

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, 1902.

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1902.

DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE,
Washington, D. C., January 1, 1902.

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, your office assistants, and deputy surveyors.

All directions in conflict with these instructions are hereby abrogated.

In all official communications, this edition will be known and referred to as the Manual of 1902.

Very respectfully,

BINGER HERMANN,
Commissioner.

TO SURVEYORS GENERAL OF THE UNITED STATES.

MANUAL OF SURVEYING INSTRUCTIONS.

HISTORY OF LEGISLATION FOR SURVEYS.

1. The present system of survey of the public lands was inaugurated by a committee appointed by the Continental Congress, 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."

2. 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 records 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.

3. 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 |

4. 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 distance 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 townships, according as the error may be in running the lines from east to west or from south to north."

5. 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 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 * * * external boundary of such fractional township."

6. 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."

7. 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."

8. 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 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, 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 water course, and running back the depth of forty acres."

9. 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.

10. 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 last two acts 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.

11. 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 wording 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 directly 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.

12. 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."

13. 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."

14. The following comprises 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.

EXISTING LAND LAWS.—CHAPTER TWO.

THE GENERAL LAND OFFICE.

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.)

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.)

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.)

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

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.)

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.

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.)

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.)

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 disbursement of public moneys. (R. S., 2215, 2216.)

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.)

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 the 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.)

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.)

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.)

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.)

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.)

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.)

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.)

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.)

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.

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. (Act of May 18, 1796, and R. S., 2395.)

Boundaries and contents of public lands, how ascertained. 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:

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. (Act of Feb. 11, 1805, and 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, etc. 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 sur-

veyed in tracts of two acres in width, fronting on any river, bayou, lake, or watercourse, 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.)

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.)

SEC. 107. The printed manual of surveying instructions for the survey of the public lands of the United States, and private land claims, prepared at the General Land Office, and bearing date Jan. 1, 1902, 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 said Commissioner, shall be taken and deemed to be part of every contract for surveying the public lands of the United States and private land claims. (R. S., 2399, as amended by act approved April 26, 1902.)

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 specially order. (R. S., 2398.)

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 platting 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.)

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.)

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.) (See amending acts 20 Stat., 352, and 22 Stat., 327, and General Land Office Circular of Aug. 7, 1895, 21 L. D. 77.)

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.)

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 been 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.)

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.)

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.)

15. An act approved June 10, 1896, contains the following:

Provided further, That hereafter it shall be unlawful for any person to destroy, deface, change, or remove to another place, any section corner, quarter-section corner, or meander post, on any Government line of survey, or to cut down any witness tree or any tree blazed to mark the line of a Government survey, or to deface or remove any monument or bench mark of any Government survey. That any person who shall offend against any of the provisions of this paragraph shall be deemed guilty of a misdemeanor, and upon conviction thereof in any court shall be fined not exceeding two hundred and fifty dollars, or be imprisoned not more than one hundred days. All the fines accruing under this paragraph shall be paid into the treasury, and the informer, in each case of conviction, shall be paid the sum of twenty-five dollars. (29 Stat. L., 343.)

APPOINTMENT OF DEPUTY SURVEYORS.

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

17. The practice of issuing commissions to deputy public-land surveyors was discontinued in 1886. Since that time the awarding of a surveying contract has been regarded as the appointment of a deputy. This appointment and this authority cease with the execution and completion or other termination of such contract, which confers no

authority to perform work outside of the terms of the contract. An oath is required to be filed with each successive contract awarded to the same deputy. Any additional work required to be done under a contract, beyond its original terms, must be specially authorized by the Commissioner.

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

18. 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," 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."

19. In this section the deputy is required to make oath to the correctness of his work, "on the return" of his field notes to the surveyor general. The deputy is responsible for their accuracy; and the surveyor general and his assistants are not charged with the duty of assisting him to complete them, neither are they permitted to informally receive his returns not verified by oath, and put them through a process of examination and alteration when not legally and officially filed. As employees of the Government they should not lend their services to aid the deputy surveyor in performing duties that are required of him only, under his contract.

20. When a deputy surveyor has completed his returns of survey and placed them in the custody of the surveyor general for examination, his care of them and his privilege of alteration has ceased; although he may later be required officially to amend the same. When so deposited in the surveyor general's care, they are filed in his office, within the meaning of the statute. If not duly attested by oath and deposited for official action, the office is not justified in expending time and labor on the returns.

21. Upon receipt of the returns of a newly-executed contract, the surveyor general is charged with the duty of inspecting the same in

order to discover if on their face the deputy has carried out his instructions as to the proper execution of his contract, and to ascertain if the returns be incorrect, deficient or unworthy of acceptance. If upon an office examination the surveyor general finds inherent defects, necessitating a return to the field, the deputy must be so advised.

The surveyor general will also examine the returns for errors not in themselves requiring field correction, and require the deputy to submit supplemental field notes embodying the corrections duly sworn to, which will be attached to the deputy's original notes. In cases of errors manifestly clerical, the surveyor general may, at the request of the deputy, alter the notes by red-ink lines. In all cases of correction, the surveyor general will retain the original notes after filing.

When correct returns duly attested are finally submitted, the surveyor general will notify the Commissioner of the General Land Office, and proceed to prepare and forward the proper field notes to Washington.

22. All persons appointed deputy surveyors will deliver to the surveyor general their official oaths, 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., 190____,

A full record of all appointments of deputy surveyors, together with their official oaths, will be carefully preserved in the office of the surveyor general.

23. The deputy surveyor having been thus selected, and his oath of allegiance filed in the surveyor general's office, a contract 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 _____, 190____, 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 hereinafter 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 chainmen, axmen, flag-bearers, and moundmen as may be necessary, in strict conformity with the laws of the United States, the printed manual of surveying instructions, as revised and approved in 1902, and other surveying instructions issued by the Commissioner of the General Land Office, and with such special instructions as _____ 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 these 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 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 and connecting lines, except where the lines of survey pass over mountainous lands, or lands heavily timbered, or covered with dense undergrowth, and in such case at the rate of _____ dollars for base, standard, meridian, and meander lines, _____ dollars for township lines, and _____ dollars for section and connecting lines per mile, for every mile and part of mile actually run and marked in the field, random lines and offsets not included. The liability of this contract is limited not to exceed _____ dollars.

Provided, however, That no payment shall be made until the plats and field notes of the survey executed under this contract shall have been accepted by the Commissioner of the General Land Office.

It is further agreed by and between the parties to this agreement that no accounts shall be paid unless properly certified by the surveyor general (or 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 — 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 _____, 190-.

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 to such special instructions as — may receive from the surveyor general in conformity therewith, make and execute the surveys which are required of — 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; otherwise, it shall remain in full force and virtue.

Signed, sealed, and acknowledged before us:

Residence: _____ [L. S.]
_____ [L. S.]
Residence: _____ [L. S.]
_____ [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 ^b _____.
Personal estate, valued at \$_____, and consisting of ^c _____.

Signature: _____,
(Post-office address:) _____.

Sworn to and subscribed before me this _____ day of _____, 190-_____.
[SEAL.] _____,

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 ^b _____.
Personal estate, valued at \$_____, and consisting of ^c _____.

Signature: _____,
(Post-office address:) _____.

Sworn to and subscribed before me this _____ day of _____, 190-_____.
[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 hereunto set my hand and affixed the seal of _____ this _____ day of _____, one thousand nine 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 _____.

* Attach an adhesive seal after each signature and covering L. S.
^b Here state whether city property, improved or unimproved, or improved farms, or unimproved lands, and where situated.
^c Here describe the nature of the property, whether bonds, stocks, merchandise, etc.

1. The names of the U. S. 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 signatures 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 day 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 bond 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.

[See Plates II and III.]

24. Existing law requires that in general the public lands of the United States "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 six miles square," and that the corners of the townships thus surveyed "must be marked with progressive numbers from the beginning."

Also, that the townships shall be subdivided into thirty-six sections, each of which shall contain six hundred and forty acres, as nearly as may be, by a system of two sets of parallel lines, one governed by true meridians and the other by parallels of latitude, the latter intersecting the former at right angles, at intervals of a mile.

25. In the execution of the public surveys under existing law, it is apparent that the requirements that the lines of survey shall conform to true meridians, and that the townships shall be 6 miles square, taken together, involve a mathematical impossibility due to the convergency of the meridians.

Therefore, to conform the meridional township lines to the true meridians produces townships of a trapezoidal form which do not contain the precise area of 23,040 acres required by law, and which discrepancy increases with the increase in the convergency of the meridians, as the surveys attain the higher latitudes.

26. In view of these facts, and under the provisions of section 2 of the act of May 18, 1796, that sections of a mile square shall contain 640 acres, as nearly as may be, and also under those of section 3 of the act of May 10, 1800, that "in all cases where the exterior lines of the townships, thus to be subdivided into sections and 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 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 public lands of the United States shall be surveyed under the methods of the system of rectangular surveying, which harmonizes the incompatibilities of the requirements of law and practice, as follows:

First. The establishment of a principal meridian conforming to the true meridian, and, at right angles to it, a base line conforming to a parallel of latitude.

Second. The establishment of standard parallels conforming to parallels of latitude, initiated from the principal meridian at intervals of 24 miles and extended east and west of the same.

Third. The establishment of guide meridians conforming to true meridians, initiated upon the base line and successive standard parallels at intervals of 24 miles, resulting in tracts of land 24 miles square, as nearly as may be, which shall be subsequently divided into tracts of land 6 miles square by two sets of lines, one conforming to true meridians, crossed by others conforming to parallels of latitude at intervals of 6 miles, containing 23,040 acres, as nearly as may be, and designated townships.

Such townships shall be subdivided into thirty-six tracts, called sections, each of which shall contain 640 acres, as nearly as may be, by two sets of parallel lines, one set parallel to a true meridian and the other conforming to parallels of latitude, mutually intersecting at intervals of 1 mile and at right angles, as nearly as may be.

27. Any series of contiguous townships or sections situated north and south of each other constitutes a RANGE, while such a series situated in an east and west direction constitutes a TIER.

The accompanying diagram (Plate II), and the specimen field notes (page 147), 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 the exterior lines of townships, and the order and mode of subdividing townships will be found illustrated in the accompanying specimen field notes (page 159), conforming with the township plat (Plate III). The method here presented is designed to insure a full compliance with every practicable requirement, meaning, and intent of the surveying laws.

28. By the terms of the original law and by general practice, section lines were surveyed from south to north and from east to west, in order to uniformly place excess or deficiency of measurement on the north and west sides of the townships. But under modern conditions many cases arise in which a departure from this method is necessary. Where the west or the north boundary is sufficiently correct as to course, to serve as a basis for rectangular subdivision, and the opposite line is defective, the section lines should be run by a reversed method.

For convenience the well-surveyed lines on which subdivisions are to be based, will be called governing boundaries of the township. The rules provided for thus securing rectangular work are given on pages 55 to 61.

29. The tiers of townships will be numbered, to the north or south, commencing with No. 1, at the base line; and the ranges of the townships, to the east or west, beginning with No. 1, at the principal meridian of the system.

30. 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, to number thirty-six in the southeast angle. In all cases of surveys of fractional townships, the sections will bear the same numbers they would have if the township was full; and where doubt arises as to which section numbers should be omitted, the proper section numbers will be used on the side or sides which are governing boundaries, leaving any deficiency to fall on the opposite sides.

