6′ E. Through timber.
2.75	Descend.
7.00	Leave timber.
18.90	Point about 40 ft. below last cor.; deep cut channel; stream 12 lks. wide; course N. 75° W.
40.00	Set a sandstone 15 × 11 × 6 ins. 10 ins. in the ground for ¼ sec. cor., marked ¼ on W. face; dug pits 18 × 18 × 12 ins. N. and S. of stone, 5½ ft. dist., and raised mound of earth 1½ ft. high, 3½ ft. base, alongside.
45.00	Enter bottom.
80.00	Set a post 4½ ft. long, 4 ins. square, with marked stone 12 ins. in the ground for cor. to secs. 19, 24, 25, and 30, marked— T. 16 N., S. 19, on N. E.; R. 25 E., S. 30, on S. E.; R. 24 E., S. 25, on S. W., and S. 24 on N. W. faces, with 4 notches on N. and 2 notches on S. edges; dug pits 18 × 18 × 12 ins. in each sec. 5½ ft. dist., and raised mound of earth 2 ft. high, 4½ ft. base, around post. Land, rolling and level. Soil, south 45 chs., clay and sandy—2d rate; north 35 chs.—1st rate. Timber, pine, of good quality; 7 chs.
	At 10.30 a. m. the variation has been diminished 4′, by diurnal change. North bet. secs. 19 and 24. Va. 19° 2′ E. *
35.40	Dry channel, 20 lks. wide, course E.
40.00	Set a sandstone 16 × 8 × 4 ins. 11 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits 18 × 18 × 12 ins. N. and S. of stone, 5½ ft. dist., and raised a mound of earth 1½ ft. high 3½ ft. base, alongside.
42.45	Ford's Creek, 25 lks. wide, course E. and enter willow brush.
47.30	Bend in Ford's Creek, course N. 25° W., to avoid which and save two crossings, I off-set W. 2.00 chs., thence N. on off-set line 7.40 chs., thence E. 2.00 chs. to line.
54.70	On line on N. side of bend, course of creek at this point N. 85° E. and leave willow brush.
61.45	Dry channel, 25 lks. wide, course S. 82° E.
80.00	Set a sandstone 18 × 10 × 4 ins. 12 ins. in the ground, for cor. to secs. 13, 18, 19, and 24, marked with 3 notches on the N. and S. edges; dug pits 18 × 18 × 12 ins. in each sec., 5½ ft. dist., and raised a mound of earth 2 ft. high, 4½ ft. base, alongside. Land, nearly level bottom. Soil, sandy loam and clay—1st and 2d rate. No timber. Thick willow and box elder brush along Ford's Creek.

* The variation must not be changed without stating the reason therefor.

Sixth guide meridian east, through township No. 16 north—Continued.

Chains.	
	North bot. secs. 13 and 18. Va. 19° 2′ E.
8.00	Leave bottom and ascend gradually.
33.00	A point about 40 ft. above bottom, top of low bluff.
38.00	Ravine, about 15 ft. deep, course E. and ascend gradually over rolling ground.
40.00	Set a sandstone 14 × 10 × 4 ins. 10 ins. in the ground for ¼ sec. cor., marked ¼ on W. face; dug pits 18 × 18 × 12 ins. N. and S. of stone, 5½ ft. dist., and raised mound of earth 1½ ft. high, 3½ ft. base, alongside.
60.60	Top of low ridge, about 60 ft. high, and descend.
80.00	Set a post, 4½ ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for cor. to secs. 7, 12, 13, and 18, marked— T. 16 N., S. 7, on N. E.; R. 25 E., S. 18, on S. E.; R. 24 E., S. 13, on S. W., and S. 12, on N. W. faces, with 2 notches on N. and 4 notches on S. edges; dug pits 18 × 18 × 12 ins. in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, around post.
	Land rolling. Soil, sandy and clay loam; 2d rate. No timber.
	September 3, 1889.
	At 9 a. m., September 4, I find the *magnetic* bearing of my line run yesterday to be S. 19° 4′ E.
	North, bet. secs. 7 and 12. Var. 19° 4′ E.
	Ascend gradually.
3.40	A point about 20 ft. above last cor. top of low ridge, and descend.
39.50	Stream 3 lks. wide, course E., and ascend over rolling ground.
40.00	Set a sandstone, 18×6×5 ins. 12 ins., in the ground, for ¼ sec. cor. marked ¼ on W. face; dug pits 18 × 18 × 12 ins. N. and S. of stone, 5½ ft. dist., and raised a mound of earth 1½ ft. high, 3½ ft. base, alongside.
71.00	Descend steep bluff.
71.85	A point about 40 ft. below top of bluff; stream 10 lks. wide, course E., and enter bottom land.
77.00	Leave bottom land and ascend bluff, course S. 87° E.
80.00	A point about 40 ft. above bottom, and set a sandstone 30 × 8 × 4 ins. 23 ins. in the ground for cor. to secs. 1, 6, 7, and 12, marked with 1 notch on N. and 5 notches on S. edges; dug pits 18 × 18 × 12 ins. in each sec. 5½ ft. dist., and raised a mound of earth 2 ft. high, 4½ ft. base, alongside.
	Land rolling. Soil, sandy and clay; 2d rate. No timber.
	North, bet. secs. 1 and 6. Va. 19° 4′ E.
18.60	Stream 4 lks. wide, course E.
40.00	Set a sandstone, 30 × 9 × 4 ins., 23 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits 18 × 18 × 12 ins. N. and S. of stone, 5½ ft. dist., and raised a mound of earth 1½ ft. high, 3½ ft. base, alongside.
61.00	Stream, 8 lks. wide, course S. 40° E.
78.42	Intersect the fourth standard parallel north at a point 6.95 chs. E. of the standard cor. to secs. 35 and 36, T. 17 N., R. 24 E., at which point I set a post 4½ ft. long., 4 ins. square, with marked stone, 12 ins. in the ground, marked— C. C., T. 16 N., on S.; R. 25 E., S. 6, on E., and R. 24 E., S. 1, on W. faces, with 6 notches on S., E., and W. faces; dug pits 24 × 18 × 12 ins. crosswise on each line, S., E., and W. of post, 6 ft. dist., and raised a mound of earth 2½ ft. high, 5 ft. base, around post.
	Land, level. Soil, sandy loam; 1st and 2d rate. No timber.
	September 4, 1889.

31,50 chs. of this line runs through timber.

GENERAL DESCRIPTION.

Townships 16 N., Rs. 24 and 25 E., are generally rolling table lands, producing an abundant growth of grass, and there is a large amount of good bottom land along Ford's Creek and its tributaries. About 2 miles east of the closing cor. is a lake some two miles wide by 2½ miles long, lying in Tps. 16 and 17 N., R. 25 E.

RICHARD ROODS,
U. S. Deputy Surveyor.

SEPTEMBER 4, 1889.

SPECIMEN FIELD NOTES.—No. 3.

(See Diagram B.)

NOTE.—These specimen field notes show only the body of the field notes of the survey of the west and north boundaries of T. 13 N., R. 24 E., of the base and principal meridian, in the Territory of Montana, it being assumed that the south and east boundaries of said township have been previously established by running the third standard parallel north and the sixth guide meridian east. The oaths and other portions omitted would be of like nature to those shown in Specimen Field Notes No. 1, it being remembered that only *one* set of chainmen is required in the survey of township lines.

Exterior Boundaries T. 13 N., R. 24 E.

Chains.	
	Survey commenced September 21st, 1889, with a Burt's improved solar compass, with telescopic attachment.
	At the standard corner to Tps. 13 N., Rs. 23 and 24 E., in Latitude 46° 48′ N., Long. 108° 45′ W., I observe Polaris at its eastern elongation at 7^{h} 19^{m} p. m. and find its *magnetic* bearing to be N. 16° 57′ W.
	North end of needle ..... 16° 57′ *east*,
	The azimuth by table in Manual is ..... 1° 53′ *east*.
	The *sum* is the variation* ..... 18° 50′ *east*.
	I lay off the azimuth to the *west*,† and mark the *true meridian* so determined by driving a picket 3.50 chs. north of the corner.
	September 21, 1889.
	NOTE.—The time of the elongation is found by table and rules on page 68, and the Azimuth by table on page 70. Interpolate back to 1889.
	At 8 a. m., Sept. 23d, I find the *magnetic* bearing of the line established last night to be N. 18° 53′ W., and (by the table on page 55 of the Manual), the *mean* declination is 18° 50′ east.
	I begin at the standard cor. to Tps. 13 N., Rs. 23 and 24 E., which is a post 4 ins. square, marked—
	S. C. T. 13 N., on N.;
	R. 24 E., S. 31, on E., and
	R. 23 E., S. 36, on W. faces, with 6 notches on N., E., and W. faces, and pits, 24 × 18 × 12 ins., crosswise on each line, N. E. and W. of post 6 feet dist., and mound of earth around post.
	Thence I run
	North, between secs. 31 and 36.
	Va. 18° 53′ E.
	Descend over rough, broken ground.
1.50	Ravine about 20 ft. deep, course N. 80° E., and ascend.
15.00	Top of hill about 50 ft. above ravine, and descend.
30.00	Head of ravine, course N. 30° E.
35.60	Descend abruptly.
40.00	A point about 150 ft. below top of hill—foot of broken bluff, course E. and W., and set a sandstone, 16 × 16 × 6 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face, and raised a mound of stone 1½ ft. high, 2 ft. base, alongside. Pits impracticable.
42.00	Stream, 4 lks. wide, course E., and ascend.
47.00	Top of ridge about 80 ft. above stream, and descend.
55.35	Ravine about 30 ft. deep, course S. 85° E.
61.95	A point about 150 ft. below top of ridge. Spring branch, 4 lks. wide, course S. 70° E., ascend.
74.50	A point about 150 ft. above stream, and enter timber.
80.00	Set a sandstone, 24 × 15 × 8 ins., 18 ins. in the ground for cor. to secs. 25, 30, 31, and 36, marked with 5 notches on N. and 1 notch on S. edges; from which
	A pine, 5 ins. diam., bears N. 22½° E., 30 lks. dist., marked T. 13 N., R. 24 E., S. 30, B. T.;

* See pages 72 and 73. † See precepts top of Table II.

Exterior Boundaries T. 13 N., R. 24 E.--Continued.

Chains.	
	A pine, 12 ins. diam., bears S. 27¼° E., 87 lks dist., marked T. 13 N., R. 24 E., S. 31, B. T.;
	A pine, 10 ins. diam., bears S. 1° W., 40 lks. dist., marked T. 13 N., R. 23 E., S. 36, B. T.;
	A pine, 17 ins. diam., bears N. 42° W., 65 lks. dist., marked T. 13 N., R. 23 E., S. 25, B. T.
	Land, mountainous, rough, and broken.
	Soil, sandy and stony; 4th rate.
	Timber, pine, 5.50 chs., and cotton wood along streams.
	North, bet. secs. 25 and 30.
	Va. 18° 53′ E.
	Descend through timber.
8.85	Ravine about 10 ft. deep, course N. 70° E.
19.00	A point about 175 ft. below cor., ravine about 60 ft. deep, course S. 80° E., and ascend.
21.00	Leave timber.
24.00	A point about 100 feet above ravine, top of hill, and descend gradually over rolling ground.
40.00	Set a sandstone, 16 × 13 × 3 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face, and raised a mound of stone 1½ ft. high, 2 ft. base, alongside. Pits impracticable.
75.50	Spring branch, 2 lks. wide, course E., and ascend.
80.00	A point about 40 ft. above stream, and set a post 4 ft. long, 4 ins. square, with marked stone 12 ins. in the ground for cor. to secs. 19, 24, 25, and 30, marked—
	T. 13 N., S. 19, on N. E.;
	R. 24 E., S. 30, on S. E.;
	R. 23 E., S. 25, on S. W., and
	S. 24, on N. W. faces, with 4 notches on N. and 2 notches on S. edges, and raised a mound of earth, 2 ft. high, 4½ ft. base, around post.
	Land, hilly, rough, and broken.
	Soil, sandy and rocky; 4th rate.
	Timber, pine, 21.00 chs., and undergrowth same.
	At 11 a. m., Sept. 23rd, the variation has diminished 3′, by diurnal change.*
	North, bet. secs. 19 and 24.
	Va. 18° 50′ E.
	Descend gradually.
4.20	A point about 40 ft. below cor. Spring branch, 3 lks. wide, course S. 80° E.
18.50	A point about 50 ft. above stream, top of ridge, course E. and W., and descend over rolling ground.
40.00	Set a sandstone, 14 × 14 × 4 ins., 10 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face, and raised a mound of stone, 1½ ft. high, 2 ft. base, alongside. Pits impracticable.
48.85	Stream, 4 lks. wide, course E.
64.95	Stream, 4 lks. wide, course S. 70° E.
80.00	Set a sandstone, 24 × 18 × 6 ins., 18 ins. in the ground, for cor. to secs. 13, 18, 19, and 24, marked with 3 notches on N. and S. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, broken and rolling.
	Soil, rocky and sandy loam; 2d and 3d rate.
	Some scattering pine along streams, with willow and rose brush.
	North, bet. secs. 13 and 18.
	Va. 18° 50′ E.
	Over rolling ground.
40.00	Set a sandstone, 18×14×3 ins., 12 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits, 18×18×12 ins., N. and S. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.

* The reason for changing the var. must always be given.

Exterior Boundaries T. 13 N., R. 24 E.—Continued.

Chains.	
80.00	Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for cor. to secs. 7, 12, 13, and 18, marked— T. 13 N., S. 7, on N. E.; R. 24 E., S. 18, on S. E.; R. 23 E., S. 13, on S. W., and S. 12, on N. W. faces, with 2 notches on N. and 4 notches on S. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, around post. Land, rolling. Soil, sandy loam; 2d rate. No timber. *September* 23, 1889.
	The *magnetic* bearing of the last line run is S. 18° 51′ E. at 7 a. m., Sept. 24th. North, bet. secs. 7 and 12. Va. 18° 53′ E.
40.00	Set a sandstone, 16×12×3 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits 18 × 18 × 12 ins. N. and S. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
54.00	Stream, 7 lks. wide. course N. 50° E.
80.00	Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for cor. to secs. 1, 6, 7, and 12, marked— T. 13 N., S. 6, on N. E.; R. 24 E., S. 7, on S. E.; R. 23 E., S. 12, on S. W., and S. 1, on N. W. faces, with 1 notch on N. and 5 notches on S. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, around post. Land, rolling. Soil, sandy loam; 2d rate. No timber; willow brush along stream.
	North, bet. secs. 1 and 6. Va. 18° 53′ E.
34.00	Stream, 6 lks. wide, course E.
40.00	Set a sandstone, 22×8×3 ins., 16 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits 18 × 18 × 12 ins. N. and S. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
80.00	Set a post, 4½ ft. long, 4 ins. square, with marked stone, 12 ins. in the ground for cor. to Tps. 13 and 14 N., Rs. 23 and 24 E., marked— T. 14 N., S. 31, on N. E.; R. 24 E., S. 6, on S. E.; T. 13 N., S. 1, on S. W., and R. 23 E., S. 36, on N. W. faces, with 6 notches on each edge; dug pits, 24 × 18 × 12 ins., crosswise on each line, N., S., E., and W. of post, 6 ft. dist., and raised a mound of earth, 2½ ft. high, 5 ft. base, around post. Land, rolling. Soil, sandy loam; 2d rate. No timber.
	At 9 a. m., Sept. 24th, the *magnetic* bearing of line between secs. 1 and 6 is S. 18° 52′ E. From the cor. to Tps. 13 and 14 N., Rs. 23 and 24 E., I run east on a random line, between said townships, the variation of my compass being 18° 52′ E. I set temporary half-mile and mile corners at each 40 and 80 chains, and find the township line to be 5 miles 77 chs. and 95 lks. long,

* The reason for changing the var. must always be given.

Exterior Boundaries T. 13 N., R. 24 E.—Continued.

Chains.	
	and the falling to be 45 lks. N. of the cor. to Tps. 13 and 14 N., Rs. 24 and 25 E. The correction for the *true* line will therefore be 7½ lks. south, and 2.05 chs. west, per mile, and its course will be N. 89° 57′ W.
	From the cor. to Tps. 13 and 14 N., Rs. 24 and 25 E., which is a post, 4 ins. square, marked—
	T. 14 N., S. 31, on N. E.;
	R. 25 E., S. 6, on S. E.;
	T. 13 N., S. 1, on S. W., and
	R. 24 E., S. 36, on N. W. faces, with 6 notches on each edge and pits N., S., E., and W. of post, 6 ft. dist., and mound of earth around post. I run
	N. 89° 57′ W. on a true line bet. secs. 1 and 36.
	Va. 18° 52′ E.
	Over very nearly level ground.
9.28	Stream, 10 lks. wide, course S.
20.40	Same stream, course N. 30° E.
40.00	Set a red sandstone, 18 × 10 × 6 ins., 12 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
80.00	Set a sandstone, 18 × 14 × 6 ins., 12 ins. in the ground, for cor. to secs. 1, 2, 35, and 36, marked with 1 notch on E. and 5 notches on W. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, level.
	Soil, rich loam; 1st class.
	No timber.
	N. 89° 57′ W. on a true line bet. secs. 2 and 35.
	Va. 18° 52′ E.
	Over nearly level ground.
40.00	Set a sandstone, 16 × 10 × 5 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside..
45.70	S. fork of Spring Creek, 15 lks. wide, course N. 40° E.
80.00	Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for cor. to secs. 2, 3, 34, and 35, marked—
	T. 14 N., S. 35, on N. E.;
	R. 24 E., S. 2, on S. E.;
	T. 13 N., S. 3, on S. W., and
	S. 34, on N. W. faces, with 2 notches on E. and 4 notches on W. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, around post.
	Land, level.
	Soil, rich loam; 1st rate.
	No timber.
	September 24, 1889.
	At 8 a. m. Sept. 25th, the *magnetic* bearing of the last line run is N. 71° 10′ E., and the variation is 18° 53′ E.
	N. 89° 57′ W. on a true line, bet. secs. 3 and 34.
	Va. 18° 53′ E.
	Ascend gradually.
18.60	Enter pine timber, in open grove, course N. 9° W.
40.00	Set a sandstone, 18 × 18 × 6 ins., 12 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; from which
	A pine, 12 ins. diam., bears N. 23° W., 89 lks. dist., marked ¼ S., B. T.
	No other tree in limits; raised a mound of stone, 1½ ft. high, 2 ft. base, alongside the corner. Pits impracticable.
52.50	Spring branch, 3 lks. wide, course S. 5° E.