31. Standard parallels (formerly called correction lines) shall be established at intervals of 24 miles, north and south of the base line, and guide meridians at intervals of 24 miles, east and west of the principal meridian; thus confining the errors resulting from convergence of meridians and inaccuracies in measurement within comparatively small areas.

INSTRUMENTS AND THEIR ADJUSTMENTS.

32. The surveys of the public lands of the United States, embracing the establishment of base lines, principal meridians, standard parallels, meander lines, and the subdivisions of townships, will be made with instruments provided with the accessories necessary to determine a direction with reference to the true meridian, independently of the magnetic needle.

33. Burt's improved solar compass, or a transit of approved construction, with or without solar attachment, will be used in all cases. When a transit without solar attachment is employed, Polaris observations and the retracements necessary to execute the work in accordance with existing law and the requirements of these instructions will be insisted upon. Observations every clear night will be necessary to secure accuracy in the direction of transit reference lines, when solar apparatus is not used. The method of connecting surveys with the stellar meridian should distinctly appear in the field notes, as evidence that the courses were not derived from the magnetic needle.

34. Deputies using instruments with solar apparatus will be required to make observations on the star Polaris at the beginning of every survey, and whenever necessary to test the accuracy of the solar apparatus.

Observations required to test the adjustments of the solar apparatus will be made at the corner where the survey begins, or at the camp of the deputy surveyor nearest said corner; and in all cases the deputy will fully state in the field notes the exact location of the observing station.

35. Deputy surveyors will examine the adjustments of their instruments, and take the latitude daily, weather permitting, while running all lines of the public surveys. (For directions see page 153.) They will make complete records in their field notes, under proper dates, of the making of all observations in compliance with these instructions, showing the character and condition of the instrument in use, and the precision attained in the survey, by comparing the direction of the line run with the meridian determined by observation.

36. On every survey executed with solar instruments, the deputy will, at least once on each working day, record in his field notes the proper reading of the latitude arc; the declination of the sun, corrected

for refraction, set off on the declination arc; and note the correct local mean time of his observation, which, for the record, will be taken at least two hours from apparent noon.

In field inspection of contract surveys, the examiners are required to obtain the meridian, both by solar and stellar observations, testing their instruments fully before reporting on the courses of the deputy's lines. Hence no deputy should incur risk by omitting any of the safeguards here required as essential to accurate work.

37. The construction and adjustments of all surveying instruments used in surveying the public lands of the United States will be tested at least once a year, and oftener, if necessary, on the true meridian, established under the direction of the surveyor general of the district; and if found defective, the instruments shall undergo such repairs or modifications as may be found necessary to secure the closest possible approximation to accuracy and uniformity in all field work controlled by such instruments.

38. The instruments for measuring lines are the chain and pins. Each deputy will be provided with a standard steel chain or steel tape of approved style, precisely adjusted to the standard measures kept by the surveyor general. The deputy's standard measure will not be used on the field work, but be carefully preserved in camp and used for purposes of frequent comparison with his field chains or steel tapes, in order that changes due to constant use may be discovered at the beginning of each day's work. All his returns of distance will be made in miles, chains, and links, a chain of 100 links being equal to 66 feet. Engineers' chains reading by feet only are not to be used in public-land surveys. Distances of height or depth may be given in feet or inches. In these details the specimen field notes are to be observed.

39. The simple conditions imperatively demanded for all accurate measurements are specified in the chainman's oath, promising that he will level the chain upon even and uneven ground, will plumb the pins, either by sticking or dropping them, and will report the true distances. These brief rules, faithfully observed, will render chaining sufficiently exact to stand the test of inspection by strict examiners.

40. Before chainmen are entrusted with their actual duties, they should be exercised for practice and thoroughly instructed, under the eye of their employer, by chaining two or three times over one or more trial lines of hilly or mountainous surface, to ascertain the accuracy and uniformity of the results. The methods used by competent surveyors to obtain true horizontal distance over steep slopes, are too important to be disregarded, yet too elementary to be given here. When using only a portion of the chain, on steep hill-sides, especially in a strong wind, accuracy requires a plumb-line or some equivalent means, to mark the vertical. The dropping of flagged pins not loaded, too often in such cases leads to repeated and serious error, which may be avoided by dropping a more suitable object, such as a piece of metal carried in the pocket.

If any other methods of obtaining measurements up or down hills or across ravines be resorted to, except that here authorized, the facts will be stated in the returns, and the distances must well sustain the tests of the field examiner.

MARKING LINES BETWEEN CORNERS.

41. The marking of trees and brush along lines was required by law as positively as the erection of monuments, by the act of 1796, which is still in force. The old rules therefore are unchanged.

42. All lines on which are to be established the legal corner boundaries will be marked after this method, viz: Those trees which may be intersected by the line will have two chops or notches cut on the sides facing the line, 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, will be blazed on two sides diagonally or quartering toward the line, in order to render the line conspicuous, and readily to be traced in either direction, 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 toward the line, the farther the line passes from the blazed trees. In early surveys, an opposite practice prevailed.

43. Due care will 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. This can be attained only by blazing through the bark to the wood. Trees marked less thoroughly will not be considered sufficiently blazed. Where trees two inches or more in diameter occur along a line, the required blazes will not be omitted.

44. Lines are also to be marked by cutting away enough of the undergrowth of bushes or other vegetation to facilitate correct sighting of instruments. Where lines cross deep wooded valleys, by sighting over the tops, the usual blazing of trees in the low ground when accessible will be performed, that settlers may find their proper limits of land and timber without resurvey.

45. The practice of blazing a random line to a point some distance away from an objective corner, and leaving through timber a marked line which is not the true boundary, is unlawful, and no such surveys are acceptable. The decisions of some State courts make the marked trees valid evidence of the place of the legal boundary, even if such line is crooked, and has the quarter-section corner far off the blazed line.

46. On trial or random lines, therefore, the trees will not be blazed, unless occasionally, from indispensable necessity, and then it will 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 line and establish therefrom the true line. To prevent confusion, the temporary stakes set on the trial or random line will be removed when the surveyor returns to establish the true line.

47. The terms of each act making appropriation for compensation of surveys, allow increased pay for lines passing through lands "covered with dense undergrowth." The evident purpose of the increase is to compensate the surveyor for the additional labor and delay of cutting away brush and trees which obstruct the proper survey of the line, and also of blazing the line as required by law.

By dense undergrowth is meant thick bushes, boughs, or other vegetable growth of such height as to obstruct the use of the transit and

require cutting away to obtain sights along line; also bushes, brush, or vines, that are of such character as to seriously impede the work of traversing and chaining the line.

48. Increased rates for heavy timber or dense undergrowth will not be allowed for lines on which no cutting away of brush is done or is necessary, or where blazing of timber is generally neglected, if these conditions shall be shown by field inspection.

INSUPERABLE OBJECTS ON LINE—WITNESS POINTS.

49. Under circumstances where the survey of a township or section line is obstructed by an impassable obstacle, such as a pond, swamp, or marsh (not meanderable), the line will be prolonged across such obstruction by making the necessary right-angle offsets (Plate III, sec. 22); or, if such proceeding be impracticable, a traverse line will be run, or some proper trigonometrical operation employed to locate the line on the opposite side of the obstruction; and in case the line, either meridional or latitudinal, thus regained, is recovered beyond the intervening obstacle, said line will be surveyed back to the margin of the obstruction and all the particulars, in relation to the field operations, will be fully stated in the field notes.

50. As a guide in alinement and measurement, at each point where the line intersects the margin of an obstacle, a witness point will be established, except when such point is less than 20 chains distant from the true point for a legal corner which falls in the obstruction, in which case a witness corner will be established at the intersection. (See Plate III, section 22; also Witness Points and Witness Corners, page 52.)

51. In a case where all the points of intersection with the obstacle to measurement fall more than 20 chains from the proper place for a legal corner in the obstruction, and a witness corner can be placed on the offset line within 20 chains of the inaccessible corner point, such witness corner will be established. (See Plate III, south boundary of section 16.)

ESTABLISHING CORNERS.

52. To procure the faithful execution of this part of a surveyor's duty is a matter of the utmost importance. After true coursing and most exact measurements, the establishment of corners is the consummation of the field work. Therefore, if the corners be not perpetuated in a permanent and workmanlike manner, the principal object of surveying operations will not have been attained.

The points at which corners will be established are fully stated in the several articles: "Base Lines," "Principal Meridians," "Standard Parallels," etc., following the title "Initial Points," page 55.

53. All marking of letters and figures should be done neatly, distinctly, and durably, using the tools best adapted to the purpose, and keeping them in good order. These tools are the chisel and hammer for marking stones, and the scribing-tool or gouge for surfaces of wood. Since the greatest permanency requires stone corner monuments, and the perishable nature of wood prohibits its use where stones can be found or brought, the deputy should be provided with good chisels, to enable him to mark neatly and expeditiously, using arabic figures for all numbers.

SURVEYING MONUMENTS.

54 These consist of what is called the corner, and its accessories. The corner itself should be durable and firmly imbedded. It may consist of an iron monument, rod, or pipe, a cross cut on a ledge, or a marked stone; or in case these can not be obtained, then a post of durable timber. Where a stone corner has to be set upon a ledge of surface rock, it should be of large size and supported in a well-built stone mound, with its marks well shown; in addition to which, the usual witness mound will be separately built.

55. The accessories are needed to witness and identify the corner as a monument of public survey, and may consist of the following, mentioned in the order of their value and desirability:

Bearing objects, such as notable cliffs, rocks, boulders, etc., marked with a cross, the letters B. O, and a section number.

Memorials, buried 12 to 24 inches under the surface at the corner, such as glass or stone ware, potsherds, marked stones, cast iron, charcoal, or charred stake.

Pits of proper size and arrangement.

Mound of stones, at proper position and distance from the corner.

Bearing trees, blazed and marked as required.

Stake in pit, with letters and figures necessary.

Mound of earth, which in many regions is the least durable and useful of all accessories.

DESCRIPTIONS OF CORNERS.

56. The form and language used in the following articles, in describing, for each one of the thirteen classes of corners, eight specific constructions and markings, with the stated modifications in certain cases, will be carefully followed by deputy surveyors in their field notes; and their field work will strictly comply with the requirements of the descriptions.

57. When pits and mounds of earth are made accessories to corners, the pits will always have a rectangular plan; while the mounds will have a conical form, with circular base; and in all cases both pits and mounds will have dimensions at least as great as those specified in the descriptions. Deputy surveyors will strictly adhere to these provisions, and no departure from the stated requirements will be permitted, either in instructions or practice in the field. (See Plates IV and V.)

58. Referring to the numbered paragraphs, the corners described in "3" will be preferred to those described in either "1" or "2", when corners are established in loose, sandy soil, and good bearing trees are available; under similar conditions, the corners described in "5" and "8" will be preferred to those described in "4" and "7", respectively.

59. The selection of the particular construction to be adopted in any class will be left, as a matter of course, to the judgment and discretion of the deputy, who will assign the greatest weight to the durability of the corner materials and permanency of the monuments.

ABBREVIATIONS ALLOWED IN RETURNS.

60. Dimensions of stones, posts, and pits should for brevity be expressed in a regular manner, in consecutive order of length, breadth,

and thickness, as shown in specimens; for instance, "a stone 23 x 10 x 8 ins." To describe a mound, the material, the altitude, and diameter of base will be given, as "mound of earth 4 ft. base, 2½ ft. high."

The following contractions are authorized to be used in the preparation of field notes, transcripts, inspection reports and similar records, and no others should be introduced. The arrangement of lines, blanks, spaces, numbers, and the general form of the specimen notes should be observed:

| | | | |
|-------------|------------------------|--------------|---------------------------|
| A. | for acres. | mag. | for magnetic. |
| a. m. | " forenoon. | M. C. | " meander corner. |
| A. M. C. | " aux. meander corner. | mer. | " meridian. |
| asc. | " ascend. | mkd. | " marked. |
| astron. | " astronomical. | N. | " north. |
| bdy. | " boundary. | NE. | " northeast. |
| bdrs. | " boundaries. | NW. | " northwest. |
| bet. | " between. | obs. | " observe. |
| B. O. | " bearing object. | obsn. | " observation. |
| B. T. | " bearing tree. | p. m. | " afternoon. |
| C. C. | " closing corner. | Pol. | " Polaris. |
| chs. | " chains. | Pr. Mer. | " principal meridian. |
| cor., corn. | " corner, corners. | Pt. of Tr. | " point of triangulation. |
| corr. | " correction. | ¼ sec. | " quarter section. |
| decl. | " declination. | R., Rs. | " range, ranges. |
| dep. | " departure. | red. | " reduce, reduction. |
| desc. | " descend. | S. | " south. |
| dia. | " diameter. | S. C. | " standard corner. |
| diff. | " difference. | SE. | " southeast. |
| dist. | " distance. | sec., secs. | " section, sections. |
| D. S. | " deputy surveyor. | S. M. C. | " special meander corner. |
| E. | " east. | sq. | " square. |
| elong. | " elongation. | St. Par. | " standard parallel. |
| frac. | " fractional. | SW. | " southwest. |
| ft. | " foot, feet. | T., or Tp. | " township. |
| G. M. | " guide meridian. | Ts., or Tps. | " townships. |
| h., hrs. | " hour, hours. | temp. | " temporary. |
| ins. | " inches. | U. C. | " upper culmination. |
| lat. | " latitude. | var. | " variation. |
| L. C. | " lower culmination. | W. | " west. |
| lks. | " links. | W. C. | " witness corner. |
| l. m. t. | " local mean time. | w. corr. | " watch correction. |
| long. | " longitude. | W. P. | " witness point. |
| m. | " minutes. | w. t. | " watch time. |

AUTHORIZED FORMS AND DESCRIPTIONS OF CORNERS.

61. The forms given below will guide the surveyor in the choice and erection of monuments and accessories, and the same forms will be followed in preparing field notes. In case a deputy is compelled to choose another style of corner, he should state in his notes the reasons that made it necessary to depart from the rules, and should erect a monument of equal or greater permanence than the one prescribed.

62. The punctuation marks heretofore shown in former editions, to be used with letters and figures on stones, posts, and trees, are now omitted, for the reason that they are neither made, nor desired to be made, in the actual field work, and hence should not be inserted in the official returns.

63. The stated dimensions of posts are minimum; if posts are longer than 3 feet, the extra length will be placed in the ground; the posts will in no case project more than 12 ins. above the natural surface of the earth.

STANDARD TOWNSHIP CORNERS.

[See Plates II and IV.]

64. When more than one-half of all the standard township and section corners on any 6 miles of a base line or standard parallel are stone corners, the descriptions in paragraphs 1 and 2, if the corners therein described are established, will be modified as follows: Strike out "S C on N." After "marked," insert the words:

"S C 13 N on N.,
22 E on E., and
21 E on W. face."

When under the conditions above specified the corner described in paragraph 1 is established, a stake may be driven in the east pit and marked instead of the stone, and described as exemplified in the last clause of paragraph 6, page 28.

1. Stone, with Pits and Mound of Earth.

Set a — stone, —×—×— ins., — ins. in the ground, for standard cor. of Tps. 13 N., Rs. 21 and 22 E., marked S C on N.; with 6 grooves on N., E., and W. faces; dig pits, 30×24×12 ins., crosswise on each line, E. and W., 4 ft., and N. of stone, 8 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ ft. high, N. of cor.

2. Stone, with Mound of Stone.

Set a — stone, —×—×— ins., — ins. in the ground, for standard cor. of Tps. 13 N., Rs. 21 and 22 E., marked S C on N.; with 6 grooves on N., E., and W. faces; and raise a mound of stone*, 2 ft. base, 1½ ft. high, N. of cor. Pits impracticable.

3. Stone, with Bearing Trees.

Set a — stone, —×—×— ins., — ins. in the ground, for standard cor. of Tps. 13 N., Rs. 21 and 22 E., marked S C on N.; with 6 grooves on N., E., and W. faces; from which

A —, — ins. diam., bears N. —° E., — lks. dist., marked^b
T 13 N R 22 E S 31 B T.

A —, — ins. diam., bears N. —° W., — lks. dist., marked
T 13 N R 21 E S 36 B T.

4. Post, with Pits and Mound of Earth.

Set a — post, 3 ft. long, 4 ins. sq., with marked stone (charred stake or quart of charcoal), 24 ins. in the ground, for standard cor. of Tps. 13 N., Rs. 22 and 23 E., marked

S C T 13 N on N.,
R 23 E S 31 on E., and

R 22 E S 36 on W. face; with 6 grooves on N., E., and W. faces; dig pits, 30 × 24 × 12 ins., crosswise on each line, E. and W., 4 ft., and N. of post, 8 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ ft. high, N. of cor.

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

^b All bearing trees will be marked with the township, range, and section in which they stand.

5. *Post, with Bearing Trees.*

Set a — post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for standard cor. of Tps. 13 N., Rs. 22 and 23 E., marked

S C T 13 N on N.,

R 23 E S 31 on E., and

R 22 E S 36 on W. face; with 6 grooves on N., E., and W. faces, from which

A —, — ins. diam., bears N. —° E., — lks. dist., marked

T 13 N R 23 E S 31 B T.

A —, — ins. diam., bears N. —° W., — lks. dist., marked

T 13 N R 22 E S 36 B T.

6. *Mound of Earth, with Deposit, and Stake in Pit.*

Deposit a marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for standard cor. of Tps. 13 N., Rs. 22 and 23 E.; dig pits, 30×24×12 ins., crosswise on each line, N., E., and W. of cor., 5 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ ft. high, over deposit.

In E. pit drive a — stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked

S C T 13 N on N.,

R 23 E S 31 on E., and

R 22 E S 36 on W. face; with 6 grooves on N., E., and W. faces.

7. *Tree Corner, with Pits and Mound of Earth.*

A —, — ins. diam., for standard cor. of Tps. 13 N., Rs. 22 and 23 E., 1 mark

S C T 13 N. on N.,

R 23 E S 31 on E., and

R 22 E S 36 on W. side, with 6 notches on N., E., and W. sides; dig pits, 24×18×12 ins., crosswise on each line, N., E., and W. of cor., 5 ft. dist.; and raise a mound of earth around tree.

8. *Tree Corner, with Bearing Trees.*

A —, — ins. diam., for standard cor. of Tps. 13 N., Rs. 22 and 23 E., 1 mark

S C T 13 N on N.,

R 23 E S 31 on E., and

R 22 E S 36 on W. side; with 6 notches on N., E., and W. sides; from which

A —, — ins. diam., bears N. —° E., — lks. dist., marked

T 13 N R 23 E S 31 B T.

A —, — ins. diam., bears N. —° W., — lks. dist., marked

T 13 N R 22 E S 36 B T.

CLOSING TOWNSHIP CORNERS.

[See Plates IV and V.]

65. *When more than one-half of all the township corners are stone corners, the descriptions in paragraphs 1 and 2, if the corners therein described are established, will be modified, as follows:* Strike out "C C on S.;" After "marked", insert the words

"C C 3 N on S.,

2 W on E., and

3 W on W. face."

When, under the conditions above specified, the corner described in paragraph 1 is established, a stake may be driven in the east pit, and marked instead of the stone, and described as exemplified in the last clause of paragraph 6, below.

1. *Stone, with Pits and Mound of Earth.*

Set a — stone, — × — × — ins., — ins. in the ground, for closing cor. of Tps. 4 N., Rs. 2 and 3 W., marked C C on S.; with 6 grooves on S., E., and W. faces; dig pits, 30 × 24 × 12 ins., crosswise on each line, E. and W., 4 ft., and S. of stone, 8 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ ft. high, S. of cor.

2. *Stone, with Mound of Stone.*

Set a — stone, — × — × — ins., — ins. in the ground, for closing cor. of Tps. 4 N., Rs. 2 and 3 W., marked C C on S.; with 6 grooves on S., E., and W. faces; and raise a mound of stone, 2 ft. base, 1½ ft. high, S. of cor. Pits impracticable.

3. *Stone, with Bearing Trees.*

Set a — stone, — × — × — ins., — ins. in the ground, for closing cor. of Tps. 4 N., Rs. 2 and 3 W., marked C C on S.; with 6 grooves on S., E., and 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.

4. *Post, with Pits and Mound of Earth.*

Set a — post, 3 ft. long, 4 ins. sq., with marked stone (charred stake or quart of charcoal), 24 ins. in the ground, for closing cor. of Tps. 4 N., Rs. 2 and 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. face; with 6 grooves on S., E., and W. faces; dig pits, 30 × 24 × 12 ins., crosswise on each line, E. and W., 4 ft., and S. of post 8 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ feet high, S. of cor.

5. *Post, with Bearing Trees.*

Set a — post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for closing cor. of Tps. 4 N., Rs. 2 and 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. face; with 6 grooves on S., E., and 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.

6. *Mound of Earth, with Deposit, and Stake in Pit.*

Deposit a marked stone (charred stake or quart of charcoal), 12 ins. in the ground, for closing cor. of Tps. 4 N., Rs. 2 and 3 W.; dig pits, 30 × 24 × 12 ins., crosswise on each line, S., E., and W. of cor., 5 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ ft. high, over deposit.

In E. pit, drive a — stake 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked

C C T 4 N on S.,

R 2 W S 6 on E., and

R 3 W S 1 on W. face; with 6 grooves on S., E., and W. faces.

7. *Tree Corner, with Pits and Mound of Earth.*

A —, — ins. diam., for closing cor. of Tps. 4 N., Rs. 2 and 3 W., I mark

C C T 4 N on S.,

R 2 W S 6 on E., and

R 3 W S 1 on W. side, with 6 notches on S., E., and W. sides; dig pits, 24 × 18 × 12 ins., crosswise on each line, S., E., and W. of cor., 5 ft. dist.; and raise a mound of earth around tree.

8. *Tree Corner, with Bearing Trees.*

A —, — ins. diam., for closing cor. of Tps. 4 N., Rs. 2 and 3 W., I mark

C C T 4 N on S.,

R 2 W S 6 on E., and

R 3 W S 1 on W. side, with 6 notches on S., E., and W. sides; 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.

66. *Connecting Lines.*

All closing township corners on base lines or standard parallels, will be connected, by course and distance, with the nearest standard corner thereon; closing corners on all other lines, will be connected, in a similar manner, with the nearest township, section, or quarter section corner, or mile or half-mile monument, as existing conditions may require.

67. *Relative positions of Closing Corners, Pits, Mounds, and Bearing Trees.*

Any line, which by intersection with another surveyed line, determines the place for a closing corner, will be called a closing line; then in general, the mound and one pit of a closing corner will be placed on such "closing line," N., S., E., or W. of the closing corner, as prevailing conditions may require; while said mound and pit, with the two bearing trees (if used), will always be located on the same side of the line closed upon, and on which the other pits will be established, as directed in the foregoing descriptions, and illustrated on Plate V.