Exterior Boundaries T. 13 N., R. 24 E.—Continued.

Chains.	
80.00	A point about 150 ft. above last sec. cor. and set a sandstone, 18 × 8 × 6 ins., 12 ins. in the ground, for cor. to secs. 3, 4, 33, and 34, marked with 3 notches on E. and W. edges; from which A pine, 36 ins. diam., bears N. 45° E., 82 lks. dist., marked T. 14 N., R. 24 E., S. 34, B. T.; A pine, 14 ins. diam., bears S. 24° W., 110 lks. dist., marked T. 13 N., R. 24 E., S. 4, B. T. No other trees within limits; raised a mound of stone, 1½ ft. high, 2 ft. base, alongside the corner. Land, slightly undulating. Soil, sandy loam; 2d rate. Timber, pine of fine quality; 61.40 chs.
	N. 89° 57′ W. on a true line, bet. secs. 4 and 33. Va. 18° 53′ E.
11.60	Spring branch, 6 lks. wide, course N. 2° E.
24.50	Leave timber.
40.00	Set a sandstone, 20 × 10 × 4 ins., 15 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face, and raised a mound of stone, covered with earth,* 1½ ft. high, 3½ ft. base, alongside.
76.30	Spring branch, 2 lks. wide, course S. 30° W.
80.00	Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for cor. to secs. 4, 5, 32, and 33, marked— T. 14 N., S. 33, on N. E.; R. 24 E., S. 4, on S. E.; T. 13 N., S. 5, on S. W., and S. 32, on N. W. faces, with 4 notches on E. and 2 notches on W. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, around post. Land, nearly level. Soil, sandy loam; 2d rate. Timber, pine; 24.50 chs.
	At 11 a. m., Sept. 25th., the variation has de reased 7′ by diurnal change. N. 89° 57′ W. on a true line, bet. secs. 5 and 32. Va. 18° 46′ E.
36.10	Spring branch, 2 lks. wide, course S. 25° W.
40.00	Set a post, 3 ft. long, 3 ins. square, with marked stone, 12 ins. in the ground, for ¼ sec. cor., marked ¼ S. on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of post, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, around post.
80.00	Set a sandstone, 18 × 12 × 6 ins., 12 ins. in the ground, for cor. to secs. 5, 6, 31, and 32, marked with 5 notches on E. and 1 notch on W. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside. Land, level. Soil, sandy loam; 2d rate. No timber.
	N. 89° 57′ W. on a true line, bet. secs. 6 and 31. Va. 18° 46′ E.
40.00	Set a sandstone, 22 × 10 × 3 ins., 16 ins, in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
77.95	The cor. to Tps. 13 and 14 N., Rs. 23 and 24 E. Land, level. Soil, sandy loam; 2d rate. No timber.
	September 25, 1889.

2 miles 26 chs. and 90 lks. of these lines run over mountainous lands, or through timber.

*See foot note page 32.

EXTERIORS OF T. 13 N., R. 24 E.

Latitudes, departures, and closing errors.

Line designated as—	True bearing.	Distance.	Latitudes.		Departures.	
			N.	S.	E.	W.
		Chs.				
W. boundary	North	480.	480.			
N. boundary	S. 89° 57′ E.	477.95		0.45	477.95	
E. boundary	S. 0° 2′ E.	478.20		478.20	9.28	
S. boundary	West	480.				480.
Convergency *					0.77	
			480.	478.65	479.00	480.
	Totals		478.65			470.00
	Error in latitude		1.35	Error in departure		1.00

* The departure column in which the *convergency* is to be placed will depend on the *direction* of the survey.

GENERAL DESCRIPTION.

The northwestern portion of this township is rough, hilly, and broken. The remainder consists of rolling land, with much rich bottom land along Spring Creek and its numerous tributaries. On the hilly and rolling land are large groves of pine timber. There is one settler near the center of the township. The township should be subdivided.

RICHARD ROODS,
U. S. Deputy Surveyor.

SPECIMEN FIELD NOTES.—No. 4.

Resurvey of a portion of the exterior boundaries of T. 25 N., R. 2 W., Willamette meridian, Washington.

Chains.

Survey commenced April 10, 1889, with a light mountain transit made by W. & L. E. Gurley, and provided with a solar attachment.

At the standard cor. to Tp. 25 N., Rs. 1 and 2 W., in latitude 47° 40′ N. and longitude 123° W., I observe Polaris at $7^h\ 26^m$ p. m. by my watch, which is 3½ minutes slow of local mean time, and find the *magnetic* bearing of the star is N. 23° 53′ W.

	h.	m.
Astronomical* time by watch April 10	7	26.0
Watch *slow, add*		3.5
Correct local mean time of observation	7	29.5
Tabular time U. C. of Polaris (Table I) April 1	0	36.0
Reduction† for 9 days, $3^m.93 \times 9 = 35^m.4$, *subtract*		35.4
Local mean time U. C. of Polaris, April 10	0	0.6
which, taken from time of observation, leaves *hour angle* of Polaris	7	28.9

	°	′	
Azimuth of Polaris for lat. 47° 40′ (Table II)	1	44	*west*
North end of needle	23	53	*east*
The *difference* is the variation	22	09	*east*

I lay off the azimuth to the *east*‡ and drive a picket on the true meridian so determined, 4 chs. north of the cor.

The *mean* variation is 22° 9′ *east*. *April* 10, 1889.

At 8 a. m., April 11th, the line established last night bears N. 22° 14′ W. by compass, and the variation is 22° 14′ *east* at this time.

In subdividing this township I commence by running north on a blank line on the east boundary of sec. 36, va. 22° 14′ E., and at 40 chs. I find the ¼ sec. cor. to be N. 80° E. 16 lks. dist., and at 80 chs. the sec. cor. to be E. 30 lks. dist. I therefore continue the true line north, find that no portion of this east boundary is in alignment, and that many of the corners are nearly obliterated, but that the cor. to Tps. 25 and 26 N., Rs. 1 and 2 W., is due north of the starting cor. As T. 25 N., R. 1 W., has not been subdivided, and, consequently, no subdivision lines have been closed on either side of this east boundary, I resurvey the same as follows:

Finding the standard cor. to Tps. 25 N., Rs. 1 and 2 W., was a post greatly decayed, and with the marks nearly obliterated, I destroy all traces of old cor. and re-establish it as follows:

Set a post, 4½ ft. long, 4 ins. square, 24 ins. in the ground, for standard cor. to Tps. 25 N., Rs. 1 and 2 W., marked—

S. C., T. 25 N., on N.;
R. 1 W., S. 31, on E., and
R. 2 W., S. 36, on W. faces, with 6 notches on N., E., and W. faces; from which

A black oak, 20 ins. diam., bears N. 37° E., 27 lks. dist., marked T. 25 N., R. 1 W., S. 31, B. T.;

A burr oak, 24 ins. diam., bears N. 43° W., 35 lks. dist., marked T. 25 N., R. 2 W., S. 36, B. T.;

A maple, 18 ins. diam., bears S. 27° W., 39 lks. dist., marked S. C. T. 25 N., Rs. 1 & 2 W., B. T.

Thence I run
North, bet. secs 31 and 36.
Va. 22° 14′ E.
Through timber.

* See page 75 and foot-note, page 76.
† May be taken directly from Part II of Table I.
‡ See precepts at top of Table II.

Exterior Boundaries T. 25 N., R. 2 W.—Continued.

Chains.	
1.00	Brook, 5 lks. wide, course N. W.
18.00	Foot of hill, course N. W. and S. E.
20.00	Top of hill, about 50 ft. high.
40.00	Set a sandstone, 20 × 8 × 4 ins., 15 ins. in the ground, for ¼ sec. cor., marked ¼ on W. side; dug pits, 18 × 8 × 12 ins., N. and S. of stone 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
	From this point the old ¼ sec. cor., which is a decayed stake, with marks almost obliterated, bears N. 80° E., 16 lks. dist. I destroyed this stake, and also the marks on the stump of a beech tree, described as a bearing tree in the field notes of original survey. No traces could be found of poplar tree described as bearing tree in said field notes.
55.00	Descend.
57.00	Foot of hill, about 40 ft. high, and enter rich level land.
72.60	A brook, 10 lks. wide, course N. 40° E.
80.00	Set a post, 4 ft. long, 4 ins. square, 2 ft. in the ground, for cor. to secs. 25, 30, 31, and 36, marked— T. 25 N., S. 30, on N. E.; R. 1 W., S. 31, on S. E.; R. 2 W., S. 36, on S. W., and S. 25, on N. W. faces, with 5 notches on N. and 1 notch on S. edges; from which A birch, 24 ins. diam., bears N. 30° E., 18 lks. dist., marked T. 25 N., R. 1 W., S. 30, B. T.; A white oak, 16 ins. diam., bears S. 25° E., 60 lks. dist., marked T. 25 N., R. 1 W., S. 31, B. T.; A white oak, 14 ins. diam., bears S. 80° W., 93 lks. dist., marked T. 25 N., R. 2 W., S. 36, B. T.; A poplar, 15 ins. diam., bears N. 60° W., 82 lks. dist., marked T. 25 N., R. 2 W., S. 25, B. T.
	From this cor. the old sec. cor., a decayed post, bears E. 30 lks. dist. I destroyed this post, and also the marks on old bearing trees.
	Land, rolling and level.
	Soil, N. and S. parts rich loam; 1st rate; middle part sandy; 2d rate.
	Timber, beech, poplar, white oak, and birch.

	At 10 a. m., April 11th, the variation has decreased 3′ by diurnal change.
	North, bet. secs. 25 and 30. Va. 22° 11′ E.
	Through timber.
4.20	A maple, 16 ins. diam., on line, marked with 2 notches on N. and S. sides.
6.10	Foot of rising ground, slopes E. and N. W.
40.00	An elm, 18 ins. diam., which I mark ¼ S., on W. side, for ¼ sec. cor., from which A poplar, 30 ins. diam., bears N. 30° E., 100 lks. dist., marked ¼ S., B. T. A beech, 13 ins. diam., bears S. 24° W., 30 lks. dist., marked ¼ S., B. T.
	From this point a post, the old ¼ sec. cor., bears N. 75° E., 100 lks. dist. I destroyed this post, and also marks on the old bearing trees, a beech and poplar.
74.00	A white oak, 16 ins. diam., on line, marked with 2 notches on N. and S. sides.
80.00	Set a post, 4 ft. long, 4 ins. square, 24 ins. in the ground, for cor. to secs. 19, 24, 25, and 30, marked— T. 25 N., S. 19, on N. E.; R. 1 W., S. 30, on S. E.; R. 2 W., S. 25, on S. W., and S. 24, on N. W. faces, with 4 notches on N. and 2 notches on S. edges; from which A beech, 18 ins. diam., bears N. 30° E., 74 lks. dist., marked T. 25 N., R. 1 W., S. 19, B. T. A poplar, 26 ins. diam., bears S. 40° E., 28 lks. dist., marked T. 25 N., R. 1 W., S. 30, B. T. A burr oak, 16 ins. diam., bears S. 80° W., 36 lks. dist., marked T. 25 N., R 2 W., S. 25, B. T.;

Exterior Boundaries T. 25 N., R. 2 W.—Continued.

Chains.	
	A white oak, 16 ins. diam., bears N. 45° W., 36 lks. dist., marked T. 25 N., R. 2 W., S. 24, B. T.
	From this point the old sec. cor., a post, bears N. 50° E., 40 lks. dist. I destroyed this post, and also the marks on old bearing trees.
	Land rolling.
	Soil, rich loam; 1st rate.
	Timber, beech, walnut, elm, and white oak.
	North, bet. secs. 19 and 24.
	Va. 22° 11′ E.
	Through timber, gradually descending.
22.10	A white walnut, 24 ins. diam., a line tree marked with 2 notches on N. and S. sides.
40.00	Set a post, 3 ft. long, 3 ins. square, 2 ft. in the ground, for ¼ sec. cor., marked ¼ S. on W. face; from which
	An ash, 10 ins. diam., bears S. 40° E., 60 lks. dist., marked ¼ S., B. T.;
	An ash, 12 ins. diam., bears N. 6° W., 13 lks. dist., marked ¼ S., B. T.
	From this point the old ¼ sec. cor., a post, bears S. 10 E., 45 lks. dist. I destroyed this post, and also the marks on old bearing trees.
44.00	Foot of slope, about 80 ft. below last sec. cor. Road from Williamsburg to Astoria, course E. and W.
50.00	Elk Creek, 130 lks. wide, shallow at this point, and gentle current, general course W.
56.40	Brook, 10 lks. wide, course S. W.
65.20	Leave creek bottom, and enter upland, course E. and W.
72.00	A hickory, 14 ins. diam., a line tree marked with 2 notches on N. and S. sides.
80.00	Set a granite bowlder, 20 × 12 × 4 ins., 15 ins. in the ground, for cor. to secs. 13, 18, 19, and 24, marked with 3 notches on N. and S. sides, and raised a mound of stone, 1½ ft. high, 2 ft. base, alongside. Pits impracticable.
	From this point the old sec. cor., a limestone, bears N. 20° E., 16 lks. dist. I destroyed marks on this stone. Found stumps of trees, which had probably been established as bearing trees at date of original survey, but could not distinguish any marks on same.
	Land, rolling and level.
	Soil, rich loam; 1st rate. Bottom is not subject to inundation.
	Timber, walnut, beech, maple, ash, and hickory.
	April 11, 1889.
	At 10.30 a. m., April 12th, the last line run bears S. 22° 9′ E. by compass.
	North, bet. secs. 13 and 18.
	Va. 22° 9′ E.
	Through timber.
12.30	A white oak, 16 ins. diam.
21.00	Foot of high broken ridge, about 200 ft. above creek bottom, course E. and N. W.
30.40	Top of ridge, about 75 ft. high, descend abruptly.
40.00	Set a limestone, 16 × 10 × 4 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on W. side, from which
	A cherry, 8 ins. diam., bears N. 30° W., 16 lks. dist., marked ¼ S., B. T.
	A cherry, 10 ins. diam., bears S. 60° W., 80 lks. dist., marked ¼ S., B. T.
	I could find no traces of old ¼ sec. cor., but found an old cherry tree marked for bearing tree, and obliterated marks on same.
44.00	A burr oak, 30 ins. diam.
59.00	Foot of descent about 300 ft. below top of ridge, and ascend.
80.00	Set a post, 4 ft. long, 4 ins. square, 24 ins. in the ground, for cor. to secs. 7, 12, 13, and 18, marked—
	T. 25 N., S. 7, on N. E.;
	R. 1 W., S. 18, on S. E.;
	R. 2 W., S. 13, on S. W., and
	S. 12, on N. W. faces, with 2 notches on N. and 4 notches on S. faces; from which

Exterior Boundaries T. 25 N., R. 2 W.—Continued.

Chains.	
	A hickory, 18 ins. diam., bears N. 40° E., 14 lks. dist., marked T. 25 N., R. 1 W., S. 7, B. T.;
	A maple, 12 ins. diam., bears S. 42° E., 23 lks. dist., marked T. 25 N., R. 1 W., S. 18, B. T.;
	A beech, 16 ins. diam., bears S. 36° W., 16 lks. dist., marked T. 25 N., R. 2 W., S. 13, B. T.;
	A hickory, 20 ins. diam., bears N. 39° W., 38 lks. dist., marked T. 25 N., R. 2 W., S. 12, B. T.
	The old sec. cor., a post, was lying on the ground near this cor. I destroyed this post. The bearing trees are those described in the field notes of original survey, and were all newly marked.
	Land (except S. 21.00 chs.) high, broken, and mountainous.
	Soil, sandy and rocky; 3d and 4th rate.
	Timber, beech, hickory, maple, and black-jack.
	North, bet. secs. 7 and 12.
	Va. 22° 9′ E.
	Through timber.
13.10	A black oak, 16 ins. diam., on line, marked with 2 notches on N. and S. sides.
40.00	Set a limestone, 20 × 8 × 4 ins., 15 ins. in the ground, for ¼ sec. cor., marked ¼ on W. side, from which
	An elm, 14 ins. diam., bears S. 40° W., 16 lks. dist., marked ¼ S., B. T.;
	An elm, 11 ins. diam., bears N. 23° W., 42 lks. dist., marked ¼ S., B. T.
	From this point, the old ¼ sec. cor., a post bears N. 75° W., 60 lks. dist. I destroyed this post, and also the marks on old bearing trees.
68.00	A point about 100 ft. above last sec. cor., and foot of mountain, course E. and N. W.
80.00	A granite rock in place, 2 × 6 × 10 ft., above ground, which I marked for cor. to secs. 1, 6, 7, and 12, with a cross (×) at exact cor. point, and 1 notch N. and 5 notches S. of cross.
	This rock is on the top of the mountain, about 300 ft. above foot. Fire has destroyed all traces of the old sec. cor. and bearing trees.
	Land, mountainous and broken.
	Soil, stony and rocky; 4th rate.
	Timber, hickory, oak, beech, and ash.
	The fire above referred to was confined to a space of about 30 acres on the summit of the mountain.
	At 1 p. m.; April 12th, the variation has decreased 6′ by diurnal change.
	North, bet. secs. 1 and 6.
	Va. 22° 3′ E.
	Descend abruptly.
6.00	A black oak, 16 ins. diam., a line tree marked with 2 notches on N. and S. sides, and enter timber.
9.00	A point about 250 feet below summit; foot of mountain.
20.13	An ash, 12 ins. diam., a line tree marked with 2 notches on N. and S. sides.
39.00	Edge of ravine, about 40 ft. deep.
40.00	Bottom of ravine, and set a limestone, 18 × 7 × 4 ins., 12 ins. in the ground, for ¼ sec. cor., marked ¼ on W. side, from which
	A poplar, 16 ins. diam., bears N. 40° E., 34 lks. dist., marked ¼ S., B. T.;
	A poplar, 14 ins. diam., bears S. 13° W., 22 lks. dist., marked ¼ S., B. T.
	From this point the old ¼ sec. cor., a post, bears S. 80° W., 10 lks. dist. I destroyed this post, and after a careful examination of all the trees within limits was unable to distinguish any marks made for bearing trees.
44.10	Leave timber, and enter open prairie, course E. and N. W.
79.75	At this point I found the old township cor., a charred stake, with remains of trench and mound. As Tp. 26 N., Rs. 1 and 2 W., had both been subdivided, I could not change the location of this cor., and therefore re-established it, as follows:
	Set a post, 4½ ft. long, 4 ins. square, 24 ins. in the ground, for cor. to Tps. 25 and 26 N., Rs. 1 and 2 W., marked—
	T. 26 N., S. 31, on N E.;

Exterior Boundaries T. 25 N., R. 2 W.—Continued.