68. *Positions and Dimensions of Pits of Closing Corners on irregular boundaries.*

When a closing line intersects an irregular boundary at an angle less than 75°, and stone or post closing corners are established, the pit on the boundary adjoining the acute angle will be omitted, and the pit on the opposite side of the closing corner will have its dimensions increased, as follows: For a closing township corner, the enlarged pit will measure 42 × 36 × 12 ins.; for a closing section corner it will be 30 × 24 × 12 ins. (See Plate V, figs. 2 and 3.)

69. *Township or Section interfering Closing Corners.*

When two closing lines, at right angles to each other, intersect an irregular boundary at points less than 8 feet apart, and stone or post

corners are established, the pits, that under ordinary circumstances would be placed on the boundary, will be omitted, and the pits on the closing lines will have their dimensions increased to $36 \times 36 \times 12$ ins. (See Plate V, fig. 4, at *a* and *b*.)

70. *Positions and Dimensions of Pits and Mounds of interfering Closing Corners.*

When, under the conditions stated in paragraphs 68 and 69, the corners "Mound of Earth, with Deposit and Stake in Pit" are established, the pits on the boundary line will be omitted when the distance between the closing corners is less than 10 feet and greater than 4 feet, and the dimensions of the pits on the closing lines will be increased as directed in said paragraphs.

In case the distance between the closing corners is less than 4 feet, one mound, 5 ft. base, $2\frac{1}{2}$ ft. high, will cover the deposits of both closing corners. (See Plate V, fig. 4, at *c*, *d*, and *e*.)

CORNERS COMMON TO FOUR TOWNSHIPS.

[See Plate IV.]

71. *When more than one-half of all the corners of a township are stone corners, the descriptions in paragraphs 1 and 2, if the corners therein described are established, will be modified as follows: After "marked", insert the words*

"3 N on NE.,
2 W on SE.,
2 N on SW., and
3 W on NW. face;"

1. *Stone, with Pits and Mound of Earth.*

Set a — stone, — \times — \times — ins., — ins. in the ground, for cor. of Tps. 2 and 3 N., Rs. 2 and 3 W., marked with 6 notches on each edge; dig pits, $24 \times 24 \times 12$ ins., on each line, N., E., and W., 4 ft., and S. of stone, 8 ft. dist.; and raise a mound of earth, 5 ft. base, $2\frac{1}{2}$ ft. high, S. of cor.

2. *Stone, with Mound of Stone.*

Set a — stone, — \times — \times — ins., — ins. in the ground, for cor. of Tps. 2 and 3 N., Rs. 2 and 3 W., marked with 6 notches on each edge, and raise a mound of stone, 2 ft. base, $1\frac{1}{2}$ ft. high, S. of cor. Pits impracticable.

3. *Stone, with Bearing Trees.*

Set a — stone, — \times — \times — ins., — ins. in the ground, for cor. of Tps. 2 and 3 N., Rs. 2 and 3 W., marked with 6 notches on each edge, from which

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

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

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

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

4. *Post, with Pits and Mound of Earth.*

Set a — post, 3 ft. long, 4 ins. sq., with marked stone (charred stake or quart of charcoal), 24 ins. in the ground, for cor. of Tps. 2 and 3 N., Rs. 2 and 3 W., marked

T 3 N S 31 on NE.,

R 2 W S 6 on SE.,

T 2 N S 1 on SW., and

R 3 W S 36 on NW. face, with 6 notches on each edge; dig pits, 24×24×12 ins., on each line, N., E., and W., 4 ft., and S. of post, 8 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ ft. high, S. of cor.

5. *Post, with Bearing Trees.*

Set a — post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for cor. of Tps. 2 and 3 N., Rs. 2 and 3 W., marked

T 3 N S 31 on NE.,

R 2 W S 6 on SE.,

T 2 N S 1 on SW., and

R 3 W S 36 on NW., face., 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.

6. *Mound of Earth, with Deposit, and Stake in Pit.*

Deposit a marked stone (charred stake or quart of charcoal), 12 ins. in the ground, for cor. of Tps. 2 and 3 N., Rs. 2 and 3 W.; dig pits 24×24×12 ins., on each line, N., S., E., and W. of cor., 5 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ ft. high, over deposit.

In E. pit drive a — stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked

T 3 N S 31 on NE.,

R 2 W S 6 on SE.,

T 2 N S 1 on SW., and

R 3 W S 36 on NW. face, with 6 notches on each edge.

7. *Tree Corner, with Pits and Mound of Earth.*

A —, — ins. diam., for cor. of Tps. 2 and 3 N., Rs. 2 and 3 W., I mark

T 3 N S 31 on NE.,

R 2 W S 6 on SE.,

T 2 N S 1 on SW., and

R 3 W S 36 on NW. side, with 6 notches facing each cardinal point; dig pits, 24×18×12 ins., on each line, N., S., E., and W. of cor., 5 ft. dist.; and raise a mound of earth around tree.

8. *Tree Corner, with Bearing Trees.*

A —, — ins. diam., for cor. of Tps. 2 and 3 N., Rs. 2 and 3 W.,
I mark

T 3 N S 31 on NE.,

R 2 W S 6 on SE.,

T 2 N S 1 on SW., and

R 3 W S 36 on NW. side, with 6 notches facing each cardinal point;
from which

A —, — ins. diam., bears N. —^o E., — lks. dist., marked

T 3 N R 2 W S 31 B T.

A —, — ins. diam., bears S. —^o E., — lks. dist., marked

T 2 N R 2 W S 6 B T.

A —, — ins. diam., bears S. —^o W., — lks. dist., marked

T 2 N R 3 W S 1 B T.

A —, — ins. diam., bears N. —^o W., — lks. dist., marked

T 3 N R 3 W S 36 B T.

CORNERS COMMON TO TWO TOWNSHIPS ONLY.

[See Plates IV and VIII.]

72. *When more than one-half of all the corners of a township are stone corners, the descriptions in paragraphs 1 and 2, if the corners therein described are established, will be modified as follows:*

After "marked", insert the words:

"2 N on SW., and

7 W on NW. face."

When, under the conditions above specified, the corner described in paragraph 1 is established, a stake may be driven in the south pit and marked instead of the stone, and described as exemplified in the last clause of paragraph 6, page 34.

1. *Stone, with Pits and Mound of Earth.*

Set a — stone, — × — × — ins., — ins. in the ground, for cor. of Tps. 2 and 3 N., R. 7 W., on W. bdy. Tp. 3 N., R. 6 W., marked with 6 notches on N. and W. edges; dig pits 30 × 24 × 12 ins., on each line, N. and S., 4 ft., and W. of stone, 8 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ ft. high, W. of cor.

2. *Stone, with Mound of Stone.*

Set a — stone, — × — × — ins., — ins. in the ground, for cor. of Tps. 2 and 3 N., R. 7 W., on W. bdy. Tp. 3 N., R. 6 W., marked with 6 notches on N. and W. edges; and raise a mound of stone, 2 ft. base, 1½ ft. high, W. of cor. Pits impracticable.

3. *Stone, with Bearing Trees.*

Set a — stone, — × — × — ins., — ins. in the ground, for cor. of Tp. 2 N., R. 5 W., and Tp. 3 N., R. 6 W., on N. bdy. Tp. 2 N., R. 6 W., marked with 6 notches on N. and W. edges; from which

A —, ins. diam., bears N. —^o E., — lks. dist., marked

T 2 N R 5 W S 6 B T.

A —, — ins. diam., bears N. —^o W., — lks. dist., marked

T 3 N R 6 W S 36 B T.

4. *Post, with Pits and Mound of Earth.*

Set a — post, 3 ft. long, 4 ins. sq., with marked stone (charred stake or quart of charcoal), 24 ins. in the ground, for cor. of Tp. 2 N., R. 5 W., and Tp. 3 N., R. 6 W., on N. bdy. Tp. 2 N., R. 6 W., marked
T 2 N R 5 W S 6 on NE., and

T 3 N R 6 W S 36 on NW. face, with 6 notches on N. and W. edges; dig pits $30 \times 24 \times 12$ ins., on each line, E. and W., 4 ft., and N. of post, 8 ft. dist.; and raise a mound of earth, 5 ft. base, $2\frac{1}{2}$ ft. high, N. of cor.

5. *Post, with Bearing Trees.*

Set a — post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for cor. of Tps. 2 and 3 N., R. 7 W., on W. bdy. Tp. 3 N., R. 6 W., marked

T 2 N R 7 W S 1 on SW., and
T 3 N R 7 W S 36 on NW. face, with 6 notches on N. and W. edges; from which

A —, — ins. diam. bears S. —^o W., — lks. dist., marked

T 2 N R 7 W S 1 B T.

A —, — ins. diam., bears N. —^o W., — lks. dist., marked

T 3 N R 7 W S 36 B T.

6. *Mound of Earth, with Deposit, and Stake in Pit.*

Deposit a marked stone (charred stake or quart of charcoal), 12 ins. in the ground, for cor. of Tps. 2 and 3 N., R. 7 W., on W. bdy. Tp. 3 N., R. 6 W.; dig pits, $30 \times 24 \times 12$ ins., on each line, N. and W. of cor., 5 ft. dist.; and raise a mound of earth, 5 ft. base, $2\frac{1}{2}$ ft. high, over deposit.

In W. pit drive a — stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked

T 2 N R 7 W S 1 on SW., and

T 3 N R 7 W S 36 on NW. face, with 6 notches on N. and W. edges.

7. *Tree Corner, with Pits and Mound of Earth.*

A —, — ins. diam., for cor. of Tps. 3 and 4 N., R. 5 W., on E. bdy. Tp. 4 N., R. 6 W., 1 mark

T. 4 N., R. 5 W. on NE., and

T. 3 N., R. 5 W. on SE. side; with 6 notches facing N. and E.; dig pits $24 \times 18 \times 12$ ins., crosswise on each line, N. and E. of cor., 5 ft. dist.; and raise a mound of earth, around tree.

8. *Tree Corner, with Bearing Trees.*

A —, — ins. diam., for cor. of Tps. 2 and 3 N., R. 7 W., on W. bdy. Tp. 3 N., R. 6 W., 1 mark

T 2 N R 7 W S 1 on SW., and

T 3 N R 7 W S 36 on NW. side, with 6 notches facing N. and W.; from which

A —, — ins. diam., bears S. —^o W., — lks. dist., marked

T 2 N R 7 W S 1 B T.

A —, — ins. diam., bears N. —^o W., — lks. dist., marked

T 3 N R 7 W S 36 B T.

CORNERS REFERRING TO ONE TOWNSHIP ONLY.

[See Plates IV and VIII.]

73. *When more than one-half of all corners of a township are stone corners, the descriptions in paragraphs 1 and 2, if the corners therein described are established, will be modified as follows: After "marked" insert the words:*

"2 N 6 W. on SW. face."

When, under the conditions above specified, the corner described in paragraph 1 is established, a stake may be driven in the south pit, and marked instead of the stone, and described as exemplified in the last clause of paragraph 6, page 36.

1. *Stone, with Pits and Mound of Earth.*

Set a — stone, —×—×— ins., — ins. in the ground, for NE. cor. of Tp. 2 N., R. 6 W., marked with 6 notches on S. and W. edges; dig pits, 36×36×12 ins., on each line, S. and W. of stone, 8 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ ft. high, SW. of cor.