Chains.	
	R. 1 W., S. 6, on S. E.; T. 25 N. S. 1, on S. W., and R. 2 W. S. 36, on N. W. faces, with 6 notches on each edge; from which A cherry, 6 ins. diam., bears N. 40° E., 14 lks. dist., marked T. 26 N., R. 1 W., S. 31, B. T.; A white oak, 5 ins. diam., bears S. 30° E., 24 lks. dist., marked T. 25 N., R. 1 W., S. 6, B. T.; A hickory, 8 ins. diam., bears S. 50° W., 30 lks. dist., marked T. 25 N., R. 2 W., S. 1, B. T.; A chestnut, 6 ins. diam., bears N. 28° W., 13 lks. dist., marked T. 26 N., R. 2 W., S. 36, B. T.
	Land, broken, rolling, and level.
	Soil, rocky and sandy loam; 2d and 4th rate.
	Timber, oak, ash, poplar, chestnut, and hickory.
	In subdividing this township, and running the random line west bet. secs. 7 and 18, I was unable to find the cor. to secs. 7, 12, 13, and 18. I found the ¼ sec. cor. bet. secs. 13 and 18, which is A post, 3 ins. square, firmly set in the ground, and marked ¼ S. on W. side; from which A white oak, 27 ins. diam., bears N. 27° W., 27 lks. dist., marked ¼ S., B. T.; A white oak, 30 ins. diam., bears N. 28° E., 92 lks. dist., marked ¼ S., B. T.;
	From this ¼ sec. cor. I run north bet. secs. 13 and 18. Va. 22° 3′ E.
6.50	Road from Williamsburg, course E. and W.
38.00	Fence, course E. and W.; leave timber and enter plowed ground.
40.00	At this point I again made careful search for the sec. cor., which is described as a post, with bearing trees, but was unable to find any traces of it, and I therefore continued the line north.
58.00	A brook, 12 lks. wide, course E.;
64.00	A trail, course N. E. and S. W.;
72.00	A white oak, 30 ins. diam., on line, marked with 2 notches on N. and S. sides.
79.90	¼ sec. cor. bet. secs. 7 and 12, which is A sandstone 15 × 10 × 4 ins., 10 ins. firmly set in the ground, marked ¼ on W. face, with mound of stone alongside.
	From this ¼ sec. cor. I run south bet. secs 7 and 12. Va. 22° 3′ E.
39.95	Re-established cor. at proportionate distance, as follows:
	Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for cor. to secs. 7, 12, 13, and 18, marked— T. 25 N., S. 7, on N. E.; R. 2 W., S. 18, on S. E.; R. 3 W., S. 13, on S. W., and S. 12, on N. W. faces, with 2 notches on N. and 4 notches on S. edges; dug pits, 18 × 18 × 12 ins. in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, around post.
	Land, level.
	Soil, rich loam; 1st rate.
	Timber, oak.
	April 12, 1882.

SPECIMEN FIELD NOTES.

No. 5.

TITLE PAGE.

(See Diagram C.)

FIELD NOTES

OF THE SURVEY OF THE

SUBDIVISION AND MEANDER LINES

OF

TOWNSHIP No. 6 NORTH, RANGE No. 34 EAST,

OF THE

PRINCIPAL BASE AND MERIDIAN

IN THE

STATE OF MONTANA,

AS SURVEYED BY

ROBERT ACRES,

U. S. DEPUTY SURVEYOR,

UNDER HIS CONTRACT, No. 87,

DATED MARCH 22, 1889.

Survey commenced August 5, 1889.

Survey completed August 20, 1889.

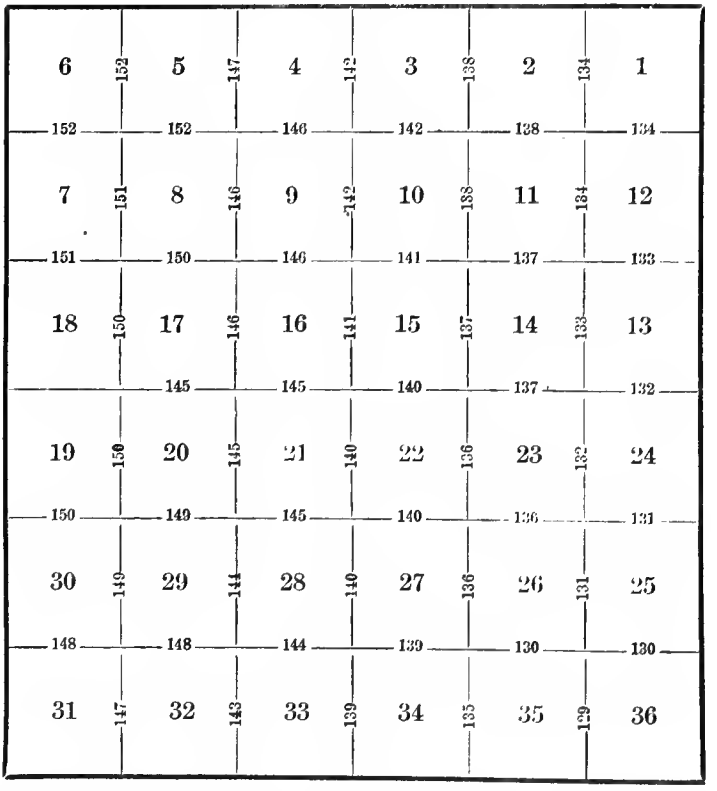
[Second page.]

NAMES AND DUTIES OF ASSISTANTS.

PETER LONG.....Chainman.
JOHN SHORT.....Chainman.
GEORGE SHARP.....Axeman.
ADAM DULL.....Axeman.
JAMES BANNER.....Flagman.

INDEX.

Township 6 north. R. 34 east.



NOTE.—When practicable, the diagram will show *meander* lines with the page references written upon them.

PRELIMINARY OATHS OF ASSISTANTS.

We, Peter Long and John Short, do solemnly swear that we will well and faithfully execute the duties of chain carriers; that we will level the chain over even and uneven ground, and plumb the tally pins either by sticking or dropping the same; that we will report the true distance to all notable objects, and the true lengths of all lines that we assist in measuring, to the best of our skill and ability, and in accordance with instructions given us in the survey of the subdivision and meander lines of Township No. 6 north, of Range No. 34 east, of the principal base and meridian in the State of Montana.

PETER LONG, *Chainman.*
JOHN SHORT, *Chainman.*

Subscribed and sworn to before me this second day of August, 1889.

HENRY DOOLITTLE,
[SEAL.] *Notary Public.*

We, George Sharp and Adam Dull, do solemnly swear that we will well and and truly perform the duties of axemen in the establishment of corners and other duties, according to instructions given us, and to the best of our skill and ability, in the survey of the subdivision and meander lines of Township No. 6 north, of Range No. 34 east, of the principal base and meridian in the State of Montana.

GEORGE SHARP, *Axeman.*
ADAM DULL, *Axeman.*

Subscribed and sworn to before me this second day of August, 1889.

HENRY DOOLITTLE,
[SEAL.] *Notary Public.*

I, James Banner, do solemnly swear that I will well and truly perform the duties of flagman according to instructions given me, to the best of my skill and ability, in the survey of the subdivision and meander lines of Township No. 6 north, of Range No. 34 east, of the principal base and meridian in the State of Montana.

JAMES BANNER, *Flagman.*

Subscribed and sworn to before me this second day of August, 1889.

HENRY DOOLITTLE,
[SEAL.] *Notary Public.*

Chains.

Survey commenced August 5, 1889, with a railroad compass having a 5½-inch needle, a revolving compass box and variation are reading to single minutes, a divided circle for measuring angles independent of the needle, reading by two opposite verniers to single minutes and provided with a telescopic attachment.

Preliminary to commencing the subdivision of this township I go to the cor. of Ts. 5 and 6 N., Rs. 34 and 35 E., which is a sandstone firmly set and 9×8×4 ins. *above* ground, marked with 6 notches on each edge and having a mound of stone, 1½ ft. high, 2 ft. base, alongside. At this corner I verify the adjustments of my compass and find them correct. Lat. 46° 15′ N., Long. 107° 24′ W.

Having set the instrument over the center of the township corner, I direct the telescope to Polaris, and at 10h., 23m. p. m., local mean time of eastern elongation,* find its *magnetic* bearing to be N. 16° 39′ W.

North end of needle.....16° 39′ *east.*
The azimuth of Polaris†.. 1° 51′ *east.*

The *sum* is the variation. 18° 30′ *east.*

I now lay off by the horizontal limb the azimuth of the star 1° 51′ to the *west* and for future reference mark the *true meridian*, so determined by driving a picket on the line 3 chains north of the township corner.

August 5, 1889.

NOTE.—In determining the variation as above indicated the deputy is supposed to have followed the directions given on page 71, but he is at liberty to ascertain its value by any correct method which may be available, provided he states exactly how it is done. The record of the observations must not be omitted in these field notes unless the contract under which the deputy is working includes standard or exterior lines, surveyed by himself, passing through the corner under consideration, and in that case he is to ascertain the variation by taking the *magnetic* bearing of his own established line and will make a record of the time, place, and observations.

To compute the time of elongation of Polaris, see table, page 68, and following rules.

At 7.30 a. m., August 6th, I place the compass on the line established last night and find its *magnetic* bearing to be N. 18° 36′ W., and after allowing 6′ for diurnal change (as per table on page 55 of printed instructions, find the *mean* declination to be 18° 30′ E.

From the township corner I run north on east boundary of sec. 36.
Va. 18° 36′ E.

And at 35 chains find meander cor. on line on right bank of main channel of Yellowstone River. I set a flag on line on opposite bank and measure a base line east 2.50 chs. to a point from which the flag bears N. 9° W., and the distance across is, cot. 9° × base or 6.314 × 2.50 = 15.78 chs., and the whole distance from township cor. 50.78 chs.; continue same line to 80.04 chs., where I find the cor. to secs. 25 and 36 on E. boundary of township, 2 links east of my line. The bearing of the range line is therefore *north*, agreeing with the notes supplied by the Surveyor-General.

I now return to the SE. cor. of township and again take the magnetic bearing of the range line, which I find to be N. 18° 33′ W. (at 9.45 A. M.).

Thence I run N. 89° 57′ W. along S. boundary of sec. 36.
Va. 18° 33′ E.

At 39.98 find ¼ sec. cor. 2 lks. south, and at 79.97 find the cor. to secs. 35 and 36 1 link north of my line. The true course of the south boundary of sec. 36 is therefore as above stated.

With the above-named *true bearings* the subdivision lines of the eastern tier of sections will be run as required by the printed instructions, and my chaining practically agrees with the original survey.

NOTE.—If the line run north from the township corner is found to fall east or west of the sec. cor. at end of first mile, the falling will be noted and

* See table on page 68.
† See table on page 70; interpolate *back* to 1889.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	the true bearing of range line deduced therefrom will be the bearing for all N. and S. sec. lines in the township, including the *random* lines in N. tier of secs. which close on corners common to 4 sections. In a similar manner the true course of the south boundary, determined from the falling at 80 chains, will be the random bearing of E. and W. section lines in east tier of sections. For the random bearings of other E. and W. sec. lines see remarks on page 88 referring to Table III and the bearings on Diagram A, Fig. 1.
	I commence at the corner to secs. 1, 2, 35, and 36 on the south boundary, which is a sandstone, 8 × 8 × 2½ ins., above ground, firmly set, with 1 notch on E. and 5 notches on W. edge, and pits, 18 × 18 × 12 ins., in each sec. 5½ feet dist., with mound of earth, 2 ft. high, 4½ ft. base, alongside. From a back-sight on the south boundary of sec. 36, I lay off at this cor. an angle of 90° 02′ to the north, which gives the direction of the *true meridian*, and which I find has (at 10 A. M.) a *magnetic* bearing of N. 18° 30′ W.
	NOTE.—The above is the method to be pursued when *much local attraction exists* (as here supposed), and is the better plan to follow under all circumstances when a common compass is used. The *direction* of the *true meridian* being carried forward by back and fore sights, the needle is not depended upon at any time. If the south boundary is a *due east* and *west* line, the angle to laid off will be 90° ; if the south boundary *appproximates* to the parallel of latitude the angle to be laid off will be equal to the *bearing* if the boundary runs *south* of west, and equal to 180° *minus* the bearing when the boundary runs *north* of west, as in this case. It should be remembered that the south boundary on Diagram C is supposed to be a *straight* line. See Diagram A, Fig. 1, and remarks on page 88. If a Solar apparatus is used the true meridian is obtained by direct observation. The course to be pursued in any particular case will depend upon the instrument used and existing conditions.
	Thence I run N. North, bet. secs. 35 and 36. Va. 18° 30′ E.
5.00	Wire fence, course E. and W.
20.00	Enter scattering timber. Alexander's house bears N. 31° W.
31.00	Leave scattering timber.
40.00	Set a post, 3 ft. long, 3 ins. square, with marked stone, 12 ins. in the ground, for ¼ sec. cor., marked ¼ S. on W. side; dug pits, 18 × 18 × 12 ins., N. and S. of post, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, around post. Alexander's house bears S. 53¾° W.
52.70	Enter brush.
53.82	Right bank of the Yellowstone River. Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for meander cor. to fractional secs. 35 and 36, marked M. C. on N. side, and T. 6 N., on S.; R. 34 E., S. 36, on E., and S. 35, on W. faces; dug pit, 3 ft. square, 12 ins. deep, 8 lks. S. of post, and raised mound of earth 2 ft. high, 4½ ft. base, around post. There being an island on line on N. side of channel, I send a flag across, and set it on line bet. secs. 35 and 36, on bar S. of island. I then go across to flag and run a base line W. 11.13 chs. to a point from which meander cor. on right bank bears S. 37° 50′ E., which gives for distance across the river to edge of bar, cot. 37° 50′ × base, or 1.288 × 11.13 = 14.34 chs. I then run north from flag 66 lks. to south bank of island, making the whole distance 53.82 + 14.34 + 0.66 chs. or
68.82	To south bank of island, which point I established by setting a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for meander cor. to fractional secs. 35 and 36 on S. bank of island, marked M. C. on S. side, and T. 6 N., on N.; R. 34 E., S. 36, on E., and S. 35, on W. faces; dug pit, 3 ft. square, 12. ins. deep, 8 lks. N. of post, and raised a mound of earth, 2 ft. high, 4½ ft. base, around post.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	Thence continue on line across island, enter brush.
72.50	Leave brush, enter timber.
80.00	Set a post, 4 ft. long, 4 ins. square, with marked stone, 24 ins. in the ground, for cor. to secs. 25, 26, 35, and 36, marked— T. 6 N., S. 25, on N. E.; R. 34 E., S. 36, on S. E.; S. 35, on S. W., and S. 26, on N. W. faces, with 1 notch on S. and E. edges, from which A cottonwood, 12 ins. diam., bears N. 12¾° E., 180 lks. dist., marked T. 6 N., R. 34 E., S. 25, B. T. A cottonwood, 18 ins. diam., bears S. 82° E., 154 lks. dist., marked T. 6 N., R. 34 E., S. 36, B. T. A cottonwood, 10 ins. diam., bears S. 29½° W., 56 lks. dist., marked T. 6 N., R. 34 E., S. 35, B. T. A cottonwood, 10 ins. diam., bears N. 46½° W., 119 lks. dist., marked T. 6 N., R. 34 E., S. 26, B. T.
	Land, level.
	Soil, rich loam; 1st rate.
	Timber, cottonwood and willow, 18.50 chs.; undergrowth same, 3.68 chains.

S. 89° 58′ E. on a random line bet. secs. 25 and 36.
Va. 18° 30′ E.

	This line is wholly on the island.
40.00	Set temporary ¼ sec. cor.
79.54	Intersect the east boundary of the township 3 lks. N. of the cor. to secs. 25, 30, 31, and 36, which is a post, 4 ft. long, 4 ins. square, firmly set in the ground, marked— T. 6 N., S. 30, on N. E.; R. 35 E., S. 31, on S. E.; R. 34 E., S. 36, on S. W., and S. 25, on N. W. faces, with 5 notches on N. and 1 notch on S. edges, from which A cottonwood, 20 ins. diam., bears N. 30½° E., 166 lks. dist., marked T. 6 N., R. 35 E., S. 30, B. T. A cottonwood, 24 ins. diam., bears S. 39° E., 67 lks. dist., marked T. 6 N., R. 35 E., S. 31, B. T. A cottonwood, 14 ins. diam., bears S. 89½° W., 170 lks. dist., marked T. 6 N., R. 35 E., S. 36, B. T. A cottonwood, 16 ins. diam., bears N. 23° W., 40 lks. dist., marked T. 6 N., R. 34 E., S. 25, B. T.
	Thence I run
	N. 89° 57′ W. on a true line bet. secs. 25 and 36, with same va.
13.50	Leave scattering timber, enter brush.
18.50	Leave brush.
28.00	Enter timber.
34.00	Leave timber.
39.77	Set a post, 3 ft. long, 3 ins. square, with marked stone, 12 ins. in the ground for ¼ sec. cor., marked ¼ S. on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of post, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, around post.
45.50	Enter timber and brush.
50.20	Leave timber and brush.
58.00	Enter timber.
78.21	A cottonwood, 20 ins. diam., a line tree marked with 2 notches on E. and W. sides.
79.54	The cor. to secs. 25, 26, 35, and 36.
	Land, level.
	Soil, alluvial; 1st rate.
	Timber, cottonwood and willow; undergrowth same, 32.24 chs.

August 6, 1889.

As the line bet. secs. 26 and 35 is fractional, I run
N. 89° 58′ W.* on a true line bet. secs. 26 and 35.
Va. 18° 30′ E.

* *Parallel* to south boundary of sec. 35. For remainder of this line see page 135.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
3.50	Leave timber.
4.83	West bank of island on river. Set a sandstone, 12 × 12 × 5 ins., 8 ins. in the ground, for meander cor. to fractional secs. 26 and 35, marked M. C. on W. side, from which a double cottonwood, 16 ins. diam., bears N. 78° E. 157 lks. dist., marked T. 6 N., R. 34 E., S. 26, M. C., B. T. A cottonwood, 18 ins. diam., bears S. 29½° W., 140 lks. dist., marked T. 6 N., R. 34 E., S. 35, M. C., B. T. NOTE.—*The remainder of this line is to be run from cor. to secs.* 26, 27, 34, *and* 35. *The line is run parallel to south boundary of sec.* 35, *not necessarily east or west.*
	I now return to the cor. to secs. 25, 26, 35, and 36, whence I run North, bet. secs. 25 and 26, Va. 18° 30′ E. Through timber and brush.
3.64	North bank of island. Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for meander cor. to fractional secs. 25 and 26, marked M. C. on N. face and T. 6 N. on S.; R. 34 E., S. 25, on E., and S. 26, on W. faces; from which A cottonwood, 8 ins. diam., bears S. 52½° E., 58 lks. dist., marked T. 6 N., R. 34 E., S. 25, M. C., B. T. A cottonwood, 10 ins. diam., bears S. 31° W., 103 lks. dist., marked T. 6 N., R. 34 E., S. 26, M. C., B. T. From this meander cor. on island I run north on bar 3.60 chs. to water's edge, and send flag across to left bank of river, and set it on line bet. secs. 25 and 26. I then run a base line east on bar 3.00 chs. to a point whence flag bears N. 55½° W., which gives for distance across, cot. 55½° × base or 0.694 × 3=2.08 chs. The whole distance from cor. to secs. 25, 26, 35, and 36 will therefore be 3.64 + 3.60 + 2.08 chs., making
9.32	To flag on left bank. This point I establish by setting a sandstone, 22 × 10 × 5 ins., 16 ins. in the ground, for meander cor. to fractional secs. 25 and 26, marked M. C. on S. side, and raised a mound of stone, 1½ ft. high, 2 ft. base, alongside. Pits impracticable. Thence I run north on line over level bottom.
40.00	Set a sandstone, 16×14×4 ins., 11 ins., in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of stone 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
59.70	Telegraph line, course S. 55° E.
78.20	Road to Miles City, course N. W. and S. E.
80.00	Set a sandstone, 36 × 8 × 5 ins., 27 ins. in the ground, for cor. to secs. 23, 24, 25, and 26, marked with 2 notches on S. and 1 notch on E. edges; dug pits, 18 × 18 × 12 ins., in each sec. 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside. Land, level. Soil, alluvial bottom; 1st rate. Timber, cottonwood on island, 3.64 chs.
	S. 89° 58′ E. on a random line bet. secs. 24 and 25. Va. 18° 30′ E.
40.00	Set temporary ¼ sec. cor.
79.90	Intersect east boundary of township 7 lks. N. of cor. to secs. 19, 24, 25, and 30, which is a post, 4 ins. square, marked— T. 6 N., S. 19, on N. E.; R. 35 E., S. 30, on S. E.; R. 34 E., S. 25, on S. W., and S. 24, on N. W. faces, with 4 notches on N. and 2 notches on S. edges, and pits, 18 × 18 × 12 ins., in each sec. 5½ ft. dist., and mound of earth, 2 ft. high, 4½ ft. base, around post. Thence I run N. 89° 55′ W. on a true line bet. secs. 24 and 25, with same va.
38.00	Fletcher's stage station bears S. 24° E.
39.95	Set a sandstone, 22 × 10 × 3 ins., 16 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face, and raised a mound of stone, 1½ ft. high, 2 ft. base, alongside. Pits impracticable.

Chains.	
46.60	Fletcher's stage station bears S. 41½° E.
57.10	Short Creek, spring water, 3 lks. wide, course S. E.
	Spring bears N. 22° W., about 14.00 chs. dist.
79.90	The cor. to secs. 23, 24, 25, and 26.
	Land, level.
	Soil, alluvial bottom; 1st rate.
	No timber.
	North, bet. secs. 23 and 24.
	Va. 18° 30′ E.
	Over nearly level ground.
21.00	Enter alkali flat.
40.00	Set a post, 3 ft. long, 3 ins. square, with marked stone, 12 ins. in the ground, for ¼ sec. cor., marked ¼ S. on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of post, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, around post.
73.71	Leave alkali flat.
75.00	Alkali creek, dry, course E.
80.00	Set a sandstone, 16 × 10 × 4 ins., 11 ins. in the ground, for cor. to secs. 13, 14, 23, and 24, marked with 3 notches on S. and 1 notch on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, gently rolling and level.
	Soil, partly alluvial and alkali; 1st and 3d rate.
	A few scattering cottonwoods on creek.
	NOTE.—The variation having been determined, the va. arc will be set to indicate its amount and will not be moved again unless an actual change (of sufficient magnitude to be appreciable) takes place, either by reason of local attraction or diurnal change. In either case, when alteration of the reading of va. vernier is required and made, the reason for the same will be stated in the notes, and the place, amount of change, hour of the day and the date will be given.
	If a change of direction is required it is to be attained by altering the *bearing*, not the *variation*.
	At 2 p. m. August 7, diurnal change has decreased the variation by 5′.
	S. 89° 58′ E. on a random line bet. secs. 13 and 24.
	Va. 18° 25′ E.
40.00	Set temporary ¼ sec. cor. in dry creek.
79.80	Intersect east boundary of township at cor. to secs. 13, 18, 19, and 24, which is a sandstone, 5 × 8 × 4 ins., above ground, firmly set, marked with 3 notches on N. and S. edges, and mound of stone, 1½ ft. high, 2 ft. base, alongside.
	Thence I run
	N. 89° 58′ W. on a true line bet. secs. 13 and 24, with same va.
	Over sage-brush plain.
37.80	Enter alkali creek, dry, course S. E., thence in creek.
39.90	The corner point being in creek, at a point 30 lks. N. on N. bank of creek, I set a post, 3 ft. long, 3 ins. square, with marked stone, 12 ins. in the ground, for witness cor. to ¼ sec. cor., marked W. C. ¼ S. on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of post, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, around post.
41.30	Leave creek, course N. E.
79.80	The cor. to secs. 13, 14, 23, and 24.
	Land, level.
	Soil, alkali, and sandy loam; 2d rate.
	A few scattering cottonwoods on creek.
	NOTE.—If the deputy is confident his own work is correct, an increase or decrease of length of E. and W. lines as he proceeds north will indicate an erroneous or crooked range line, and if discrepancies exceed limits prescribed on page 40 the deputy will examine and if necessary, retrace the

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	entire east boundary, in order to locate the error; he will then correct the range line if practicable, but if subdivisions have been made closing on east boundary, he will report the facts to the Surveyor-General and await his instructions.
	At 2.30 p. m. the line bet. secs. 23 and 24 bears S. 18° 35′ E., by compass. Some local attraction at this corner.
	North, bet. secs. 13 and 14.
	Va. 18° 35′ E.
33.50	Leave bottom and ascend.
35.50	Top of bench about 50 ft. high, course N. E., thence over gently rolling ground.
40.00	Deposited a marked stone, 12 ins. in the ground, for ¼ sec. cor.; dug pits, 18 × 18 × 12 ins., N. and S. of cor., 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, over it. In N. pit drove stake, 2 ft. long, 2 ins. square, 12 ins. in the ground, marked ¼ S. on W. face.
68.00	Foot of bluff, about 150 ft. high, course E., and ascend.
74.00	Top of bluff, enter pine timber, and thence descend along rocky slope, sloping westerly to
80.00	A point about 100 ft. below top of bluff. This point falling on a flat rock in place, I marked a cross (×) at exact cor. point for cor. to secs. 11, 12, 13, and 14, with 4 notches S. and 1 notch E., and raised a mound of stone, 1½ ft. high, 2 ft. base, alongside. Pits impracticable.
	From corner point
	A pine, 10 ins. diam., bears N. 15° E., 27 lks. dist., marked T. 6 N., R. 34 E., S. 12, B. T.
	A pine, 10 ins. diam., bears S. 42° E., 46 lks. dist., marked T. 6 N., R. 34 E., S. 13, B. T.
	A pine, 6 ins. diam., bears S. 5° W., 86 lks. dist., marked T. 6 N., R. 34 E., S. 14, B. T.
	A pine, 9 ins. diam., bears N. 15° W., 90 lks. dist., marked T. 6 N., R. 34 E., S. 11, B. T.
	Land, 33.50 chs. bottom, remainder broken.
	Soil, alluvial and rocky; 1st and 4th rate.
	Timber, pine, 6.00 chains.
	August 7, 1889.
	By a back-sight* on line bet. secs. 13 and 14, from cor. to secs. 11, 12, 13, and 14, at 7 a. m., August 8, I find its *magnetic* bearing to be S. 18° 34′ E. and the variation 18° 34′ E.
	S. 89° 58′ E. on a random line bet. secs. 12 and 13.
	Va. 18° 34′ E.
40.00	Set temporary ¼ sec. cor.
80.00	Intersect E. boundary of township, 14 lks N. of cor., to secs. 7, 12, 13, and 18, which is a post, 4 ins. square, marked—
	T. 6 N., S. 7, on N. E.
	R. 35 E., S. 18, on S. E.;
	R. 34 E., S. 13, on S. W., and
	S. 12, on N. W. faces, with 2 notches on N. and 4 notches on S. edges, and mound of earth, 2 ft. high, 4½ ft. base, around post.
	Thence I run
	N. 89° 52′ W. on a true line bet. secs. 12 and 13, with same va.
37.00	Couleé, about 30 ft. deep, course S. W., thence over rolling ground.
40.00	Set a post, 3 ft. long, 3 ins. square, with marked stone, 12 ins. in the ground, for ¼ sec. cor., marked ¼ S. on N. face, and raised a mound of stone, 1½ ft. high, 2 ft. base, alongside. Pits impracticable.
52.00	Couleé, 100 ft. deep, course S. E.
57.00	West side of couleé, thence ascend.
66.00	Top of ridge about 125 ft. high, course S., thence over rolling ground.
75.00	Enter timber and commence descending.
80.00	The cor. to secs. 11, 12, 13, and 14.
	Land, rolling and broken.
	Soil, stony; 4th rate.
	Timber, pine; 5 chs.

*To obtain the true meridian and variation when no solar apparatus is attached to the instrument.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	North, bet. secs. 11 and 12. Va. 18° 34′ E.
	Ascend along west side of hill, through timber.
11.00	Top of table-land, about 30 ft. above last cor., and leave timber, thence over rolling ground.
40.00	Deposited a marked stone, 12 ins. in the ground, for ¼ sec. cor.; dug pits, 18×18×12 ins., N. and S. of cor., 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, over it. In N. pit drove stake, 2 ft. long, 2 ins. square, 12 ins. in the ground, marked ¼ S. on W. face.
60.00	Stream, 6 lks. wide, course S. E.
80.00	Set a sandstone, 20 × 6 × 5 ins., 15 ins. in the ground, for cor. to secs. 1, 2, 11, and 12, marked with 5 notches on S. and 1 notch on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, rolling.
	Soil, sandy; 3d rate.
	Timber, pine; 11 chs.
	At 10 a. m. August 8, at cor. to 1, 2, 11, and 12, diurnal change has reduced va. by 4′.
	S. 89° 58′ E. on a random line bet. secs. 1 and 12. Va. 18° 30′ E.
40.00	Set temporary ¼ sec. cor.
80.00	Intersect E. boundary of township at 22 lks. N. of cor. to secs. 1, 6, 7, and 12, which is a sandstone, 5 × 6 × 5 ins., above ground, marked with 1 notch on N. and 5 notches on S. edges, and mound of stone, 1½ ft. high, 2 ft. base, alongside. Pits impracticable.
	Thence I run N. 89° 49′ W. on a true line bet. secs. 1 and 12, with same va.
10.00	Foot of ridge enter timber and ascend.
14.50	Top of ridge about 100 ft. high, course N. E.
16.50	Descend about 75 ft. to
30.50	Couleé, about 12 ft. deep, course N. E.
40.00	Set a sandstone, 18 × 14 × 3 ins., 12 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; from which A pine, 8 ins. diam., bears S. 31° E., 95 lks. dist., marked ¼ S., B. T. A pine, 12 ins. diam., bears N. 25° W., 25 lks. dist., marked ¼ S., B. T.
43.00	Couleé, about 18 ft. deep, course N. E.
50.50	Couleé, about 15 ft. deep, course N. E.
58.50	Couleé, about 100 ft. deep, course N. W.
71.00	Leave pine timber and ascend.
80.00	The cor. to secs. 1, 2, 11, and 12.
	Land, rolling and broken.
	Soil, sandy and rocky; 3d and 4th rate.
	Timber, pine, of excellent quality; 61 chs.
	North, on a random line bet. secs. 1 and 2. Va. 18° 30′ E.
40.00	Set temporary ¼ sec. cor.
79.77	Intersect north boundary of township at 21 lks. west of cor. to secs. 1, 2, 35, and 36, which is a sandstone, 5 × 8 × 4 ins., above ground, with pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Thence I run S. 0° 09′ W. on a true line bet. secs. 1. and 2, with same va.
	Over rolling ground.
19.50	Couleé, about 20 ft. deep, course S. W.
30.00	Couleé, about 15 ft. deep, course S. W.
39.40	Couleé, about 20 ft. deep, course S. W.
39.77	A pine, 7 ins. diameter, in couleé, which I marked ¼ S. on W. face for ¼ sec. cor.; dug pits, 18 × 18 × 12 ins., N. and S. of tree, 5½ ft. dist., and raised a mound of earth around tree.
79.77	The cor. to secs. 1, 2, 11, and 12.
	Land, rolling.
	Soil, sandy and alkali; 3d rate.
	Timber, scattering pines in couleés.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	From the cor. to secs. 2, 3, 34, and 35, on the south boundary of the township, which is a post, 4 ins. square, marked— T. 6 N., S. 35, on N. E.; R. 34 E., S. 2, on S. E.; T. 5 N., S. 3, on S. W., and S. 34, on N. W. faces, with 2 notches on E. and 4 notches on W. edges, and mound of earth, 2 ft. high, 4½ ft. base, around post; I take a back-sight* to flag on ¼ sec. cor. S. bdy. sec. 35, and lay off to the north an angle of 90° 01′, which gives the true meridian. Its *magnetic* bearing is N. 18° 34′ W. at 6 a. m., August 9, thence I run
	North, bet. secs. 34 and 35. Va. 18° 34′ E.
	Over level bottom.
40.00	Set a sandstone, 24 × 14 × 3 ins., 18 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
80.00	Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for cor. to secs. 26, 27, 34, and 35, marked— T. 6 N., S. 26, on N. E.; R. 34 E., S. 35, on S. E.; S. 34, on S. W., and S. 27, on N. W. faces, with 1 notch on S. and 2 notches on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, level.
	Soil, alluvial bottom; 1st rate.
	No timber.
	As a portion of the line bet. secs. 26 and 35 has been run N. 89° 58′ W.† from the cor. to secs. 25, 26, 35, and 36, I run
	S. 89° 59′ E.† on a true line bet. secs. 26 and 35. Va. 18° 34′ E.
	Over level bottom.
40.00	Deposited a marked stone, 12 ins. in the ground, for ¼ sec. cor.; dug pits, 18 × 18 × 12 ins., E. and W. of cor., 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, over it. In E. pit drove a stake, 2 ft. long, 2 ins. square, 12 ins. in the ground, marked ¼ S. on N. face.
69.30	Left bank of Yellowstone River. Set a sand stone, 20 × 10 × 6 ins., 15 ins. in the ground, for meander cor. to fractional secs. 26 and 35, marked M. C. on E. face, and raised a mound of stone, 1½ ft. high, 2 ft. base, alongside. Pit impracticable.
	In order to get the distance to meander corner across the river, which bears N. 89° E., I run a base N. 1° W. 3.00 chs. to a point whence meander cor. on island bears S. 66° E., which gives for distance, tan. 65° × base, or 2.145×3 = 6.43 chs.
	The length of the line bet. secs. 26 and 35 is as follows:
	East of arm of river, on island..... 4.83 chs. Across river..... 6.43 " West of river, on main land ..... 69.30 " Total..... 80.56 "
	Land, level.
	Soil, alluvial bottom; 1st rate.
	Timber, cottonwood; 3.50 chs. on island.

* This method should be followed when the instrument is not provided with a solar attachment, or when one can not be used. See note on page 129.

† These two bearings will have the same angular value when the south boundary is run on a parallel of latitude or *approximates* to a parallel.

Subdivisions T. 6 N., R. 24 E.—Continued.

Chains.	
	I now return to the cor. to secs. 26, 27, 34 and 35, and run
	North, bet. secs. 26 and 27.
	Va. 18° 34′ E.
	Over gently rolling ground.
26.30	Telegraph line, course N. E.
40.00	Set a post, 3 ft. long, 3 ins. square, with marked stone, 12 ins. in the ground, for ¼ sec. cor., marked ¼ S. on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of post, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, around post.
49.50	Spring branch, 1 lk. wide, course S. 80° E.
	From this point a spring of pure cold water, about 2 ft. diam., bears N. 70° W., 2.36 chs. dist.
57.40	Road to Miles City, course N. E.
80.00	Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for cor. to secs. 22, 23, 26, and 27, marked—
	T. 6 N., S. 23, on N. E.;
	R. 34 E., S. 26, on S. E.;
	S. 27, on S. W., and
	S. 22, on N. W. faces, with 2 notches on S. and E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, around post.
	Land, gently rolling.
	Soil, sandy; 2d rate.
	No timber.

	S. 89° 59′ E., on a random line, bet. secs. 23 and 26.
	Va. 18° 34′ E.
40.00	Set temporary ¼ sec. cor.
80.00	Intersect N. and S. line 7 lks. N. of cor. to secs. 23, 24, 25, and 26. Thence I run
	N. 89° 56′ W. on true line bet. secs. 23 and 26, with same va.
	Over rolling ground.
1.60	Road to Miles City, course S. 50° E.
40.00	Set a sandstone, 14×10×6 ins., 9 ins. in the ground, for ¼ sec. cor., marked ¼ on N. side; dug pits, 18 × 18×12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
54.00	Road to Miles City, course N. E.
80.00	The cor. to secs. 22, 23, 26, and 27.
	Land, gently rolling.
	Soil, sandy; 2d rate.
	No timber.

	At 10 a. m. diurnal change has reduced the va. 2′.
	North, bet. secs. 22 and 23.
	Va. 18° 32′ E.
	Over rolling ground.
40.00	Deposited a marked stone, 12 ins. in the ground, for ¼ sec. cor.; dug pits, 18 × 18 × 12 ins., N. and S. of cor., 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, over it. In N. pit drove stake, 2 ft. long, 2 ins. square, 12 ins. in the ground, marked ¼ S. on W. face. Thence ascend to
56.00	Top of table-land, about 40 ft. above ¼ sec. cor.
63.00	Old military road, course S. E.
80.00	Set a sandstone, 20 × 14 × 3 ins., 15 ins. in the ground, for cor. to secs. 14, 15, 22, and 23, marked with 3 notches on S. and 2 notches on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, rolling and table.
	Soil, sandy; 2d rate.
	No timber.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	S. 89° 59′ E. on a random line bet. secs. 14 and 23. Va. 18° 32′ E.
40.00	Set temporary ¼ sec. cor.
79.84	Intersect N. and S. line 14 lks. N. of cor. to secs. 13, 14, 23, and 24. Thence I run
	N. 89° 53′ W. on a true line bet. secs. 14 and 23, with same va.
10.00	Alkali Creek, dry, course S. E., ascend about 30 ft. to
18.80	Top of table land
39.92	Set a sandstone, 18×12×4 ins., 12 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face, and raised a mound of stone, 1½ ft. high, 2 ft. base, alongside. Pits impracticable.
70.50	
79.84	Old military road, course S.
	The cor. to secs. 14, 15, 22, and 23.
	Land, table,
	Soil, sandy; 2d and 3d rate.
	No timber.
	August 9, 1889.