2. *Stone, with Mound of Stone.*

Set a — stone, —×—×— ins., — ins. in the ground, for NE. cor. of Tp. 2 N., R. 6 W., marked with 6 notches on S. and W. edges; and raise a mound of stone, 2 ft. base, 1½ ft. high, SW. of cor. Pits impracticable.

3. *Stone, with Bearing Tree.*

Set a — stone, —×—×— ins., — ins. in the ground for NE. cor. of Tp. 2 N., R. 6 W., marked with 6 notches on S. and W. edges; from which

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

T 2 N R 6 W S 1 B T.

4. *Post, with Pits and Mound of Earth.*

Set a — post, 3 ft. long, 4 ins. sq., with marked stone (charred stake or quart of charcoal), 24 ins. in the ground, for NE. cor. of Tp. 2 N., R. 6 W., marked

T 2 N R 5 W S 6 on NE.,

S 6 on SE.,

T 2 N R 6 W S 1 on SW., and

S 6 on NW. face, with 6 notches on S. and W. edges; dig pits, 36×36×12 ins., on each line, S. and W. of post, 8 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ ft. high, SW. of cor.

5. *Post, with Bearing Tree.*

Set a — post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for SW. cor. of Tp. 3 N., R. 6 W., marked

T 3 N R 6 W S 31 on NE.,

S 1 on SE.,

T 2 N R 7 W S 1 on SW., and

S 1 on NW. face, with 6 notches on N. and E. edges; from which

A —, — ins. diam., bears N. —° E., — lks. dist., marked

T 3 N R 6 W S 31 B T.

6. *Mound of Earth, with Deposit, and Stake in Pit.*

Deposit a marked stone (charred stake or quart of charcoal), 12 ins. in the ground, for SW. cor. of T. 3 N., R. 6 W.; dig pits, $36 \times 36 \times 12$ ins., on each line, N. and E. of cor., 5 ft. dist.; and raise a mound of earth, 5 ft. base, $2\frac{1}{2}$ ft. high, over deposit.

In E. pit drive a — stake, 2 ft. long, 2 in. sq., 12 ins. in the ground, marked

T 3 N R 6 W S 31 on NE.,

S 1 on SE.,

T 2 N R 7 W S 1 on SW., and

S 1 on NW. face, with 6 notches on N. and E. edges.

7. *Tree Corner, with Pits and Mound of Earth.*

A —, — ins. diam., for SW. cor. of Tp. 3 N., R. 6 W., I mark

T 3 N R 6 W S 31 on NE.,

S 1 on SE.,

T 2 N R 7 W S 1 on SW., and

S 1 on NW side, with 6 notches facing N. and E.; dig pits, $30 \times 24 \times 12$ ins., crosswise on each line, N. and E. of cor., 5 ft. dist.; and raise a mound of earth around tree.

8. *Tree Corner, with Bearing Tree.*

A —, — ins. diam., for SE. cor. of Tp. 4 N., R. 6 W., I mark

S 6 on NE.,

T 3 N R 5 W S 6 on SE.,

S 6 on SW., and

T 4 N R 6 W S 36 on NW. side, with 6 notches facing N. and W.; from which

A —, — ins. diam., bears N. —° W., — lks. dist., marked

T 4 N R 6 W S 36 B T.

STANDARD SECTION CORNERS.

[See Plates II and IV.]

74. 1. *Stone, with Pits and Mound of Earth.*

Set a — stone, —×—×— ins., — ins. in the ground, for standard cor. of secs. 31 and 32, marked S C on N.; with 5 grooves on E., and 1 groove on W. face; dig pits, $24 \times 18 \times 12$ ins., crosswise on each line, E. and W., 3 ft., and N. of stone, 7 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, N. of cor.

2. *Stone, with mound of Stone.*

Set a — stone, —×—×— ins., — ins. in the ground, for stand. cor. of secs. 35 and 36, marked S C on N.; with 1 groove on E. and 5 grooves on W. face; and raise a mound of stone, 2 ft. base $1\frac{1}{2}$ ft. high, N. of cor. Pits impracticable.

3. *Stone, with Bearing Trees.*

Set a — stone, —×—×— ins., — ins. in the ground, for standard cor. of secs. 33 and 34, marked S C on N.; with 3 grooves on E. and W. faces; from which

A —, — ins. diam., bears N. —° E., — lks. dist., marked

T 13 N R 21 E S 34 B T.

A —, — ins. diam., bears N. —° W., — lks. dist., marked

T 13 N R 21 E S 33 B T.

4. *Post, with Pits and Mound of Earth.*

Set a — post, 3 ft. long, 4 ins. sq., with marked stone (charred stake or quart of charcoal), 24 ins. in the ground, for standard cor. of secs. 32 and 33, marked

S C T 13 N R 21 E on N.,

S 33 on E., and

S 32 on W. face, with 4 grooves on E., and 2 grooves on W. face; dig pits, 24×18×12 ins., crosswise on each line, E. and W., 3 ft., and N. of post, 7 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, N. of cor.

5. *Post, with Bearing Trees.*

Set a — post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for standard cor. of secs. 34 and 35, marked

S C T 13 N R 21 on N.,

S 35 on E., and

S 34 on W. face, with two grooves on E., and 4 grooves on W. face; from which

A —, — ins. diam., bears N. —° E., — lks. dist. marked

T 13 N R 21 E S 35 B T.

A —, — ins. diam., bears N. —° W., — lks. dist., marked

T 13 N R 21 E S 34 B T.

6. *Mound of Earth, with Deposit, and Stake in Pit.*

Deposit a marked stone (charred stake or quart of charcoal), 12 ins. in the ground, for standard cor. of secs. 33 and 34; dig pits, 24×18×12 ins., crosswise on each line, N., E., and W. of cor., 5 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, over deposit.

In E. pit drive a — stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked

S C T 13 N R 22 E on N.,

S 34 on E., and

S 33 on W. face; with 3 grooves on E. and W. faces.

7. *Tree Corner, with Pits and Mound of Earth.*

A —, — ins. diam., for standard cor. of secs. 31 and 32, I mark

S C T 13 N R 22 E on N.,

S 32 on E., and

S 31 on W. side, with 5 notches on E., and 1 notch on W. side; dig pits, 18×18×12 ins., N., E., and W. of cor., 4 ft. dist.; and raise a mound of earth around tree.

8. *Tree Corner, with Bearing Trees.*

A —, — ins. diam., for standard cor. of secs. 35 and 36, I mark

S C T 13 N R 22 E on N.,

S 36 on E., and

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

A —, — ins. diam., bears N. —° E., — lks. dist., marked

T 13 N R 22 E S 36 B T.

A —, — ins. diam., bears N. —° W., — lks. dist., marked

T 13 N R 22 E S 35 B T.

CLOSING SECTION CORNERS.

[See Plates IV and V.]

75. 1. *Stone, with Pits and Mound of Earth.*

Set a — stone, — × — × — ins., — ins. in the ground, for closing cor. of secs. 1 and 2, marked C C on S.; with 1 groove on E., and 5 grooves on W. face; dig pits, 24 × 18 × 12 ins. crosswise on each line, E. and W., 3 ft., and S. of stone, 7 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, S. of cor.

2. *Stone, with Mound of Stone.*

Set a — stone, — × — × — ins., — ins. in the ground, for closing cor. of secs. 3 and 4, marked C C on S.; with 3 grooves on E. and W. faces; and raise a mound of stone, 2 ft. base, 1½ ft. high, S. of cor. Pits impracticable.

3. *Stone, with Bearing Trees.*

Set a — stone, — × — × — ins., — ins. in the ground, for closing cor. of secs. 1 and 2, marked C C on S.; with 1 groove on E., and 5 grooves on W. face; 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.

4. *Post, with Pits and Mound of Earth.*

Set a — post, 3 ft. long, 4 ins. sq., with marked stone (charred stake or quart of charcoal), 24 ins. in the ground, for closing cor. of secs. 1 and 2, marked

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

S 1 on E., and

S 2 on W. face, with 1 groove on E., and 5 grooves on W. face; dig pits, 24 × 18 × 12 ins., crosswise on each line, E. and W., 3 ft., and S. of post, 7 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, S. of cor.

5. *Post, with Bearing Trees.*

Set a — post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for closing cor. of secs. 1 and 2, marked

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

S 1 on E., and

S 2 on W. face, with 1 groove on E., and 5 grooves on W. face; 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.

6. *Mound of Earth, with Deposit, and Stake in Pit.*

Deposit a marked stone (charred stake or quart of charcoal), 12 ins. in the ground, for closing cor. of secs. 3 and 4; dig pits, 24 × 18 × 12 ins., crosswise on each line, S., E., and W. of cor., 4 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, over deposit.

In E. pit drive a—stake, 2 ft. long, 2 ins. sq., 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. face, with 3 grooves on E. and W. faces.

7. *Tree Corner, with Pits and Mound of Earth.*

A —, — ins. diam., for closing cor. of secs. 1 and 2, I mark

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

S 1 on E., and

S 2 on W. side, with 1 notch on E., and 5 notches on W. side; dig pits, 18×18×12 ins., S., E., and W. of cor., 5 ft. dist.; and raise a mound of earth around tree.

8. *Tree Corner, with Bearing Trees.*

A —, — ins. diam., for closing cor. secs. 1 and 2, I mark

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

S 1 on E., and

S 2 on W. side, with 1 notch on E., and 5 notches on W. side; 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.

9. All closing section corners, on base lines or standard parallels, will be connected by course and distance with the nearest standard corner thereon. (See section 143.)

CORNERS COMMON TO FOUR SECTIONS.

[See Plates IV and V.]

76. *When more than one-half of all the corners in a township are stone corners, the descriptions in paragraphs 1 and 2, if the corners therein described are established for cor. of secs. 15, 16, 21 and 22, will be modified as follows: after "marked," insert the words*

"4 N on NE., and

3 W on SE. face."

When, under the conditions above specified, the corner described in paragraph 1 is established, a stake may be driven in the southeast pit, and marked instead of the stone, and described as exemplified in the last clause of paragraph 6, page 40.

1. *Stone, with Pits and Mound of Earth.*

Set a — stone, — × — × — ins., — ins. in the ground, for cor. of secs. 14, 15, 22, and 23, marked with 3 notches on S. and 2 notches on E. edge; dig pits, 18×18×12 ins., in each sec. 5½ ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor.

2. *Stone, with Mound of Stone.*

Set a — stone, — × — × — ins., — ins. in the ground, for cor. of secs. 14, 15, 22, and 23, marked with 3 notches on S. and 2 notches on E. edge; and raise a mound of stone, 2 ft. base, 1½ ft. high, W. of cor. Pits impracticable.

3. *Stone, with Bearing Trees.*

Set a — stone, — × — × — ins., — ins. in the ground, for cor. of secs. 9, 10, 15, and 16, marked with 4 notches on S., and 3 notches on E. edge; 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.

4. *Post, with Pit and Mound of Earth.*

Set a — post, 3 ft. long, 4 ins. sq., with marked stone (charred stake or quart of charcoal), 24 ins. in the ground, for cor. of secs. 15, 16, 21, and 22, marked

T 2 N S 15 on NE.,

R 2 W S 22 on SE.,

S 21 on SW., and

S 16 on NW. face with 3 notches on S. and E. edges; dig pits, 18×18×12 ins., in each sec., 5½ ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor.

5. *Post, with Bearing Trees.*

Set a — post, 3 ft. long, 4 ins. sq., 24 ins. in the ground for cor. of secs. 25, 26, 35 and 36, marked

T 2 N S 25 on NE.,

R 2 W S 36 on SE.,

S 35 on SW., and

S 26 on NW. face, with 1 notch on S. and 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.