	At 8 a. m., Aug. 10, the line between secs. 22 and 23 has a *magnetic* bearing of S. 18° 32′ E.
	North, bet. secs. 14 and 15. Va. 18° 32′ E.
11.00	Enter pine timber and ascend to
22.00	Top of small hill, about 30 ft. high and nearly conical in shape. Descend to
31.00	Foot of hill, and leave timber.
33.00	Old military road, four wagon tracks, course N. W.
40.00	Set a sandstone, 15×15×3 ins., 10 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
41.80	Commence ascending.
43.90	Top of table-land, about 50 ft. above last ¼ sec. cor. Thence over nearly level land to
80.00	Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for cor. to secs. 10, 11, 14, and 15, marked— T. 6 N., S. 11, on N. E.; R. 34 E., S. 14, on S. E.; S. 15, on S. W., and S. 10, on N. W. faces, with 4 notches on S. and 2 notches on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, around post.
	Land, rolling and table.
	Soil, sandy and gravelly; 3d rate.
	Timber, pine; 20.00 chs.

	At 10.30 a. m. the needle has returned to its mean place.
	S. 89° 59′ E. on a random line bet. secs. 11 and 14. Va. 18° 30′ E.
40.00	Set temporary ¼ sec. cor.
80.00	Intersect N. and S. line 23 lks. N. of cor. to secs. 11, 12, 13, and 14. Thence I run
	N. 89° 49′ W., on a true line, bet. secs. 11 and 14, with same va.
11.86	Edge of bluff about 75 ft. high, course N. and S.
14.00	Foot of bluff, leave scattering pine timber, descend gradually.
40.00	Deposited a marked stone, 12 ins. in the ground, for ¼ sec. cor.; dug pits, 18 × 18 × 12 ins., E. and W. of cor., 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, over it. In E. pit drove stake, 2 ft. long, 2 ins. square, 12 ins. in the ground, marked ¼ S. on N. face.
80.00	The cor. to secs. 10, 11, 14, and 15. Land, table and broken. Soil, gravelly; 3d rate. Timber, scattering pine.
	August 10, 1889.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	At cor. to secs. 10, 11, 14, and 15, by back-sight on line bet. secs. 14 and 15, I find its mag. bearing to be S. 18° 35′ E., at 8 a. m., August 12.
	North, bet. secs. 10 and 11.
	Va. 18° 35′ E.
	Over table-land.
26.00	Foot of spur of high mountain, ascend abruptly over broken ground.
34.00	Head of ravine, course S. 70° E.
40.00	Set a sandstone, 20×8×4 ins., 15 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face, and raised a mound of stone, 1½ ft. high, 2 ft. base, alongside. Pits impracticable.
42.00	Foot of sharp ridge, course E. and W.
43.25	Top of ridge, about 40 ft. high, and about 500 ft. above last sec. cor. Descend abruptly.
44.00	Foot, about 30 ft. below top, and ascend over broken ground.
51.10	Enter heavy pine timber.
80.00	A point about 900 ft. above last sec. cor. Set a sandstone, 24×6×4 ins., 18 ins. in the ground, for cor. to secs. 2, 3, 10, and 11, marked with 5 notches on S. and 2 notches on E. edges, from which
	A pine, 15 ins. diam., bears N. 67° E., 30 lks. dist., marked T. 6 N., R. 34 E., S. 2, B. T.
	A pine, 27 ins. diam., bears S. 23° E., 67 lks. dist., marked T. 6 N., R. 34 E., S. 11, B. T.
	A pine, 12 ins. diam., bears S. 47° W., 110 lks. dist., marked T. 6 N., R. 34 E., S. 10, B. T.
	A pine, 16 ins. diam., bears N. 50° W., 82 lks. dist., marked T. 6 N., R. 34 E., S. 3, B. T.
	Land, mountainous and broken.
	Soil, rocky; 4th rate.
	Timber, pine; 28.90 chs.
	54.00 chs. of line run over mountainous land.
	At 9.30 a. m. August 12, diurnal change has diminished the variation 2′.
	S. 89° 59′ E. on a random line bet. secs. 2 and 11.
	Va. 18° 33′ E.
40.00	Set temporary ¼ sec. cor.
80.00	Intersected N. and S. line at cor. to secs. 1, 2, 11, and 12. Thence I run N. 89° 59′ W. on a true line bet. secs. 2 and 11, with same va.
	Over rolling ground.
9.50	Foot of spur.
20.00	Stream, 4 lks. wide, course S. E., and enter timber.
40.00	Set a sandstone, 16×8×4 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face, from which
	A pine, 18 ins. diam., bears N. 17° E., 48 lks. dist., marked ¼ S., B. T.
	A pine, 14 ins. diam., bears N. 40 W., 63 lks. dist., marked ¼ S., B. T.
50.00	Ascend abruptly.
55.65	Top of ascent.
58.90	Descend into deep ravine.
61.70	Bottom of ravine about 100 ft. deep, and ascend.
68.00	Across ravine, thence over rough, broken ground through timber to
80.00	The cor. to secs. 2, 3, 10, and 11.
	Land, mountainous and broken.
	Soil, rocky; 4th rate.
	Timber, pine; 60.00 chs.
	72.08 chs. of line run over mountainous land.
	Diurnal change has diminished the variation 3′, at 11 a. m., Aug. 12.
	North on a random line bet. secs. 2 and 3.
	Va. 18° 30′ E.
40.00	Set temporary ¼ sec. cor.
80.10	Intersect N. boundary of township 25 lks. W. of cor. to secs. 2, 3, 34, and 35, which is
	A post, 4 ins. square, marked
	T. 7 N., S. 35, on N. E.;
	R. 34 E., S. 2, on S. E.;
	T. 6 N., S. 3, on S. W., and

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	S. 34, on N. W. faces, with 2 notches on E. and 4 notches on W. edges, and mound of stone, 1½ ft. high, 2 ft. base, around post.
	Thence I run
	S. 0° 11′ W. on a true line bet. secs. 2 and 3, with same va.
	Over open ground.
4.80	Top of spur leave open ground and enter heavy pine timber, descend abruptly.
40.10	A pine, 16 ins. diam., which I mark ¼ S. on W. face, for ¼ sec. cor., from which
	A pine, 14 ins. diam., bears S. 40° E., 78 lks. dist., marked ¼ S., B. T.
	A pine, 20 ins. diam., bears N. 70° W., 24 lks. dist., marked ¼ S., B. T.
80.10	The cor. to secs. 2, 3, 10, and 11. This cor. is about 850 ft. below the top of the spur.
	Land, mountainous and broken.
	Soil, rocky; 4th rate.
	Timber, pine; 75.30 chs.
	Whole line runs over mountainous land. *August* 12, 1889.

	From the cor. to secs. 3, 4, 33, and 34 on the S. boundary, of the township, which is a sandstone, 7 × 8 × 3 ins., above ground, with 3 notches on E. and W. edges, and mound of stone, 1½ ft. high, 2 ft. base, alongside, I take a back-sight on S. bonndary sec. 34 and lay off a right angle to the north, which gives the true meridian, and its *magnetic* bearing at 1 p. m. August 13, is N. 18° 23′ W.; thence
	I run
	North, bet. secs. 33 and 34.
	Va. 18° 23′ E.
	Over bottom land.
40.00	Set a post, 3 ft. long, 3 ins. square, with marked stone, 12 ins. in the ground, for ¼ sec. cor., marked ¼ S. on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of post, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, aronnd post.
45.00	Stream, 8 lks. wide, course S. 88° E., joins another stream about 20 chs. E. of line. Enter meadow.
65.00	Leave meadow.
76.00	Stream, 8 lks. wide, course S. 34° E., joins first stream.
80.00	Set a post, 4 ft. long, 4 ins. sqnare, with marked stone, 12 ins. in the grounnd, for cor. to secs 27, 28, 33, and 34, marked—
	T. 6 N., S. 27, on N. E.;
	R. 34 E., S. 34, on S. E.;
	S. 33, on S. W., and
	S. 28, on N. W. faces, with 1 notch on S. and 3 notches on E. edges, dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, around post.
	Land level.
	Soil, rich, black loam; 1st rate.
	No timber.

	East on a random line bet. secs. 27 and 34.
	Va. 18° 23′ E.
40.00	Set temporary ¼ sec. cor.
79.87	Intersect N. and S. line 5 lks. N. of cor. to secs. 26, 27, 34, and 35.
	Thence I run
	N. 89° 58′ W. on a true line bet. secs. 27 and 34, with same va.
	Over bottom land.
39.93	Deposited a marked stone, 12 ins. in the ground, for ¼ sec. cor.; dug pits, 18 × 18 × 12 ins., E. and W. of cor., and raised mound of earth, 1½ ft. high, 3½ ft. base, over it. In E. pit drove stake, 2 ft. long, 2 ins. square, 12 ins. in the ground, marked ¼ S. on N. face.
79.87	The cor. to secs. 27, 28, 33, and 34.
	Land, level.
	Soil, rich, black loam; 1st rate.
	No timber.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	Local attraction has increased va. 2′, at 2 p. m., Aug. 13.
	North, bet. secs. 27 and 28.
	Va. 18° 25′ E.
	Over bottom land.
2.00	Creek, 7 lks. wide, course S. W.
3.00	Same creek, course S. E.
20.00	Telegraph line, course E.
26.00	Road to Miles City, course N. E.
40.00	Set a sandstone, 17 × 10 × 3 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on W. side; dug pits, 18 × 18 × 12 ins., N. and S. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
80.00	Set a sandstone, 22 × 6 × 4 ins., 15 ins. in the ground, for cor. to secs. 21, 22, 27, and 28, marked with 2 notches on S. and 3 notches on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, level.
	Soil, rich, black loam; 1st rate.
	No timber.
	East on a random line bet. secs. 22 and 27.
	Va. 18° 25′ E.
40.00	Set temporary ¼ sec. cor.
79.80	Intersect N. and S. line, 3 lks. N. of cor. to secs. 22, 23, 26, and 27.
	Thence I run
	N. 89° 59′ W. on a true line bet. secs. 22 and 27, with same va.
	Over gently rolling ground.
21.80	Small coulee, about 2 ft. deep, course S. E.
	Thence over level land.
39.90	Set a sandstone, 16 × 9 × 4 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on N. side; dug pits, 18 × 18× 12 ins., E. and W. of stone, 5½ ft. dist., and raised mound of earth, 1½ ft. high, 3½ ft. base, alongside.
79.80	The cor. to secs. 21, 22, 27, and 28.
	Land, level and rolling.
	Soil, black loam and sandy; 1st and 2d rate.
	No timber.
	At 3.30 p. m., va. increased by local attraction, 2′.
	North. bet. secs. 21 and 22.
	Va. 18° 27′ E.
	Over gently rolling ground, descending,
14.00	Enter swamp.
40.00	Set a sandstone, 20 × 14 × 3 ins., 15 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of stone 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base alongside.
62.00	Leave swamp, thence over gently rolling ground.
76.20	Old military road, course N. W.
80.00	Deposited a marked stone, 12 ins. in the ground, for cor. to secs. 15, 16, 21, and 22; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, over it. In S. E. pit drove stake, 2 ft. long, 2 ins. square, 12 ins. in the ground, marked— T. 6 N., S. 15, on N. E.; R. 34 E., S. 22, on S. E.; S. 21, on S. W., and S. 16, on N. W. faces, with 3 notches on S. and E. edges.
	Land, gently rolling and swamp.
	Soil, sandy and wet loam; 2d rate.
	No timber.
	NOTE.—Swamp can be drained into Yellowstone River.
	East on a randon line bet. secs. 15 and 22.
	Va. 18° 27′ E.
40.00	Set temporary ¼ sec. cor.
79.66	Intersect N. and S. line 15 lks. N. of cor. to secs. 14, 15, 22, and 23. Thence I run

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	N. 89° 54′ W. on a true line bet. secs. 15 and 22, with same va.
	Over table-land.
11.26	Edge of table-land, descend about 40 ft.
18.00	Foot of descent, thence over gently rolling ground.
39.83	Set a sandstone, 16 × 14 × 5 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face, and raised a mound of stone, 1½ ft. base, 2 ft. high, alongside. Pits impracticable.
79.66	The cor. to secs. 15, 16, 21, and 22.
	Land, rolling and table.
	Soil, sandy; 2d rate.
	No timber.
	August 13, 1889.

* NOTE.—In my camp, N. E. ¼ sec. 16, which is S. 50° W., 20 chs. from cor. to secs. 9, 10, 15, and 16, I observe Polaris at 9h 52m p. m., the local mean time for *eastern* elongation, computed from table on page 68 of printed instructions, and mark the point under instrument. I drive a picket 2 chs. N. on the true meridian, determined by laying off the Azimuth of Polaris, 1° 51′ to the *west*.

August 13, 1889.

* NOTE.—At 6.30 a. m., August 14, I take the *magnetic* bearing of the line established last night, and find it to be N. 18° 37′ W., which, corrected by the table on page 55 of printed instructions, gives for the *mean declination* 18° 32′ east.

	At corner to secs. 15, 16, 21, and 22 I find the *magnetic* bearing of line bet. secs. 21 and 22 to be S. 18° 34′ E. at 7 a. m., August 14.
	North, bet. secs. 15 and 16.
	Va. 18° 34′ E.
	Over gently rolling ground.
40.00	Set a sandstone, 16 × 12 × 3 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of stone, 5½ ft dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside. Wells's house bears N. 45° W., 6.00 chs. dist.
50.00	Easterly end of pond bears W. about 10 chs. dist.
80.00	Set a sandstone, 20 × 6 × 5 ins., 15 ins. in the ground, for cor. to secs. 9, 10, 15, and 16, marked with 4 notches on S. and 3 notches on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, rolling.
	Soil, sandy; 2d rate.
	No timber.

	East on a random line bet. secs. 10 and 15.
	Va. 18° 34′ E.
40.00	Set temporary ¼ sec. cor.
79.70	Intersect N. and S. line at 3 lks. N. of cor. to secs. 10, 11, 14, and 15. Thence I run
	N. 89° 59′ W. on a true line bet. secs. 10 and 15, with same va.
	Over nearly level table-land.
23.34	Edge of table-land, descend about 50 ft.
28.60	Enter rolling ground.
39.85	Set a sandstone, 20 × 10 × 16, 15 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth 1½ ft. high, 3½ ft. base, alongside.
79.70	The cor. to secs. 9, 10, 15, and 16.
	Land, rolling and table.
	Soil, sandy and gravelly; 2d and 3d rate.
	No timber.

* The observations here recorded are required when the deputy uses *magnetic* apparatus only. If *solars* are used in subdividing the observation at this place may be omitted.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	North, bet. secs. 9 and 10. Va. 18° 34′ E.
	Over rolling ground, ascending.
5.40	Enter timber, thence over broken ground.
20.90	Ravine about 20 ft. deep, course S. W.
27.00	Foot of steep ascent.
40.00	Set a sandstone, 24 × 15 × 4 ins., 18 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; from which A pine, 12 ins. diam., bears S. 75° E., 90 lks. dist., marked ¼ S., B. T. A pine, 11 ins. diam., bears N. 55° W., 30 lks. dist., marked ¼ S., B. T.
80.00	A point about 100 ft. above last sec. cor., set a post, 4 ft. long, 4 ins. square, with marked stone, 24 ins. in the ground, for cor. to secs. 3, 4, 9, and 10, marked— T. 6 N., S. 3, on N. E.; R. 34 E., S. 10, on S. E.; S. 9, on S. W., and S. 4, on N. W. faces, with 5 notches on S. and 3 notches on E. edges, from which A pine, 17 ins. diam., bears N. 23° E., 78 lks. dist., marked T. 6 N., R. 34 E., S. 3, B. T.; A pine, 14 ins. diam., bears S. 47° E., 43 lks. dist., marked T. 6 N., R. 34 E., S. 10, B. T.; A pine, 20 ins. diam., bears S. 10° W., 16 lks. dist., marked T. 6 N., R. 34 E., S. 9, B. T.; A pine, 10 ins. diam., bears N. 73° W., 82 lks. dist., marked T. 6 N., R. 34 E., S. 4, B. T.
	Land, rolling and broken.
	Soil, sandy and rocky; 3d and 4th rate.
	Timber, pine; 74.60 chs.
	East on a random line bet. secs. 3 and 10. Va. 18° 34′ E.
40.00	Set temporary ¼ sec. cor.
79.80	A point about 700 ft. above last sec. cor. and intersect N. and S. line 30 lks. N. of cor. to secs. 2, 3, 10, and 11.
	Thence I run N. 89° 47′ W. on a true line bet. secs. 3 and 10, with same va.
	Descend steep west slope of spur of mountain over broken ground and through heavy pine timber.
12.77	Pine, 30 ins. diam.
39.90	A pine, 28 ins. diam., which I mark ¼ S. on N. face for ¼ sec. cor.; from which A pine, 16 ins. diam., bears S. 42° E., 30 lks. dist., marked ¼ S., B. T. A pine, 40 ins. diam., bears N. 23° E., 78 lks. dist., marked ¼ S., B. T.
62.18	Pine, 20 ins. diam., a line tree marked with 2 notches on E. and W. sides.
66.60	Pine, 24 ins. diam., a line tree marked with 2 notches on E. and W. sides.
79.80	The cor. to secs. 3, 4, 9, and 10.
	Land, mountainous.
	Soil, rocky; 4th rate.
	Timber, pine; 79.80 chs.
	Whole line runs over mountainous land.
	At 10.30 a. m. August 14, the va. has been diminished by diurnal change, 4.′
	North on a random line bet. secs. 3 and 4. Va. 18° 30′ E.
40.00	Set temporary ¼ sec. cor.
80.00	Intersect N. boundary of township, 23 lks. W. of cor., to secs. 3, 4, 33, and 34, which is a sandstone, 5 × 8 × 6 ins., above ground, marked with 3 notches on E. and W. edges, with mound of stone, 1½ ft. high, 2 ft. base, alongside. Thence I run S. 0° 10′ W. on a true line bet. secs. 3 and 4, with same va.
	Alongside of west slope of spur of mountain, over broken ground.
36.40	Enter timber.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
40.00	Set a sandstone, 16 × 14 × 5 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; from which A pine, 12 ins. diam., bears S. 45° E., 65 lks. dist., marked ¼ S., B. T. A pine, 12 ins. diam., bears S. 30° W., 120 lks. dist., marked ¼ S., B. T.
40.20	At thie point the variation began to increase and on account of *local* attraction at
48.90	The compass showed a va. of 27° 45′ E. Upon examination I found croppings of iron ore.
80.00	The cor. to secs. 3, 4, 9, and 10. Land, broken. Soil, rock; 4th rate. Timber, pine; 43.60 chs. Whole line runs over mountainous land.

NOTE.—A small but deep lake, containing more than twenty-five acres is situated about the middle of sec. 33, which I prepare to meander as follows:

	From the ¼ sec. cor. on S. boundary of sec. 33 I run North on a true line, Va. 18° 30′ E.
19.00	Enter timber bearing E. and W.
20.30	Bank of lake, 7 ft. high, where I set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for meander cor. on S. side of lake, marked— M. C., on N.; T. 6 N., on S.; R. 34 E., S. 33, on E., and S. 33, on W. faces; from which A maple, 13 ins. diam., bears S. 15° W., 20 lks. dist., marked— T. 6 N., R. 34 E., S. 33, M. C., B. T. An ash, 12 ins. diam., bears S. 21½ E., 15 lks. dist., marked— T. 6 N., R. 34 E., S. 33, M. C., B. T. Land, rolling. Soil, rich, black loam; 1st rate. Timber on lake shores, maple, ash, pine, and white oak. *August* 14, 1889.

	The cor. to secs. 4, 5, 32, and 33, on the south boundary of the township, is a post, 4 ins. square, marked— T. 6 N., S. 33, on N. E.; R. 34 E., S. 4, on S. E.; T. 5 N., S. 5, on S. W., and S. 32, on N. W. faces, with 4 notches on E. and 2 notches on W. edges, and pits, 18×18×12 ins., in each sec., 5½ ft. dist., and mound of earth, 2 ft. high, 4½ ft. base, around post. I lay off an angle of 89° 59′* to the north (from a back-sight to the eastward on S. bdy. sec. 33), and find the *magnetic* bearing of true meridian so determined to be N. 18° 35′ W., at 8 a. m., August 15. North, bet. secs. 32 and 33. Va. 18° 35′ E. Over level bottom.
40.00	Set a sandstone, 18 × 18 × 3 ins., 12 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
46.00	Creek, 6 lks. wide, course S. E. about 15 chs. then E. to lake.
80.00	Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for cor. to secs. 28, 29, 32, and 33, marked— T. 6 N., S. 28, on N. E.; R. 34 E., S. 33, on S. E.; S. 32, on S. W., and

* See note on page 129.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	S. 29, on N. W. faces, with 1 notch on S. and 4 notches on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, around post.
	Land, level.
	Soil, rich, black loam; 1st rate.
	No timber.
	N. 89° 59′ E. on a random line bet. secs. 28 and 33.
	Va. 18° 35′ E.
40. 00	Set temporary ¼ sec. cor.
79. 50	Intersect N. and S. line 3 lks. N. of cor. to secs. 27, 28, 33, and 34.
	Thence I run
	West on a true line bet. secs. 28 and 33, with same va.
	Over level bottom.
2. 00	Creek, 6 lks. wide, course S. W.
39. 75	Set a sandstone, 20×8×5 ins., 15 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
43. 50	Creek, 8 lks. wide, course S. E.
79. 50	The cor. to secs. 28. 29, 32, and 33.
	Land, level.
	Soil, rich, black loam.
	No timber.
	I now return to the ¼ sec. cor. between secs. 28 and 33 and run south in sec. 33 on a true line,
	Va. 18° 35′ E.
4. 50	Creek, 8 lks. wide, course S. E.
24. 00	To shore of the small lake previously mentioned, bank, 8 ft. high, where I set a limestone, 19 × 12 × 6 ins., 15 ins. in the ground, for meander cor. on north shore of lake, marked—
	M. C. on S. face; dug a pit, 3 ft. square, 1 ft. deep, 8 lks. N. of stone, and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, level.
	Soil, rich black loam.
	No timber.
	NOTE.—The meanders of this lake follow the subdivisions.
	At 10 a. m., August 15, va. has been diminished 5′ by diurnal change.
	North, bet. secs. 28 and 29.
	Va. 18° 30′ E.
	Over level bottom.
16. 30	Ascend about 10 ft., and thence over rolling ground.
40. 00	Set a sandstone, 18 × 16 × 3 ins., 12 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
44. 00	Telegraph line, course E.
48. 10	Road to Miles City, course E.
53. 50	Creek, 4 lks. wide, course S. E. Its source, a spring of clear water, about 6 ft. diam., bears N. 80° W., 3.25 chs. dist.
80. 00	Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for cor. to secs. 20, 21, 28, and 29, marked—
	T. 6 N., S 21, on N. E.;
	R. 34 E., S. 28, on S. E.;
	S. 29, on S. W., and
	S. 20, on N. W. faces, with two notches on S. and 4 notches on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, around post.
	Land, level and rolling.
	Soil, black loam and sandy; 1st and 2d rate.
	No timber.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	N. 89° 59′ E. on a random line bet. secs. 21 and 28. Va. 18° 30′ E.
40.00	Set temporary ¼ sec. cor.
79.40	Intersect N. and S. line 2 lks. N. of cor. to secs. 21, 22, 27, and 28.
	Thence I run
	West on a true line bet. secs. 21 and 28, with same va.
	Over level bottom land.
3.50	Ascend about twenty feet, thence over rolling ground.
39.70	Set a sandstone, 20 × 20 × 4 ins., 15 ins., in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
79.40	The cor. to secs. 20, 21, 28, and 29.
	Land, rolling and level.
	Soil, sandy and black loam; 1st and 2d rate.
	No timber.
	North, bet. secs. 20 and 21. Va. 18° 30′ E.
	Over rolling ground.
40.00	Deposited a marked stone, 12 ins. in the ground, for ¼ sec. cor.; dug pits, 18 × 18 × 12 ins., N. and S. of cor., 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, over it. In N. pit drove stake, 2 ft. long, 2 ins. square, 12 ins. in the ground, marked ¼ S. on W. face.
80.00	Set a sandstone, 18 × 15 × 3 ins., 12 ins. in the ground, for cor. to secs. 16, 17, 20, and 21, marked with 3 notches on S. and 4 notches on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, rolling.
	Soil, sandy; 2d rate.
	No timber.
	N. 89° 59′ E. on a random line between secs. 16 and 21. Va. 18° 30′ E.
40.00	Set temporary ¼ sec. cor.
79.72	Intersected N. and S. line at cor. to secs. 15, 16, 21, and 22.
	Thence I run
	S. 89° 59′ W. on true line bet. secs. 16 and 21, with same va.
	Over rolling ground.
3.00	Old military road, course N. W.
39.86	Set a post, 3 ft. long, 3 ins. square, with marked stone, 12 ins. in the ground, for ¼ sec. cor., marked ¼ S. on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of post, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, around post.
79.72	The cor. to secs. 16, 17, 20, and 21.
	Land, rolling.
	Soil, sandy; 2d rate.
	No timber.
	At 3 p. m., Aug. 15, the va. has been reduced 4′ by diurnal change.
	From the cor. to secs. 16, 17, 20, and 21 I run
	S. 89° 59′ W. on a true line bet. secs. 17 and 20, knowing that it will strike the easterly shore of Lin's Lake in less than 80 chs. Va. 18° 26′ E.
	Over rolling ground, descending.
15.00	Telegraph line, course N., soon bends to N. W.
20.00	Road to Williamsburg, course N.
40.00	Set a sandstone, 19 × 11 × 4 ins., 14 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
43.24	East bank of Lin's Lake. Set a sandstone, 30 × 15 × 8 ins., 22 ins. in the ground, for meander cor. to fractional secs. 17 and 20, marked M. C. on west side, and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, rolling.
	Soil, sandy; 2d rate.
	No timber.

Chains.	
	North, bet. secs. 16 and 17. Va. 18° 26′ E.
	Over rolling ground.
40.00	Set a sandstone, 20×12×4 ins., 15 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside. From cor., Wilkie's house bears N. 80° W.
44.60	A creek, 4 lks. wide, course S. W. Wilkie's house, bears S. 65° W. Westerly end of pond, area about 50 acres, bears N. E., about 15 chs. dist.
80.00	Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for cor. to secs. 8, 9, 16, and 17, marked— T. 6 N., S. 9, on N. E.; R. 34 E., S. 16, on S. E.; S. 17, on S. W., and S. 8, on N. W. faces, with 4 notches on S. and E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, rolling.
	Soil, sandy; 2d rate.
	No timber.

	N. 89° 59′ E. on a random line bet. secs. 9 and 16. Va. 18° 26′ E.
40.00	Set temporary ¼ sec. cor.
79.90	Intersect N. and S. line 20 lks. S. of cor. to secs. 9, 10, 15, and 16.
	Thence I run
	S. 89° 50′ W. on a true line bet. secs. 9 and 16, with same va.
	Over rolling ground.
39.95	Set a post, 3 ft. long, 3 ins. square, with marked stone, 12 ins. in the ground, for ¼ sec. cor., marked ¼ S. on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of post, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, around post. Northerly side of pond bears S. about 6.00 chains.
79.90	The cor. to secs. 8, 9, 16, and 17.
	Land, rolling.
	Soil, sandy; 2d rate.
	No timber.

	At 4.30 p. m., August 15, the variation has increased 2′ by diurnal change.
	North, bet. secs. 8 and 9. Va. 18° 28′ E.
	Over rolling ground.
38.10	Edge of limestone quarry, about 30 ft. deep, to avoid which I run west on an offset line 1.00 ch., thence north 2.50 chs., thence east 1.00 ch. to
40.60	On line on north side of quarry. Set a limestone, 30 × 12 × 8 ins., 22 ins. in the ground for witness cor. to ¼ sec. cor., marked W. C. ¼ on W. side, and raised a mound of stone, 1½ ft. high, 2 ft. base, alongside. Pits impracticable.
80.00	Set a limestone, 24 × 8 × 4 ins., 18 ins. in the ground, for cor. to secs. 4, 5, 8, and 9, marked with 5 notches on S. and 4 notches on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, rolling.
	Soil, sandy and light; 2d and 3d rate.
	No timber.

August 15, 1889.

	At 7 a. m., August 16, I find the last line run bears S. 18° 35′ E. (*magnetic* bearing).
	N. 89° 59′ E. on a random line bet. secs. 4 and 9. Va. 18° 35′ E.
40.00	Set temporary ¼ sec. cor.
79.84	Intersect N. and S. line 5 lks. S. of cor. to secs. 3, 4, 9, and 10.
	Thence I run
	S. 89° 57′ W. on a true line bet. secs. 4 and 9, with same va.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	Over rolling ground.
31.74	Wood road, course N. 20° E. Porter's house bears N. 40° E.
39.92	Set a limestone, 16 × 12 × 4 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on N. side; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
79.84	The cor. to secs. 4, 5, 8, and 9.
	Land, rolling.
	Soil, sandy and light; 2d and 3d rate.
	No timber.
	North on a random line bet. secs. 4 and 5.
	Va. 18° 35′ E.
40.00	Set temporary ¼ sec. cor.
79.96	Intersect N. boundary of township 19 lks. W. of cor. to secs. 4, 5, 32, and 33, which is a post, 4 ins square, marked—
	T. 7 N., S. 33, on N. E.;
	R. 34 E., S. 4, on S. E.;
	T. 6 N., S. 5, on S. W., and
	S. 32, on N. W. faces, with 4 notches on E. and 2 notches on W. edges, and mound of earth, 2 ft. high, 4½ ft. base, around post.
	Thence I run
	S. 0° 8′ W. on a true line bet. secs. 4 and 5, with same va.
	Over rolling ground.
39.96	Set a sandstone, 18 × 10 × 6 ins., 12 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face, and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
79.96	The cor. to secs. 4, 5, 8, and 9.
	Land, rolling.
	Soil, sandy and light; 2d and 3d rate.
	No timber.
	At 10.30 a. m., August 16, the variation has decreased 3′ by diurnal change.
	From the cor. to secs. 5, 6, 31, and 32, on the south boundary of the township, which is a sandstone, 5 × 8 × 4 ins. above ground, marked with 5 notches on E. and 1 notch on W. edges, with mound of earth, 2 ft. high, 4½ ft. base, alongside.
	I run
	North, bet. secs. 31 and 32.
	Va. 18° 32′ E.
	Over table land.
8.00	Indian trail, course N. 65° W. and S. 50° E.
40.00	Set a sandstone, 16 × 12 × 6 ins., 11 ins. in the ground, for ¼, sec. cor., marked ¼ on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
	From this cor. a cor. of James Parker's desert-land claim, a post, 8 ins. square, with mound of stone around post, marked J. P. D. L. C. 2, bears S. 20° E., 1.45 chs. dist. The land included in this claim was unsurveyed at date of location.
80.00	Set a sandstone, 20 × 14 × 6 ins., 15 ins. in the ground, for cor. to secs. 29, 30, 31, and 32, marked with 1 notch on S. and 5 notches on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, level, table.
	Soil, sandy; 2d and 3d rate.
	No timber.
	This evening I go to the S. W. cor. of the township,* in lat. 46° N., long. 107° 31′ W., set my compass over its center, with the limb and vernier clamped at zero, and before nightfall direct the telescope to a flag on cor. to secs. 25, 30, 31, and 36, which is plainly visible. After dark I loosen the clamp of vernier plate and direct the telescope to Po-

* This observation, here given as an illustration, properly belongs to subdivision of T. 6 N., R. 33 E.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	laris and at 7h 27m p. m., local mean time, the reading is 1° 31′ *east* of the range line. The *magnetic* bearing of the star is N. 16° 57′ W.

	h.	m.
Local astronomical mean time of observation is 1889, August 16	7	27.0
Tabular local m. t. U, C. of Polaris, August 15* (Table I), *subtract*	15	38.9
Diff. is *Hour Angle* of Polaris at obs.	15	48.1
Subtract from	23	56.0
Argument† for Table II	8	7.9

Azimuth of Polaris for lat. 46. (Tab. II)	1°	32′ *east.*
Reading of vernier	1	31 *east.*
The *diff.* is the true bearing of W. bdy. sec. 31	N.0°	1′ *east.*
Azimuth of Polaris	1°	32′ *east.*
N. end of needle	16	57 *east.*
Sum is the variation at this time	18°	29′ *edst.*

As I do not know exactly how much to allow for diurnal change, the mean declination will be determined at the sec. cor. above named, when I reach that point.

August 16, 1889.

At 7 a. m., August 17, the *magnetic* bearing of last line run (bet. secs. 31 and 32) is S. 18° 34′ E.
N. 89° 58′ E., on a random line bet. secs. 29 and 32.
Va. 18° 34′ E.

40.00 Set temporary ¼ sec. cor.

79.60 Intersect N. and S. line 9 lks. S. of cor. to secs. 28, 29, 32, and 33. Thence I run
S. 89° 54′ W. on a true line bet. secs. 29 and 32, with same va.
Over bottom land.

11.00 Commence ascent to table land.

15.00 Top of table land about 70 ft. high.

28.50 From this point a spring, about 2 ft. diam., bears S. about 3 chs. dist.
From spring a stream flows S. E.

39.80 Set a sandstone, 17 × 8 × 6 ins., in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of cor., 5½ ft dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside. From this point a post, 8 ins. square, with mound of stone around post, marked J. P. D. L. C. 4 for cor. to James Parker's desert-land claim, bears S. 17° E., 64 lks. dist.

79.60 The cor. to secs. 29, 30, 31, and 32.
Land, table and bottom.
Soil, sandy and black loam; 1st and 2d rate.
No timber.

S. 89° 58′ W.
West on a random line bet. secs. 30 and 31.
Va. 18° 34′ E.

40.00 Set temporary ¼ sec. cor.

79.18 Intersect west boundary of township 3 lks. N. of cor. to secs. 25, 30, **31,** and 36, which is a post, 4 ft. long, 4 ins. square, marked—
T. 6 N., S. 30, on N. E.;
R. 34 E., S. 31, on S. E.;
R. 33 E., S. 36, on S. W.;
S. 25, on N. W. faces, and with 5 notches on N. and 1 notch on S. edges, with mound of stone, 1½ ft. high, 2 ft. base, around post.
NOTE.—From this corner at 8 a. m. I take the *magnetic* bearing of the S. W. cor. of the township and find it to be S. 18° 33′ E.; its *true* bear-

* See pages 78 and 81,

† See foot note, page 80.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	ing is S. 0° 01′ W., determined last night; consequently, S. 18° 34′ E. is the *magnetic* bearing of the *true meridian*, and the variation is 18° 34′ E. Subtracting 6′ (reduction to mean magnetic meridian) leaves the *mean* declination 18° 28′ east.*
	Thence I run
	N. 89° 57′ E. on a true line, bet. secs. 30 and 31.
	Va. 18° 34′ E.
	Over table land.
39.18	Set a sandstone, 20 × 12 × 8 ins., 15 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside. From this point a post, 8 ins. square, with mound of stone around post, marked J. P. D. L. C. 8, for cor. to James Parker's desert-land claim, bears S. 80° E., 87 lks dist.
79.18	The cor. to secs. 29, 30, 31, and 32.
	Land, table.
	Soil, sandy; 2d and 3d rate.
	No timber.
	At 9.30 a. m., August 17, the variation has decreased 2′ by diurnal change.
	North bet. secs. 29 and 30.
	Va. 18° 32′ E.
	Over table land.
40.00	Set a post, 3 ft. long, 3 ins. square, with marked stone, 12 ins. in the ground, for ¼ sec. cor., marked ¼ S. on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of post, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, around post.
	From this cor. a post, 8 ins. square, with mound of stone around post, marked J. P. D. L. C. 6, for cor. to James Parker's desert land claim, bears S. 30° E., 1.47 chs. dist.
55.00	Telegraph line, course E. and W.
60.00	Road to Miles City, course E. and W.
76.10	Edge of table land, and descend gradually.
80.00	A point about 30 ft. below table land. Set a sandstone, 30 × 12 × 8 ins., 23 ins. in the ground, for cor. to secs. 19, 20, 29, and 30, marked with 2 notches on S. and 4 notches on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, table.
	Soil, sandy; 2d and 3d rate.
	No timber.
	At 10.30 a. m., August 17, the variation has decreased 2′ by diurnal change.
	N. 89° 58′ E. on random line bet. secs. 20 and 29.
	Va. 18° 30′ E.
40.00	Set temporary ¼ sec. cor.
79.77	Intersect N. and S. line 10 lks. S. of cor. to secs. 20, 21, 28, and 29.
	Thence I run
	S. 89° 54′ W. on a true line bet. secs. 20 and 29, with same va.
15.00	Telegraph line, course N.
19.00	Road to Williamsburg, course N.
39.88	Set a sandstone, 20 × 12 × 3 ins., 15 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
79.77	The cor. to secs. 19, 20, 29, and 30.
	Land, rolling.
	Soil, sandy; 2d rate.
	No timber.