6. *Mound, with Deposit, and Stake in Pit.*

Deposit a marked stone (charred stake or quart of charcoal), 12 ins. in the ground, for cor. of secs. 25, 26, 35 and 36; dig pits, 18×18×12 ins., in each sec., 4 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, over deposit.

In SE. pit drive a — stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked

T 2 N S 25 on NE.,

R 2 W S 36 on SE.,

S 35 on SW., and

S 26 on NW. face, with 1 notch on S. and E. edges.

7. *Tree Corner, with Pits and Mound of Earth.*

A—, — ins. diam., for cor. of secs. 29, 30, 31, and 32, I mark
 T 2 N S 29 on NE.,
 R 2 W S 32 on SE.,
 S 31 on SW., and
 S 30 on NW. side, with 1 notch on S., and 5 notches on E. side; dig
 pits $18 \times 18 \times 12$ ins., in each sec., 5 ft. dist.; and raise a mound of
 earth around tree.

8. *Tree Corner, with Bearing Trees.*

A—, — ins. diam., for cor. of secs. 5, 6, 7, and 8, I mark
 T 2 N S 5 on NE.,
 R 2 W S 8 on SE.,
 S 7 on SW., and
 S 6 on NW. side, with 5 notches on S. and E. sides; from which
 A—, — ins. diam. bears N. —^o E., — lks. dist., marked
 T 2 N R 2 W S 5 B T.
 A—, — ins. diam., bears S. —^o E. lks. dist., marked
 T 2 N R 2 W S 8 B T.
 A—, — ins. diam., bears S. —^o W. lks. dist., marked
 T 2 N R 2 W S 7 B T.
 A—, — ins. diam., bears N. —^o W. — lks. dist., marked
 T 2 N R 2 W S 6 B T.

SECTION CORNERS COMMON TO TWO SECTIONS ONLY.

[See Plates IV and VIII.]

77. *When more than one-half of all the corners in a township are stone corners, the descriptions in paragraphs 1 and 2, if the corners therein described are established near cor. of secs. 15, 16, 21, and 22, will be modified, as follows:*

After "marked", insert the words

"3 N on SW., and
 7 W on NW. face."

When, under the conditions above specified, the corner described in paragraph 1 is established, a stake may be driven in the southwest pit, and marked instead of the stone, and described as exemplified in the last clause of paragraph 6, page 42.

1. *Stone, with Pits and Mound of Earth.* (Tp. 3 N., R. 7 W.)

Set a — stone, — \times — \times — ins., —ins. in the ground for cor. of secs. 25 and 36* marked with 5 notches on N., and 1 notch on S. edge; dig pits $24 \times 24 \times 12$ ins., in each sec., 6 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor.

2. *Stone, with Mound of Stone.* (Tp. 3 N., R. 7 W.)

Set a — stone, — \times — \times — ins., — ins. in the ground, for cor. of secs. 15 and 22 marked with 3 notches on N. and S. edges; and raise a mound of stone, 2 ft. base, $1\frac{1}{2}$ ft. high, W. of cor. Pits impracticable.

*The corner established on the range line and described in paragraph 1, will have notches to indicate the distances to the NE. and SE. corners of the township. See Plate IV, fig. 18; and Plate VIII, Tp. 3 N., R. 7 W.

3. *Stone, with Bearing Trees.* (Tp. 3 N., R. 7 W.)

Set a — stone, —×—×— ins., — ins. in the ground, for cor. of secs. 28 and 29, marked with 4 notches on E. edge; from which

A —, — ins. diam., bears N. —° E., — lks. dist., marked
T 3 N R 7 W S 28 B T.

A —, — ins. diam., bears N. —° W., — lks. dist., marked
T 3 N R 7 W S 29 B T.

4. *Post, with Pits and Mound of Earth.* (Tp. 2 N., R. 6 W.)

Set a — post, 3 ft. long, 4 ins. sq., with marked stone (charred stake or quart of charcoal), 24 ins. in the ground, for cor. of 33 and 34 marked

T 2 N S 34 on NE., and

R 6 W S 33 on NW. face, with three notches on E. and W. edges; dig pits 24×24×12 ins., in each sec., 6 ft. dist., and raise a mound of earth, 4 ft. base, 2 ft. high, N. of cor.

5. *Post, with Bearing Trees.* (Tp. 3 N., R. 5 W.)

Set a — post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for cor. of secs. 24 and 25, marked

T 3 N S 25 on SW., and

R 5 W S 24 on NW. face, with 4 notches on N., and 2 notches on S. edge; from which

A —, — ins. diam., bears S. —° W., — lks. dist., marked
T 3 N R 5 W S 25 B T.

A —, — ins. diam., bears N. —° W., — lks. dist., marked
T 3 N R 5 W S 24 B T.

6. *Mound of Earth with Deposit and Stake in Pit.* (Tp. 2 N., R. 6 W.)

Deposit a marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for cor. of secs. 13 and 24; dig pits 24×24×12 ins., in each sec., 4 ft., dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, over deposit.

In SW. pit drive a — stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked

T 2 N S 24 on SW., and

R 6 W S 13 on NW. face, with 3 notches on N. and S. edges.

7. *Tree Corner, with Pits and Mound of Earth.* (Tp. 3 N., R. 6 W.)

A —, — ins. diam., for cor. of secs. 24 and 25, I mark

T 3 N S 25 on SW. and

R 6 W S 24 on NW. side, with 4 notches on N. and 2 notches on S. side; dig pits, 18×18×12 ins., in each sec., 5 ft. dist.; and raise a mound of earth around tree.

8. *Tree Corner with Bearing Trees.* (Tp. 3 N., R. 7 W.)

A—, — ins. diam., for cor. of secs. 22 and 27 I mark

T 3 N S 27 on SW., and

R 7 W S 22 on NW. side, with 4 notches on N., and 2 notches on S. side; from which

A—, — ins. diam., bears S. —° W., — lks. dist., marked
T 3 N R 7 W S 27 B T.

A —, — ins. diam., bears N. —° W., — lks. dist., marked
T 3 N R 7 W S 22 B T.

SECTION CORNERS REFERRING TO ONE SECTION ONLY.

[See Plates IV and VIII.]

78. *When more than one-half of all corners in a township are stone corners, the descriptions in paragraphs 1 and 2, if the corners therein described, are established near the place for cor. of secs. 15, 16, 21, and 22, will be modified, as follows: After "marked" insert the words:*

"2 N 5 W on NE. face;"

When, under the conditions above specified, the corner described in paragraph 1 is established, a stake may be driven in the pit, and marked instead of the stone, and described as exemplified in the last clause of paragraph 6, below.

1. *Stone, with Pit and Mound of Earth.* (Tp. 2 N., R. 5 W.)

Set a — stone, — × — × — ins., — ins. in the ground, for SW. cor. of sec. 12, marked with 1 notch on E. edge; dig a pit, 36 × 36 × 12 ins., in the sec., 8 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, NE. of cor.

2. *Stone, with Mound of Stone.*

Set a — stone, — × — × — ins. in the ground, for SW. cor. of sec. 12, marked with one notch on E. edge; and raise a mound of stone, 2 ft. base, 1½ ft. high, NE. of cor.

3. *Stone, with Bearing Tree.*

Set a — stone, — × — × — ins., — ins. in the ground, for SW. cor. of sec. 12, marked with 1 notch on E. edge; from which

A —, — ins. diam., bears N. —° E., — lks. dist., marked

T 2 N R 5 W S 12 B T.

4. *Post, with Pit and Mound of Earth.* (Tp. 3 N., R. 5 W.)

Set a — post, 3 ft. long. 4 ins. sq., with marked stone (charred stake or quart of charcoal), 24 ins. in the ground, for NW. cor. of sec. 10; marked

T 3 N S 9 on NE.

R 5 W S 10 on SE.

S 9 on SW., and

S 9 on NW. face, with 5 notches on S. and 3 notches on E. edge; dig a pit, 36 × 36 × 12 ins., in the sec., 8 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, SE. of cor.

5. *Post, with Bearing Tree.* (T. 2 N., R. 5 W.)

Set a — post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for SW. cor. of sec. 12; marked

T 2 N S 12 on NE.,

R 5 W S 13 on SE.,

S 13 on SW., and

S 13 on NW. face, with 1 notch on E. edge; from which

A —, — ins. diam., bears N. —° E., — lks. dist., marked

T 2 N R 5 W S 12 B T.

6. *Mound of Earth, with Deposit, and Stake in pit.* (Tp. 3 N., R. 5 W.)

Deposit a marked stone (charred stake or quart of charcoal), 12 ins. in the ground, for NW. cor. of sec. 10; dig a pit, 36 × 36 × 12 ins. in the sec., 5 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high over deposit.

In the pit drive a — stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked

T 3 N S 9 on NE.,
R 5 W S 10 on SE.,
S 9 on SW., and
S 9 on NW. face, with 5 notches on S., and 3 notches on E. edge.

7. *Tree Corner, with Pits and Mound of Earth.* (Tp. 2 N., R. 5 W.)

A —, — ins. diam., for SW. cor. of sec. 12, I mark
T 2 N S 12 on NE.,
R 5 W S 13 on SE.,
S 13 on SW., and
S 13 on NW. side, with 1 notch on E. side; dig a pit, 24×24×12 ins., in the sec., 5 ft. dist.; and raise a mound of earth around tree.

8. *Tree Corner, with Bearing Trees.* (Tp. 3 N., R. 5 W.)

A —, — ins. diam., for NW. cor. of sec. 10, I mark
T 3 N S 9 on NE.,
R 5 W S 10 on SE.,
S 9 on SW., and
S 9 on NW., side, with 5 notches on S., and 3 notches on E. side;
from which

A —, — ins. diam., bears S. —° E., — lks. dist., marked
T 3 N R 5 W S 10 B T.

QUARTER SECTION CORNERS.

[See Plates IV and V.]

79. 1. *Stone, with Pits and Mound of Earth.*

Set a — stone, —×—×— ins., — ins. in the ground, for $\frac{1}{4}$ sec. cor. marked $\frac{1}{4}$ on N. face; dig pits, 18×18×12 ins., E. and W. of stone, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, N. of cor.

2. *Stone, with Mound of Stone.*

Set a — stone, —×—×— ins., — ins. in the ground, for $\frac{1}{4}$ sec. cor. marked $\frac{1}{4}$ on W. face; and raise a mound of stone, 2 ft. base, 1 $\frac{1}{2}$ ft. high, W. of cor. Pits impracticable.

3. *Stone, with Bearing Trees.*

Set a — stone, —×—×— ins., — ins. in the ground, for $\frac{1}{4}$ sec. cor. marked $\frac{1}{4}$ on W. face; from which

A —, — ins. diam., bears N. —° E., — lks. dist., marked
 $\frac{1}{4}$ S 16 B T.

A —, — ins. diam., bears N. —° W., — lks. dist., marked
 $\frac{1}{4}$ S 17 B T.

4. *Post, with Pits and Mound of Earth.*

Set a — post, 3 ft. long, 3 ins. sq., with marked stone (charred stake or quart of charcoal), 2 $\frac{1}{2}$ ins. in the ground, for $\frac{1}{4}$ sec. cor. marked $\frac{1}{4}$ S 4 on N. face and 9 on S. face; dig pits 18×18×12 ins., E. and W. of post, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, N. of cor.

5. *Post, with Bearing Trees.*

Set a — post, 3 ft. long, 3 ins. sq., 24 ins. in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ S 21 on W. face and 22 on E. face; from which

A —, — ins. diam., bears S. — \circ E., — lks. dist., marked

$\frac{1}{4}$ S 22 B T.

A —, — ins. diam., bears S. — \circ W., — lks. dist., marked

$\frac{1}{4}$ S 21 B T.

6. *Mound, with Deposit and Stake in Pit.*

Deposit a marked stone (charred stake or quart of charcoal), 12 ins. in the ground, for $\frac{1}{4}$ sec. cor.; dig pits, 18×18×12 ins., E. and W. of cor., 4 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, over deposit.

In E. pit drive a — stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked

$\frac{1}{4}$ S 21 on N. face and 28 on S. face.

7. *Tree Corner, with Pits and Mound of Earth.*

A —, — ins. diam., for $\frac{1}{4}$ sec. cor. I mark $\frac{1}{4}$ S 7 on W. side and 8 on E. side; dig pits, 18×18×12 ins., N. and S. of cor., 4 ft. dist.; and raise a mound of earth around tree.

8. *Tree Corner, with Bearing Trees.*

A —, — ins. diam., for $\frac{1}{4}$ sec. cor. I mark $\frac{1}{4}$ S 20 on N. side and 29 on S. side; from which

A —, — ins. diam., bears N. — \circ W., — lks. dist., marked

$\frac{1}{4}$ S 20 B T.

A —, — ins. diam., bears S. — \circ W., — lks. dist., marked

$\frac{1}{4}$ S 29 B T.

80. *Pits and Mounds of Quarter Section Corners.*

On meridional lines, the pits will be dug N. and S., and the mound will be placed on the west side of the corner; on latitudinal lines, the pits will be located E. and W., and the mound will be built on the north side of the corner. See Plate V.

81. *Markings on Quarter Section Corners.*

On meridional lines, the marks will be placed on the west side, and on latitudinal lines, on the north side of the stone, post, or other corner.

82. *Stakes in Pits of Quarter Section Corners.*

On meridional lines the stakes will be driven in the S. pit, and on latitudinal lines, in the E. pit.

STANDARD QUARTER SECTION CORNERS.

[See Plates IV and V.]

83. All standard quarter-section corners, on base lines or standard parallels, will have the letters S C (for standard corner), precede the marking $\frac{1}{4}$ or $\frac{1}{4}$ S, as the case may be; such corners will be established in all other respects like other quarter-section corners.

When bearing trees are described for standard quarter-section corners, each tree will be marked, S C $\frac{1}{4}$ S B T.

QUARTER SECTION CORNERS COMMON TO TWO QUARTERS OF ONLY ONE SECTION.

84. These corners will be similar in all respects to those that are common to four quarters of two sections. See notes on Plates VI and VII.

MEANDER CORNERS.

[See Plates III, IV, and V.]

85. 1. *Stone, with Pit and Mound of Earth.*

Set a — stone, —×—×— ins. — ins. in the ground for meander cor. of fracl. secs. 26 and 35, marked

M C on E. face, with 1 groove on S. face; dig a pit $36 \times 36 \times 12$ ins., 8 ft. W. of stone; and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor.

2. *Stone, with Mound of Stone.*

Set a — stone, —×—×— ins., — ins. in the ground, for meander cor. of fracl. secs. 17 and 18, marked

M C on S. face, with 5 grooves on E. face; and raise a mound of stone, 2 ft. base, $1\frac{1}{2}$ ft. high, N. of cor. Pits impracticable.

3. *Stone, with Bearing Trees.*

Set a — stone —×—×— ins., — ins. in the ground, for meander cor. of fracl. secs. 26 and 35, with 1 groove on S. face, marked

M C on W. face; from which

A —, — ins., diam., bears N. —^o E., — lks. dist., marked

T 15 N R 20 E S 26 M C B T.

A —, — ins., diam., bears S. —^o E. — lks., dist., marked

T 15 N R 20 E S 35 M C B T.

4. *Post, with Pit and Mound of Earth.*

Set a — post, 3 ft. long, 4 ins. sq., with marked stone (charred stake or quart of charcoal), 24 ins. in the ground for meander cor. of fracl. secs. 19 and 20, marked

M C on N.,

T 15 N on S.,

R 20 E S 20 on E., and

S 19 on W. face, dig a pit, $36 \times 36 \times 12$ ins., 8 ft. S. of post; and raise a mound of earth, 4 ft. base, 2 ft. high, S. of cor.

5. *Post, with Bearing Trees.*

Set a — post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for meander cor. of fracl. secs. 25 and 26, marked

M C on N.,

T 15 N on S.,

R 20 E S 25 on E., and

S 26 on W. face; from which

A —, — ins. diam., bears S. —^o E., — lks. dist., marked

T 15 N R 20 E S 25 M C B T.

A —, — ins. diam., bears S. —^o W., — lks. dist., marked

T 15 N R 20 E S 26 M C B T.

6. *Mound with Deposit, and Stake in Pit.*

Deposit a marked stone (charred stake or quart of charcoal) 12 ins. in the ground, for meander cor. of fracl. secs. 25 and 26; dig a

pit, $36 \times 36 \times 12$ ins., 5 ft. N. of cor.; and raise a mound of earth, 4 ft. base, 2 ft. high, over deposit.

In the pit drive a — stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked

M C on S.,
T 15 N on N.,
R 20 E S 26 on W., and
S 25 on E. face.

7. *Tree Corner, with Pits and Mound of Earth.*

A —, — ins. diam., for meander cor. of fractl. secs. 17 and 20, I mark

M C on W.,
T 15 N on E.,
R 20 E S 17 on N., and
S 20 on S. side; dig a pit, $36 \times 36 \times 12$ ins., 8 ft. E. of tree; and raise a mound of earth, 4 ft. base, 2 ft. high, E. of cor.

8. *Tree Corner, with Bearing Trees.*

A —, — ins. diam., for a special meander cor. of fractl. E. and W. halves of sec. 33, I mark

S M C on N.,
T 15 N on S.,
R 20 E S 33 on E., and
S 33 on W. side; from which
A —, — ins. diam., bears S. —^o E. — lks. dist., marked
T 15 N R 20 E S 33 S M C B T.

A —, — ins. diam., bears S. —^o W. — lks. dist., marked
T 15 N R 20 E S 33 S M C B T.

86. *Pits and Mounds of Meander Corners.*

When a pit is dug as an accessory to a meander corner, it will be located on line and 8 feet from such corner (except as otherwise provided for in paragraph 6), on the side opposite the stream or lake meandered; while the mound will be placed midway between the corner and nearest side of the pit.

87. *Markings on Meander Corners.*

On all meander corners, the letters M C (for meander corner) will be cut into the side facing the stream or lake to be meandered. On post or tree meander corners, within township exteriors, additional marks will be placed, as follows: the township number will be marked on the side opposite M C; the proper range and section number will be placed on the right-hand side (when looking along line toward the stream or lake), and the appropriate section number on the opposite side.

All meander corners on base lines or standard parallels will be further marked S C on north side or face.

On principal or guide meridians, and on meridional township lines, the letters M C will be placed as above directed; the township number will be marked on the opposite side; while the proper range and section numbers will be marked on the sides facing the east and west cardinal points.

On base lines or standard parallels and on latitudinal township lines, the township and section numbers will be marked on the sides facing

the north and south cardinal points; while the range numbers will be placed on the side opposite the marking M C.

In all the markings provided for in this paragraph, the numbers indicating township, range, and section, will be preceded by the initial letters T R and S, respectively.

88. *Descriptions will be modified in certain cases.*

When a tree is marked for a regular meander corner, the descriptions in paragraph 8 will be modified, as follows: strike out "special"; in place of "E. and W. halves of sec. 33", write "secs. — and —,"; and omit the letter S, preceding M C, in the marking on corner and bearing trees.

The descriptions in paragraphs 1 to 7, inclusive, will be modified to describe special meander corners, as illustrated in paragraph 8, by writing "special" before meander cor. and S before M C when conditions require the change.

89. *Special Meander Corners and Auxiliary Meander Corners.*

Regular meander corners are those established on standard, township, or section lines. See Plate IV, for plans of meander corners, and the specimen plat, Plate III, sections 17, 18, 19, 20, 25, 26, and 35, for locations of meander corners described in Specimen Field Notes, pages 179 and 180.

The meander corners on lines of legal subdivisions, other than standard, township, or section lines, will be designated special meander corners, e. g., those located on the Specimen Plat, Plate III, in section 33.

Meander corners, not on a line belonging to the system of rectangular surveying, will be called auxiliary meander corners, e. g., the meander corner on Diamond Rock, in section 18.

90. *Meander Corners on unsafe ground will be witnessed.*

When a Meander Corner falls at a point where prevailing conditions would threaten its destruction by natural causes, a witness corner to such meander corner will be established, as provided for in the article Witness Corners, page 52.

91. CORNERS ON RESERVATION OR OTHER BOUNDARIES NOT CONFORMING TO THE RECTANGULAR SYSTEM.

[See Plate V.]

Stones for corners on Indian Reservation or other boundaries will not be less than 20 ins. long, or less than 6 ins. thick, and will measure at least one cubic foot in volume; consequently, a stone $20 \times 14\frac{1}{2} \times 6$ ins., will be about minimum size, and $32 \times 9 \times 6$ ins., represents satisfactory proportions. N. P. for Nez Perces (Indian Reservation), on the east, and P. L. for Public Land (unsurveyed), on the west, applies to paragraph 1 only.

1. *Stone, with Mound of Earth.*

Set a — stone, — \times — \times — ins., — ins. in the ground, for the 17-mile cor., marked

17 M on S.,

N P on E., and

P L on W. face; dig pits $36 \times 36 \times 12$ ins., E. and W. of stone, 4 ft. dist.; and raise a mound of earth, 5 ft. base, $2\frac{1}{2}$ ft. high, S. of cor.

2. *Stone, with Mound of Stone.*

Set a — stone, —×—×— ins., — ins. in the ground, for the 38-mile cor., marked
 38 M on NE.,
 N P on NW., and
 P L on SE. face, and raise a mound of stone, 3 ft. base, 2 ft. high,*
 N. E. of cor. Pits impracticable.

3. *Stone, with Bearing Trees.*

Set a — stone, —×—×— ins., — ins. in the ground, for the 35-mile cor., marked
 35 M on E.,
 N P on N., and
 8 W on S. face; from which
 A —, — ins. diam., bears N. —° E., — lks. dist., marked
 N P I R 35 M B T.
 A —, — ins. diam., bears S. —° E.,^b — lks. dist., marked
 T 6 N R 8 W S 9 35 M B T.
 A —, — ins. diam., bears S. —° W.,^b — lks. dist., marked
 T 6 N R 8 W S 8 35 M B T.
 A —, — ins. diam., bears N. —° W., — lks. dist., marked
 N P I R 35 M B T.

4. *Post, with Pits and Mound of Earth.*

Set a — post, 3 ft. long, 5 ins. sq., with marked stone (charred stake or quart of charcoal), 24 ins. in the ground, for the 17 mile cor., marked
 17 M on S.,
 N P I R on E., and
 P L on W. face; dig pits, 36×36×12 ins., E. and W. of post, 4 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ ft. high, S. of cor.