*This observation, here given as an illustration, properly belongs to subdivision of T. 6 N., R. 33 E.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	S. 89° 58′ W. on a random line bet. secs. 19 and 30. Va. 18° 30′ E.
40.00	Set temporary ¼ sec. cor.
79.10	Intersect west boundary of township at cor. to secs. 19, 24, 25, and 30, which is a post, 4 ins. square, marked— T. 6 N., S. 19, on N. E.; R. 34 E., S. 30, on S. E.; R. 33 E., S. 25, on S. W., and S. 24, on N. W. faces, with 4 notches on N. and 2 notches on S. edges, and mound of stone covered with earth, 2 ft. high, 4½ ft. base, around post.
	Thence I run N. 89° 58′ E. on a true line bet. secs 19 and 30, with same va. Over rolling ground.
39.10	Set a sandstone, 18 × 12 × 8 ins., 12 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
79.10	The cor. to secs. 19, 20, 29, and 30. Land, rolling. Soil, sandy; 2d rate. No timber.
	North, bet. secs. 19 and 20. Va. 18° 30′ E.
	Over rolling ground, descending.
40.00	Set a sandstone, 20 × 11 × 6 ins., 15 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
44.18	South bank of Lin's Lake. Set a post, 4 ft. long, 4 ins. square, with marked stone, 12 ins. in the ground, for meander cor. to fractional secs. 19 and 20, marked M. C. on N. side, and T. 6 N., on S.; R. 34 E., S. 20, on E., and S. 19, on W. faces; dug pit, 3 ft. sq., 12 ins. deep, 8 lks. S. of post, and raised a mound of earth, 2 ft. high, 4½ ft. base, around post.
	Land, rolling. Soil, sandy; 2d rate. No timber. *August* 17, 1889.
	At the cor. to secs. 8, 9, 16, and 17, I find the *magnetic* bearing of line bet. secs. 16 and 17 to be S. 18° 35′ E. at 7.30 a. m. August 19, and run S. 89° 59′ W.* on a true line bet. secs. 8 and 17. Va. 18° 35′ E.
	Over rolling ground.
35.00	Telegraph line, course N. 60° W. and S.
40.00	Set a sandstone, 16 × 11 × 8 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
47.00	Road to Williamsburg, course N. W. and S. E.
80.00	Set a sandstone, 24 × 11 × 6 ins., 18 ins. in the ground, for cor. to secs. 7, 8, 17, and 18, marked with 4 notches on S. and 5 notches on E. edges; dug pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and raised a mound of earth, 2 ft. high, 4½ ft. base, alongside.
	Land, rolling. Soil, sandy; 2d rate. No timber.
	South, bet. secs. 17 and 18. Va. 18° 35′ E.
	Over even ground, descending.
20.19	North bank of Lin's Lake. Set a sandstone, 24 × 10 × 8 ins., 18 ins. in the ground, for meander cor. to fractional secs. 17 and 18, marked M. C. on S. side, and raised a mound of stone, 1½ ft. high, 2 ft. base, alongside. Pit impracticable.

* Parallel to S. boundary, sec. 32.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	Land, nearly level. Soil, sandy and black loam; 1st and 2d rate. No timber.
	S. 89° 58′ W. on a random line bet. secs. 7 and 18. Va. 18° 35′ E.;
40.00	Set temporary ¼ sec. cor.;
78.20	Intersect W. boundary of township 2 lks. N. of cor. to secs. 7, 12, 13, and 18, which is a post, 4 ins. square, marked— T. 6 N., S. 7, on N. E.; R. 34 E., S. 18, on S. E.; R. 33 E., S. 13, on S. W., and S. 12, on N. W. faces, with 2 notches on N. and 4 notches on S. edges, and mound of earth, 2 ft. high, 4½ ft. base, around post.
	Thence I run N. 89° 57′ E. on a true line bet. secs. 7 and 18, with same va. Over gently rolling ground.
5.50	Telegraph line, course N. E. and S. W.
6.60	Railroad, course N. E. and S. W.
16.10	Methodist church bears S. 45° E.
18.20	Intersect W. boundary line of town of Williamsburg. N. W. cor., which is a post, 12 ins. square, marked "T. S. 3," with mound of stone around post, bears N. 40 chs. S. W. cor., which is a post, 12 ins. square, marked "T. S. 4," with mound of stone around post, bears S. 29.75 chs.
19.10	Center of street, course N. and S.
21.45	Methodist church bears S. 13½° W.
25.00	Center of street, course N. and S.
30.00	Center of street, course N. and S.
30.10	Episcopal church bears N. 10° W., 4.50 chs. dist.
35.00	Center of Main street of Williamsburg, course N. and S. Court-house bears N.
38.20	Set a sandstone, 18 × 15 × 5 ins., 12 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
40.00	Center of street, course N. and S.
45.00	Center of street, course N. and S.
50.00	Center of street, course N. and S.
55.00	Intersect E. boundary line of town of Williamsburg. N. E. cor., which is a post, 12 ins. square, marked "T. S. 2," with mound of stone around post, bears N. 40 chs. S. E. cor., which is a post, 12 ins. square, marked "T. S. 1," with mound of stone around post, bears S., 7.35 chs.
78.20	The cor. to secs. 7, 8, 17, and 18. Land, rolling. Soil, sandy; 2d rate. No timber.
	At 10 a. m. August 19, the variation has decreased by diurnal change 4′. North, bet. secs. 7. and 8. Va. 18° 31′ E.
	Over rolling ground.
30.40	Telegraph line, course W.
30.50	Road to Williamsburg, course E. and W. changes to S. E. about 10 chs. E. of line.
40.00	Set a limestone, 20 × 15 × 8 ins., 15 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits, 18 × 18 × 12 ins., E. and W. of post, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, alongside.
80.00	Set a sandstone, 15 × 15 × 6 ins., 10 ins. in the ground, for cor. to secs. 5 6, 7, and 8, marked with 5 notches on S. and E. edges, and raised a mound of stone, 1½ ft. high, 2 ft. base, alongside. Pits impracticable.
	Land, rolling. Soil, sandy; 2d rate. No timber.

Subdivisions T. 6 N., R. 34 E.—Continued.

Chains.	
	N. 89° 58′ E. on a random line bet. secs. 5 and 8 Va, 18° 31′ E.
40.00	Set temporary ¼ sec. cor.
79.96	Intersected N. and S. line, 6 lks. S. of cor. to secs. 4, 5, 8, and 9.
	Thence I run
	S. 89° 55′ W. on a true line bet. secs. 5 and 8 with same va.
	Over rolling ground.
39.98	Set a post, 3 ft. long, 3 ins. square, with marked stone, 12 ins. in the ground, for ¼ sec. cor., marked ¼ S. on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of post, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, around post.
63.00	Road to Williamsburg, course S.
79.96	The cor. to secs. 5, 6, 7, and 8.
	Land, rolling.
	Soil, sandy; 2d rate.
	No timber.

	S. 89° 58′ W. on a random line between secs. 6 and 7. Va. 18° 31′ E.
40.00	Set temporary ¼ sec. cor.
78.40	Intersect west boundary of township 15 lks. N. of cor. to secs. 1, 6, 7, and 12, which is a post, 4 ft. long, 4 ins. square, marked— T. 6 N., S. 6, on N. E.; R. 34 E., S. 7, on S. E.; R. 33 E., S. 12, on S.W., and S. 1, on N.W. faces, with pits, 18 × 18 × 12 ins., in each sec., 5½ ft. dist., and mound of earth, 2 ft. high, 4½ ft. base, around post.
	Thence I run
	N. 89° 52′ E. on a true line bet. secs. 6 and 7 with same va.
	Over rolling ground.
38.40	Set a sandstone, 18 × 14 × 3 ins., 12 ins. in the ground, for ¼ sec. cor., marked ¼ on N. face; dug pits, 18 × 18 × 12 ins., E. and W. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ base, alongside.
53.00	Road to Williamsburg, course S.
78.40	The cor. to secs. 5, 6, 7, and 8.
	Land, rolling.
	Soil, sandy; 2d rate.
	No timber.

	North on a random line bet. secs. 5 and 6. Va. 18° 31′ E.
40.00	Set temporary ¼ sec. cor.
80.05	Intersect N. boundary of township 20 lks. W. of cor. to secs. 5, 6, 31, and 32, which is a sandstone, 8 × 12 × 6 ins., above ground, marked with 5 notches on E. and one notch on W. edges, and mound of stone, covered with earth, 2 ft. high, 4½ ft. base, alongside.
	Thence I run
	S. 0° 09′ W. on a true line bet. sec. 5 and 6, with same va.
	Over rolling ground
40.05	Set a sandstone, 16 × 12 × 3 ins., 11 ins. in the ground, for ¼ sec. cor., marked ¼ on W. face; dug pits, 18 × 18 × 12 ins., N. and S. of stone, 5½ ft. dist., and raised a mound of earth, 1½ ft. high, 3½ ft. base, along side.
80.05	The cor. to secs. 5, 6, 7, and 8.
	Land, rolling.
	Soil, sandy; 2d rate.
	No timber.

August 19, 1889.

Meanders of the right bank of the Yellowstone River, up stream.

I commence at the meander cor. to fractional secs. 31 and 36, on the east boundary of the township, which is a sandstone, 8 × 10 × 5 ins, above ground marked M. C. on N. side, with pit, 3 ft. sq., 1 ft. deep, 8 lks. S. of stone, with mound of earth, 2 ft. high, 4½ ft. base, alongside. At noon, August 9, the *magnetic* bearing of east boundary of sec. 36 is S. 18° 27′ E.
Thence I run with meanders in sec. 36.
Va. 18° 27′ E.
Bank, 20 ft. high.

S. 65¾° W.	4.00 chs.	
S. 78¼° W.	7.40 "	Lower end of bar bears N. 15° W. about 5.00 chs. dist.
S. 63¾° W.	7.60 "	At 6.60 chs. leave bluff bank; bank, 15 ft. high.
S. 89¾° W.	8.40 "	
N. 72½° W.	10.00 "	
N. 60° W.	7.60 "	Bank, 10 ft. high.
N. 33½° W.	4.70 "	
N. 50⅓° W.	7.80 "	At 1.90 chs. mouth of creek.
N. 60° W.	4.80 "	
N. 72½° W.	3.80 "	At 2.80 chs. enter Curran's field, fence course S.
N. 78½° W.	4.80 "	
S. 77½° W.	3.50 "	Bank, 6 ft. high.
N. 80½° W.	5.00 "	Leave Curran's field, fence bears S.
N. 71° W.	2.40 "	
N. 25½° W.	2.40 "	
N. 71½° W.	3.50 "	Low bank, 3 ft. high.
N. 76½° W.	1.40 "	To meander cor. to fractional secs. 35 and 36.

Land, 18 chs. W. part bluff; remainder level bottom.
Soil, black loam and sandy; 1st and 2d rate.
No timber.

Thence in sec. 35.
Va. 18° 27′ E.
In dense brush and scattering timber.

S. 8½° W.	3.00 chs.	
S. 75¾° W.	3.30 "	
S. 65° W.	2.30 "	Upper end of bar.
S. 35½° W.	11.00 "	At 6.00 chs. leave brush. At 7.50 chs. Curran's house bears S. 1.50 chs. At end of course, enter Alexander's field, fence course S.
S. 38¼° W.	5.60 "	
S. 46⅓° W.	9.00 "	
S. 54½° W.	5.00 "	At 3.00 chs. enter brush. At 4.00 chs. leave field.
S. 44½° W.	2.00 "	
S. 65° W.	2.60 "	At 50 lks. mouth of slough, 2.00 chs. wide.
S. 55¼° W.	8.70 "	
S. 55½° W.	2.80 "	
S. 48¾° W.	5.80 "	Leave scattering timber.
S. 56½° W.	8.70 "	Banks, 4 ft. high.
S. 40¼° W.	16.12 "	(At 12.00 chs. leave brush. Head of slough 1.00 ch. wide) to meander cor. to fractional secs. 2 and 35 on S. boundary of township, which is a sandstone, 20 × 10 × 8 ins., marked M. C. on west face with mound of stone, covered with earth, 2 ft. high, 4½ ft. base, alongside.

Land, level bottom.
Soil, black loam; 1st rate.
Timber and dense brush, cottonwood and willow, together 56.50 chs.
August 9, 1889.

Meanders of island contained in secs. 25, 26, 35 and 36.

This island is partly in this township and partly in T. 6 N., R. 35 E.
I go to the point for meander cor. to fractional secs. 31 and 36 on the south side of island, and finding cor. has been washed away, I re-established it as follows: I go to a cottonwood tree on line, which is described in field notes of the survey of the east boundary of this township as being 26.23 chs. S. of cor. to secs. 25, 30, 31, and 36, and run S. 3.02 chs. to south bank of island, making altogether 29.25 chs. instead of 29.70 chs. as stated in said notes. At this point
Set a post, 4 ft. long, 4 ins. square, 12 ins. in the ground, for meander cor. to fractional secs. 31 and 36, marked—
T. 6 N., on N.;
R. 35 E., S. 31, on E.;
M. C., on S., and
R. 34 E., S. 36, on W. faces, dug pit, 3 ft. sq., 1 ft. deep, 8 lks. N. of post, and raised mound of earth, 2 ft. high, 4½ ft. base, around post.
I find the magnetic bearing on the east boundary to be N. 18° 25′ W. at 1 p. m. August 7.
Thence I run with meanders in sec. 36.
Va. 18° 25′ E.
Through dense brush, up steam, banks 10 ft. high.

S. 70½° W.	2.40 chs.	Lower end of bar bears S.
S. 86° W.	3.00 "	Leave brush.
N. 81° W.	8.50 "	
N. 68½° W.	7.00 "	At 1.00 ch. enter timber and brush.
N. 73¾° W.	7.30 "	At 7.00 chs. leave timber and brush.
N. 84° W.	3.40 "	At 1.50 chs. center of head of slough, 3.00 chs. wide. At end of course, head of bar bears S. Enter brush.
N. 61½° W.	1.50 "	
N. 60¼° W.	3.50 "	
N. 53½° W.	2.50 "	
N. 61¾° W.	2.60 "	
N. 57¼° W.	4.90 "	Enter timber, leave brush.
N. 62¼° W.	8.20 "	
N. 71½° W.	4.80 "	
N. 77½° W.	5.80 "	
N. 88½° W.	5.40 "	Leave timber.
S. 80° W.	9.60 "	At 1.25 chs., mouth of slough, 2 chs. wide. At 2.50 chs. enter dense brush, and leave brush at end of course.
N. 88¾° W.	3.75 "	(At 2.00 chs., center of head of slough, 2.50 chs. wide) to meander cor. to fractional secs. 35 and 36 on S. W. end of island.

Land, level.
Soil, alluvial; 1st rate.
Timber and brush, cottonwood and willow; 71.70 chs.

Thence in sec. 35.
Va. 18° 25′ E.
Along low bank.

S. 79° W.	6.70 chs.	
N. 15½° W.	3.90 "	
N. 7¼° W.	3.40 "	
N. 17½° E.	3.80 "	
N. 50° E.	2.59 "	To meander cor. to fractional secs. 26 and 35.

Land, level.
Soil, alluvial; 1st rate.
No timber.

At 3.30 p. m. August 7 the va. has increased by diurnal change 3′.
Thence in sec. 26.
Va. 18° 28′ E.
N. 52¾° E. 6.05 chs. To meander cor. to fractional secs. 25 and 26.
Land, level.
Soil, alluvial; 1st rate.
No timber.

Meanders T. 6 N., R. 34 E.—Continued.

Meanders of island contained in secs. 25, 26, 35 and 36—Continued.

Thence in sec. 25.
Va. 18° 28′ E.
Enter brush; bank, 5 ft. high.

N. 64° E.	2.50 chs.		
N. 69¾° E.	8.80	"	At 5.00 chs. leave brush, enter heavy timber.
N. 63½° E.	9.40	"	Bank, 8 ft. high.
N. 63¾° E.	9.10	"	
N. 49° E.	4.30	"	
N. 33° E.	2.30	"	
N. 13¾° E.	9.00	"	Enter brush.
N. 46½° E.	4.80	"	Bank, 6 ft. high.
N. 27½° E.	7.30	"	
N. 34½° E.	4.70	"	Bank, 8 ft. high.
N. 45½° E.	4.60	"	
N. 61½° E.	17.00	"	
N. 74½° E.	11.00	"	
N. 89½° E.	7.10	"	
N. 54¾° E.	.69	"	To meander cor. to fractional secs. 25 and 30 on E. boundary of township, which is a sandstone, 8 × 12 × 8 ins., above ground, marked M. C. on N. face, from which

A cottonwood, 10 ins. diam., bears S. 28 W., 20 lks. dist., marked T. 6 N., R. 34. E., S. 25, M. C., B. T.
A cottonwood, 8 ins. diam., bears S. 45° E., 30 lks. dist., marked T. 6. N., R. 35 E., S. 30, M. C., B. T.
Land, level.
Soil, alluvial; 1st rate.
Timber and brush, cottonwood and willow; 102.49 chs.
This island has a rich alluvial soil, and is generally covered with fine cottonwood timber.

August 7, 1889.

Meanders of the left bank of the Yellowstone River, down stream.

At 11.30 a. m. August 9, the magnetic bearing of line between secs. 34 and 35 is N. 18° 30′ W.
I commence at the meander cor. to fractional secs. 2 and 35, on S. boundary of township, which is a sandstone, 5 × 15 × 2 ins., above ground, marked M. C. on E. face, with a mound of stone, 1½ ft. high, 2 ft. base, alongside.
Thence I run with meanders in sec. 35.
Va. 18° 30′ E.
Bank 6 ft. high.

N. 47° E.	2.80 chs.		
N. 37½° E.	6.30	"	
N. 31° E.	5.50	"	
N. 31½° E.	6.40	"	
N. 38½° E.	7.10	"	Bar in river bears S. 20° E. 1 ch. dist.
N. 27° E.	2.70	"	
N. 53½° E.	4.00	"	
N. 47½° E.	4.90	"	
N. 51½° E.	6.00	"	
N. 54½° E.	12.00	"	
N. 52½° E.	6.00	"	
N. 47¾° E.	3.90	"	
N. 40½° E.	8.50	"	At 7.00 chs. enter dense willow brush.
N. 28½° E.	7.60	"	
N. 31° E.	3.70	"	Leave brush.
N. 15½° E.	9.20	"	
N. 33½° E.	3.80	"	
N. 50½° E.	6.42	"	To meander cor. to fractional secs. 26 and 35.

Land, level.
Soil, alluvial; 1st rate.
No timber. 12.80 chs. of dense willow brush.

Meanders of the Left Bank of the Yellowstone River, etc.—Continued.

At 2.30 p. m. the variation has been reduced by diurnal change, 2′.
Thence in sec. 26.
Va. 18° 28′ E.
N. 59° E. 4.80 chs.
N. 45½° E. 7.80 "
N. 49° E. 2.05 " To meander cor. to fractional secs. 25 and 26.
Land, level.
Soil, alluvial; 1st rate.
No timber or brush.

Thence in sec. 25.
Va. 18° 28′ E.
N. 65½° E. 7.40 chs.
N. 63¼° E. 5.30 "
N. 61½° E. 12.00 " At 7.00 chs. head of slough, 2 chs. wide.
N. 40½° E. 5.60 "
N. 35° E. 7.70 "
N. 7½° E. 2.50 "
N. 1½° W. 2.70 " At 1.90 chs. mouth of slough, 1.50 chs. wide.
N. 41½° E. 9.00 "
N. 35° E. 1.70 "
N. 41° E. 4.60 "
N. 40¼° E. 5.60 " At 1.00 ch. enter cottonwood timber.
N. 54¾° E. 3.00 "
N. 54° E. 3.00 " At 2.00 chs. mouth of Short C. K., 10 lks. wide.
N. 49¾° E. 2.60 " Fletcher's Stage Station bears N. 6.50 chs. dist.
N. 62½° E. 11.30 "
N. 71° E. 5.50 "
S. 87½° E. 13.00 "
N. 67¼° E. 0.80 " To meander cor. to fractional secs. 25 and 30 on E. boundary of township, which is a sandstone, 6 × 12 × 6 ins., above ground, marked M. C. on S. face, from which
A cottonwood, 4 ins. diam., bears N. 73° E., 48 lks. dist., marked T. 6 N., R. 35 E., S. 30, M. C., B. T.
A cottonwood, 24 ins. diam., bears N. 27° W., 185 lks. dist., marked T. 6 N., R. 34 E., S. 25, M. C., B. T.
Land, level.
Soil, alluvial; 1st rate.
44.00 chs. of fine cottonwood timber.

August 9, 1889.

Meanders of a small lake in section 33.

I commence at the meander corner on the north side of the lake, which is a limestone, 4 × 12 × 6 ins., above ground, firmly set, marked—
M. C. on S. face, with a pit, 3 ft. sq. 1 ft. deep, 8 lks. N. of stone, and mound of earth, 2 ft. high, 4½ ft. base, alongside.
The *magnetic* bearing of ¼ S. C. bet. secs. 28 and 33 is N. 18° 35′ W. at 4 p. m., August 15.
Thence I run with meanders in sec. 33.
Va. 18° 35′ E.
S. 53° E. 17.75 chs. To outlet to lake, 10 lks. wide, course N. E.
S. 3° E. 13.00 "
S. 0½° W. 7.00 " Enter timber, bears S. W. and N. E.
S. 70° W. 15.70 " To meander corner on south side of lake previously described.
N. 63° W. 10.00 " Leave timber at 8.00 chs., bears N. and S.
N. 13° W. 21.00 " At 6.50 chs. clear stream of water, 8 lks. wide enters lake from N. 70° W. Along this line we discovered remarkable fossil remains of animals well worthy the attention of naturalists.
N. 52° E. 17.30 " To the place of beginning.

Meanders of a small lake in section 33—Continued.

This is a beautiful lake, with well defined banks 6 to 10 feet high.
The water is about 14 feet deep.
Land, rolling.
Soil, 1st rate.

August 15, 1889.

Meanders of easterly end of Lin's Lake in secs. 17, 18, 19, *and* 20.

I find the west boundary of fractional sec. 19 has a *magnetic* bearing of S. 18° 34′ E. at 7 a. m., August 20. The variation is therefore 18° 35′ W.
I commence at the meander cor. to fractional secs. 19 and 24 on west boundary of township, which is a post, 4 ft. long, 4 ins. sq., marked M. C. on N. face, with
T. 6 N., on S.;
R. 34 E., S. 19, on E., and
R. 33 E., S. 24, on W. faces; from which
A cottonwood, 24 ins. diam., bears S. 45° W., 11 lks. dist., marked T. 6 N., R. 33 E., S. 24, M. C., B. T.
A cottonwood, 20 ins. diam., bears S. 57° E., 14 lks. dist., marked T. 6 N., R. 34 E., S. 19, M. C., B. T.
Thence I run with meanders in sec. 19.
Var. 18° 35′ E.
Through cottonwood timber. Bank, 3 ft. high.

S. 59° E.	8.80 chs.	
S. 46½° E.	3.40 "	Leave timber.
S. 44½° E.	2.40 "	
S. 43¾° E.	5.70 "	
S. 43° E.	4.40 "	
S. 46½° E.	5.80 "	
S. 52¾° E.	5.80 "	
S. 53¾° E.	4.50 "	
S. 70½° E.	5.50 "	
S. 75½° E.	3.00 "	
S. 88½° E.	4.00 "	
N. 78° E.	9.60 "	At 6.00 chs. Smith's house bears S., 50 lks. dist.
S. 88½° E.	6.50 "	
S. 72½° E.	6.70 "	
S. 71½° E.	14.00 "	To meander cor. to fractional secs. 19 and 20.

Land, level.
Soil, sandy loam; 2d rate.
Timber, cottonwood; 12.20 chs.

Thence in sec. 20.
Va. 18° 35′ E.

N. 89° E.	6.20 chs.	
N. 55½° E.	11.50 "	
N. 32½° E.	9.90 "	
N. 48¾° E.	6.40 "	
N. 31½° E.	5.00 "	
N. 24¾° E.	3.90 "	
N. 22½° E.	2.10 "	
N. 33° E.	2.40 "	
N. 32½° E.	3.40 "	
N. 51¾° E.	3.30 "	To meander cor. to fractional secs. 17 and 20.

Land, level.
Soil, sandy loam; 2d rate.
No timber.

Meanders of easterly end of Lin's Lake, etc.—Continued.

At 10 a. m., Aug. 20, the variation has been decreased 5′ by diurnal change.
Thence in sec. 17.

Va. 18° 30′ E.

N. 20° E.	11.00	chs.	
N. 8½° W.	10.10	"	At 6.00 chs. mouth of ck., 5 lks. wide.
N. 83½° W.	2.00	"	
N. 76° W.	2.30	"	
N. 69¼° W.	7.00	"	
N. 83¾° W.	6.10	"	
N. 53¼° W.	8.00	"	
N. 20¼° W.	14.00	"	
N. 13¼° W.	6.80	"	
N. 39° W.	2.30	"	
N. 47½° W.	6.00	"	
N. 49¾° W.	5.00	"	
N. 55½° W.	3.50	"	
N. 49¼° W.	0.20	"	To meander cor. to fractional secs. 17 and 18.

Land, level.
Soil, sandy loam; 2d rate.
No timber.

Thence in sec. 18.

Va. 18° 30′ E.

N. 38¾° W.	15.00	chs.	
N. 63¾° W.	5.00	"	
S. 84° W.	13.00	"	At 10.28 chs. S. E. cor. town of Williamsburg.
S. 61¼° W.	19.00	"	At 3.08 chs. center of street, course N.
			At 8.79 chs. center of street, course N.
			At 14.49 chs. center of street, course N.
S. 43° W.	13.00	"	At 0.94 chs. center of main street, course N.
			At 8.27 chs. center of street, course N.
S. 55½° W.	4.00	"	At 2.15 chs. center of street, course N.
S. 74¾° W.	4.70	"	At 4.53 chs. S. W. cor. town of Williamsburg.
S. 85½° W.	5.60	"	
N. 88¼° W.	12.47	"	To meander cor. to fractional secs. 13 and 18 on W. boundary of township, which is a sandstone, 30 × 12 × 8 ins., marked M. C. on S face, with mound of earth, 2 ft. high, 4½ ft. base, along side.

Land, level.
Soil, sandy loam; 2d rate.
No timber.

August 20, 1889.

7 miles 36 chs. and 82 lks. of the subdivision lines run over mountainous land, or through timber; and 3 miles 59 chs. and 69 links of the meander lines run through timber or dense brush.

GENERAL DESCRIPTION.

This township contains nearly every variety of land from plains to mountains, and the soil ranges from alkali to rich loam. The soil of the bottom land along the Yellowstone River and on the island is generally rich, black loam, capable of producing abundant crops without irrigation. The soil of the remaining portion of the township, except the alkali flat in secs. 23 and 24, and the mountainous land, can nearly all be classed as second rate, is covered with an abundant growth of rich and nutritious grasses, and will produce crops without irrigation. In the southwestern portion of the township only the grass is more scanty, and irrigation may be necessary.

Cottonwood timber is found along the Yellowstone River, on the island, and some scattering along the creeks. The mountain is covered with a dense growth of pine and fir timber, many of the trees being very large.

There is one limestone quarry in secs. 8 and 9 which affords excellent building stones, and, from surface indications, it is probable that large bodies of limestone and sandstone underlie other portions of the township. Iron ore was found in sec. 3.

The mean declination for the plat, the average of three observations, is 18° 30′ east.

The township is well watered by the Yellowstone River, which runs through the southeastern portion, and many small springs and brooks. The eastern end, comprising only a small portion of Lin's Lake, is included in this township. This lake is about 10 miles long, and its greatest width about 4 miles. The water is clear and pure, and varies in depth from 10 to 200 feet.

The town of Williamsburg is the county seat of Custer County, contains a courthouse, two churches, two hotels, several stores, and about 50 dwelling-houses. Its estimated population is 300.

There are two settlers in sec. 35, and one each in secs. 4, 16, 17, 19, and 25.

James Parker has fenced a portion of his desert-land claim in sec. 32, and is boring an artesian well to bring water upon it.

ROBERT ACRES,
U. S. Deputy Surveyor.

FINAL OATHS FOR SURVEYS.

LIST OF NAMES.

A list of the names of the individuals employed by Robert Acres, U. S. deputy surveyor, to assist in running, measuring, and marking the lines and corners described in the foregoing field-notes of the survey of the subdivision and meander lines of township No. 6 north, of range No. 34 east of the principal base and meridian, in the State of Montana, showing the respective capacities in which they acted:

PETER LONG	Chainman.
JOHN SHORT	Chainman.
GEORGE SHARP	Axeman.
ADAM DULL	Axeman.
JAMES BANNER	Flagman.

FINAL OATHS OF ASSISTANTS.

We hereby certify that we assisted Robert Acres, U. S. deputy surveyor, in surveying all those parts or portions of the subdivision and meander lines of township No. 6 north, of range 34 east of the principal base and meridian, State of Montana, as are represented in the foregoing field-notes as having been surveyed by him and under his direction; and that said survey has been in all respects, to the best of our knowledge and belief, well and faithfully surveyed, and the corner monuments established, according to the instructions furnished by the U. S. surveyor-general for Montana.

PETER LONG, *Chainman.*
JOHN SHORT, *Chainman.*
GEORGE SHARP, *Axeman.*
ADAM DULL, *Axeman.*
JAMES BANNER, *Flagman.*

Subscribed and sworn to before me this twenty-third day of August, 1889.
[SEAL.]

HENRY DOOLITTLE,
Notary Public.

FINAL OATH OF U. S. DEPUTY SURVEYOR.

I, Robert Acres, U. S. deputy surveyor, do solemnly swear that in pursuance of a contract received from A——— B———, U. S. surveyor-general for Montana, bearing date of the twenty-second day of March, 1889, I have well, faithfully, and truly, in my own proper person, and in strict conformity with the instructions furnished by the U. S. surveyor-general for Montana, the manual of surveying instructions, and the laws of the United States, surveyed all those parts or portion of the subdivision and meander lines of township No. 6 north, of range No. 34 east of the principal base and meridian, in the State of Montana, as are represented in the foregoing field-notes as having been surveyed by me and under my directions; and I do further solemnly swear that all the corners of said survey have been established and perpetuated in strict accordance with the surveying manual, printed instructions, the special written instructions of the U. S. surveyor-general for Montana, and in the specific manner described in the field-notes, and that the foregoing are the *true* field-notes of such survey, and should any fraud be detected I will suffer the penalty of perjury under the provisions of an act of Congress approved August 8, 1846.

ROBERT ACRES,
U. S. Deputy Surveyor.

Subscribed by said Robert Acres, and sworn to before me this thirty-first day of August, 1889.

[SEAL.]

A —— B ——,
U. S. Surveyor-General for Montana.

To each of the original field-books, the surveyor-general will append his official approval, according to the following form, or so varied as to suit the facts in the case:

OFFICE OF THE U. S. SURVEYOR-GENERAL,
Helena, Montana, September 1, 1889.

The foregoing field-notes of the survey of [here describe the survey], executed by Robert Acres under his contract No. 87, dated March 22, 1889, having been critically examined, the necessary corrections and explanations made, the said field-notes, and the surveys they describe, are hereby approved.

A —— B——,
U. S. Surveyor-General.

To the copies of the field-notes transmitted to the General Land Office the surveyor-general will append the following certificate:

I certify that the foregoing transcript of the field-notes of the survey of the [here describe the character of the surveys, whether meridian, base line, standard parallel, exterior township lines, or subdivision lines, and meanders of a particular township], in the State [or Territory] of ....., has been correctly copied from the original notes on file in this office.

A—— B——,
U. S. Surveyor-General.

PRIVATE LAND CLAIM SURVEYS.

1. Before ordering any survey of a private land claim the surveyor-general will receive full instructions from this office, by which he will be governed in issuing his instructions to the deputy. The instructions to the deputy must be entered *in extenso* at the commencement of the field notes of such survey.

2. The instruments used in the survey of private land claims must be the same as those required for the survey of public lands, and must be registered and tested in like manner at the surveyor-general's office previous to the deputy's commencing work; and the instructions for the survey of public lands must, as far as applicable, be strictly observed in the survey of private land claims.

3. The true magnetic variation must be noted at the beginning point of each survey and at each angle thereof, and wherever the variation of the needle is observed to change along the line the same must be noted and the reasons therefor stated, if known.

4. At the end of each mile along a boundary the character of the soil and amount of timber, grass, etc., will be stated; and the date of each day's work in the field must be noted at the end of the record thereof.

5. The requirements in the "Summary of objects and data required to be noted," as set forth in the instructions for the survey of public lands, must be observed by the deputy in the survey of private land claims. Where practicable, bearings must be taken from at least two points on the line to all prominent or otherwise notable objects in the vicinity, and where only one bearing can be taken the estimated distance must be noted.

6. At the beginning point upon the out boundaries of each grant survey a corner must be established of the same character, size, and materials as prescribed for township corners upon the lines of the survey of public lands, except that only two pits will be dug, one on each side of the corner, on the line. Upon the side of such corner facing the claim the initial letters of the name of the grant, and immediately under the same the letters "Beg. Cor. 1" (for beginning corner one) must be neatly cut, chiseled, or affixed.

7 Each of the mile corners or stations of survey must be established in the manner prescribed for the establishment of section corners upon the lines of public surveys, except that they will be marked on the side facing the grant with the initials of the grant and the number of the station or mile, as the case may be; and only two pits will be dug, one on each side of the corner, on the line.

8. Where mile corners are established, except upon meandered portions of the line, half-mile corners will also be established in the manner prescribed for the establishment of quarter-section corners upon the

lines of public surveys, except that they will be marked upon the side facing the grant with the initials of the grant.

9. Such other marks, in addition to those above described, will be placed upon the corners as may be required by the surveyor-general in his special written instructions.

10. As far as practicable bearings and distances must be taken from each of the corners or stations to two or more trees, or prominent natural objects, if any, within a convenient distance, in the same manner as required in the instructions for the survey of public lands, and such trees or objects must be marked with the initials of the grant, and underneath same the letters "B. T." or "B. O.," as the case may be.

11. Witness corners will be established, where necessary, in the same manner as required in the instructions for the survey of public lands.

12. In all cases where the lines of the grant boundary surveys intersect the established lines of survey of public lands or private land claims the course and distance from such point of intersection to the nearest corner on the line of the prior survey must be carefully run, measured, and noted, and whenever necessary such corner must be re-established.

13. The survey of a private land claim must always be connected by a line actually run and measured in the field with some corner of the public surveys, if any such have been established within a distance not exceeding two miles from any point on the boundary lines of the private land claim.

14. Boundaries or portions of boundaries of previously established grant surveys, which also form a portion of the boundaries of the claim to be surveyed, will be adopted so far as common to both grants, but no payment will be made for such common boundaries unless it is necessary to re-establish same.

15. The field notes must embrace a full, clear, and concise statement of the reasons why each boundary is established.

16. A general description of each tract must be given at the end of the field notes of the survey of same, which description must embrace a brief statement of the main features of the tract surveyed, character of the land, timber, and other natural growth, kinds of mineral, if any, population of towns and settlements, characteristics of mountains, streams, springs, etc., and such other data as may be of importance.

17. The deputy must particularly note all facts relative to present inhabitancy of the land and designate all tracts occupied by actual settlers or residents.

18. The deputy surveyor must return with the field notes a topographical map or plat of the survey. As far as practicable all objects described in field notes, and the main features of the tract surveyed, including towns, streams, mountains, roads, etc., must be protracted on such plat as accurately as possible.

19. The field-note books must embrace a list of assistants, and preliminary and final oaths, as required in the instructions for the survey of public lands.

20. The deputy will note all objections to his survey that may be brought to his knowledge, and the surveyor-general will promptly report to this office all complaints made to him and send up all protests filed in his office, together with a full report thereon.

21. Official plats of the survey of private land claims will not be furnished to any person until the cost of surveying and platting same shall have been paid to the United States.