5. *Post, with Bearing Trees.*

Set a — post, 3 ft. long, 5 ins. sq., 24 ins. in the ground, for the 35-mile cor., marked
 35 M on E.,
 N P I R on N., and
 T 6 N R 8 W S 9 on S.; from which
 A —, — ins. diam., bears N. —° E., — lks. dist., marked
 N P I R 35 M B T.
 A —, — ins. diam., bears S. —° E., — lks. dist., marked
 T 6 N R 8 W S 9 35 M B T.
 A —, — ins. diam., bears S. —° W., — lks. dist., marked
 T 6 N R 8 W S 8 35 M B T.
 A —, — ins. diam., bears N. —° W., — lks. dist., marked
 N P I R 35 M B T.

6. *Mound, with Deposit and Stake in Pit.*

Deposit a marked stone (charred stake or quart of charcoal), 12 ins. in the ground, for the 33-mile cor.; dig pits, 36×36×12 ins., NE. and

* The above are minimum dimensions for mounds of stone on reservation boundaries.

^b The bearing trees, "S. —° E." and "S. —° W." from the corner, are supposed to stand on surveyed land, near the line between sections 8 and 9.

SW. of cor., 5 ft. dist.; and raise a mound of earth, 5 ft. base, $2\frac{1}{2}$ ft. high, over deposit.

In NE. pit drive a — stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked

33 M on SE.,

N P I R on NE., and

T 6 N R 8 W S 15 on SW. face.

7. *Tree Corner, with Pits and Mound of Earth.*

A —, — ins. diam., for the 29-mile cor., I mark

29 M on E.,

N P I R on N., and

T 5 N R 7 W S 8 on S. side; dig pits, $36 \times 36 \times 12$ ins., N. and S. of tree, 5 ft. dist.; and raise a mound of earth, 5 ft. base, $2\frac{1}{2}$ ft. high, E. of cor.

8. *Tree Corner, with Bearing Trees.*

A —, — ins. diam., for the 35-mile cor., I mark

35 M on E.,

N P I R on N., and

T 6 N R 8 W S 9 on S. side; from which

A —, — ins. diam., bears N. —^o E., — lks. dist., marked

N P I R 35 M B T.

A —, — ins. diam., bears S. —^o E., — lks. dist., marked

T 6 N R 8 W S 9 35 M B T.

A —, — ins. diam., bears S. —^o W., — lks. dist., marked

T 6 N R 8 W S 8 35 M B T.

A —, — ins. diam., bears N. —^o W., — lks. dist., marked

N P I R 35 M B T.

9. *Corner Monument of Stone, with Deposit.*

Deposit a marked stone (charred stake, quart of charcoal, or vial with record^a inclosed), 12 ins. in the ground, for the SW. cor. of the Nez Perces Indian Reservation; and build a monument of stone, 3 ft. sq. at base, 2 ft. sq. on top, 3 ft. high, over deposit; marked

SW cor N P I R on NE.,^b

P L —^c M —^c chs on SE.,

P L —^d on SW., and

P L on NW. face.

10. *A Post for Corner Monument, with Pits and Mound of Earth.*

Set a — post, 3 ft. long, 5 ins. sq., 24 ins. in the ground, for the NW. cor. of the Nez Perces Indian Reservation, marked

P L on SE.,

NW cor N P I R on SE.,

P L —^c M —^c chs on SW., and

P L —^d on NW. face; dig pits, $36 \times 36 \times 12$ ins., S. and NE. of post, 8 ft. dist.; and raise a mound of earth, 5 ft. base, $2\frac{1}{2}$ ft. high, SE. of cor.

^a The record will consist of a brief description of the corner, with the date of its construction.

^b The markings will be cut into large stones, inserted in the middle of the lowest course on each side of the monument.

^c The proper number of miles and chains, from the initial point, will be stated.

^d The year in which the monument is established will be placed in the blank.

11. *A Stone for Corner Monument, with Pits and Mound of Earth.*

Set a — stone, 36 × 10 × 7 ins., 27 ins. in the ground, for the NE. cor. of the Nez Perces Indian Reservation, marked

P L on NE.,

P L on SE.,

NE cor N P I R on SW., and

P L on NW. face; dig pits 36 × 36 × 12 ins., S. and W. of stone, 8 ft. dist.; and raise a mound of earth, 5 ft. base, 2½ ft. high, SW. of cor.

92. *Modifications of descriptions.*

When a stone or post is established for a corner monument, i. e., at a corner of a reservation, and four bearing trees are available, the descriptions in paragraphs 10 and 11 will be modified, as follows: Replace all that refers to pits and mound of earth, by correct descriptions of four properly marked bearing trees, for each corner.

The dimensions and arrangement of pits and mounds, described in the last two paragraphs, are similar to those described for "Corners referring to one township only."

93. The following table will be convenient for reference to the rules of the above descriptions, so far as they apply to pits and mounds.

TABLE I.—Size, position, and distance of pits and mounds.

Part 1.—Requirements as to size and position of pits.

| Kind of corner. | Size at tree corner. | Size at other corners. | Position from corner. |
|--------------------|----------------------|------------------------|------------------------------|
| Standard tp. cor. | 24 x 18 x 12 | 30 x 24 x 12 | Across N., E., and W. lines. |
| Closing tp. cor. | 24 x 18 x 12 | 30 x 24 x 12 | Across E., W., and S. lines. |
| Cor. of 4 tps. | 24 x 18 x 12 | 24 x 24 x 12 | On lines N., E., S., and W. |
| Cor. of 2 tps. | 24 x 18 x 12 | 30 x 24 x 12 | On each line. |
| Cor. of 1 tp. | 30 x 24 x 12 | 36 x 36 x 12 | Do. |
| Standard sec. cor. | 18 x 18 x 12 | 24 x 18 x 12 | Across E., W., and N. lines. |
| Closing sec. cor. | 18 x 18 x 12 | 24 x 18 x 12 | Across E., W., and S. lines. |
| Cor. of 4 secs. | 18 x 18 x 12 | 18 x 18 x 12 | In each sec. NE., etc. |
| Cor. of 2 secs. | 18 x 18 x 12 | 24 x 24 x 12 | In both secs. |
| Cor. of 1 sec. | 24 x 24 x 12 | 36 x 36 x 12 | In the sec. |
| Quarter sec. cor. | 18 x 18 x 12 | 18 x 18 x 12 | On line each side. |
| Meander cor. | 36 x 36 x 12 | 36 x 36 x 12 | On line, rear of cor. |
| On res'n line. | 36 x 36 x 12 | 36 x 36 x 12 | See Manual. |

Part 2.—Distance of pits and requirements as to mounds.

| Kind of corner. | Distance of pits at— | | | Mounds. | | |
|--------------------|----------------------------------|------------------------|--------------|-----------------|---------|-----------------------|
| | Post corner. | Mound of earth corner. | Tree corner. | Size (in feet). | | Position from corner. |
| | | | | Stone. | Earth. | |
| | | <i>Feet.</i> | <i>Feet.</i> | | | |
| Standard tp. cor. | E. and W. 4 feet, N. 8 feet | 5 | 5 | 2 x 1½ | 5 x 2½ | N. |
| Closing tp. cor. | E. and W. 4 feet, S. 8 feet | 5 | 5 | 2 x 1½ | 5 x 2½ | S. |
| Cor. of 4 tps. | N., E., and W. 4 feet, S. 8 feet | 5 | 5 | 2 x 1½ | 5 x 2½ | S. |
| Cor. of 2 tps. | E. and W. 4 feet, N. 8 feet | 5 | 5 | 2 x 1½ | 5 x 2½ | Various. |
| Cor. of 1 tp. | 8 feet | 5 | 5 | 2 x 1½ | 5 x 2½ | Do. |
| Standard sec. cor. | E. and W. 3 feet, N. 7 feet | 5 | 4 | 2 x 1½ | 4 x 2 | N. |
| Closing sec. cor. | E. and W. 3 feet, S. 7 feet | 4 | 5 | 2 x 1½ | 4 x 2 | S. |
| Cor. of 4 secs. | 5½ feet | 4 | 5 | 2 x 1½ | 4 x 2 | W. |
| Cor. of 2 secs. | 6 feet | 4 | 5 | 2 x 1½ | 4 x 2 | W. |
| Cor. of 1 sec. | 8 feet | 5 | 5 | 2 x 1½ | 4 x 2 | Various. |
| Quarter sec. cor. | 3 feet | 4 | 4 | 2 x 1½ | 3½ x 1½ | Do. |
| Meander cor. | 8 feet | 5 | 8 | 2 x 1½ | 4 x 2 | With pit. |
| On res'n line. | 4 feet | 5 | 5 | 3 x 2 | 5 x 2½ | Various. |

WITNESS CORNERS.

94. *Witness Corners will be established in certain cases.*

When the true point for any corner described in these instructions falls where prevailing conditions would insure its destruction by natural causes, a witness corner will be established in a secure position, on a surveyed line if possible, and within twenty chains of the corner point thus witnessed.

95. *Markings on Witness Corners.*

A witness corner will bear the same marks that would be placed upon the corner for which it is a witness, and in addition, will have the letters, W C (for witness corner), conspicuously displayed above the regular markings on the NE. face when witnessing a township or section corner; such witness corners will be established, in all other respects, like a regular corner, marking bearing trees with the proper numbers for the sections in which they stand.

96. *Markings on Bearing Trees of Witness Corners.*

When bearing trees are described as accessories to a witness corner; the prescribed markings on each tree will be preceded by the letters W C distinctly cut into the wood.

The true bearing and distance of witness corners, from the true point for the corner, will always be clearly stated in the field notes.

97. *Witness Corners to corner points falling in roads, etc.*

The point for a corner falling on a railroad, street, or wagon road, will be perpetuated by a marked stone (charred stake or quart of charcoal), deposited 24 inches in the ground, and witnessed by two witness corners, one of which will be established on each limiting line of the highway.

In case the point for any regular corner falls at the intersection of two or more streets or roads, it will be perpetuated by a marked stone (charred stake or quart of charcoal), deposited 24 inches in the ground, and witnessed by two witness corners established on opposite sides of the corner point, and at the mutual intersections of the lines limiting the roads or streets, as the case may be.

WITNESS POINTS.

98. Witness points will be perpetuated by corners similar to those described for quarter section corners, with the marking W P (for witness point), in place of $\frac{1}{4}$, or $\frac{1}{4}$ S, as the case may be.

If bearing trees are available as accessories to witness points, each tree will be marked W P B T. (See "Insuperable objects on line—Witness Points," page 24.)

MISCELLANEOUS.

99. *Corners on Rock in place, or on Boulders.*

When a corner falls on rock in place, or on a boulder, a cross (×), will be made at the exact corner point, and witnessed by the proper number of bearing trees, if they are available; in the absence of suitable trees, a mound of stones will be raised, or of earth if stones are not found and pits are available. Owing to the difficulty of identify-

ing the corner coming upon a flat rock in place, when only a cross is cut thereon, it is imperative that some adequate witness be used and marked.

100. *Location of Mounds.*

When mounds of earth or other material are raised as accessories to corners, they will be placed as specified in the foregoing Description of Corners, and in every case the direction of the mound from the corner will be carefully stated. The use of the indefinite description "alongside" will not be approved.

In case the character of the land is such that the mound can not be placed as hereinbefore described, the deputy will state in his notes, by bearing and distance, exactly where the mound is located with reference to the corner, and will give his reasons for placing it as described.

101. *Mounds of Stone, covered with Earth.*

In a case where pits are practicable and the deputy prefers raising a mound of stone, or a mound of stone covered with earth, he will use the form given for "Stone with mound of stone," omitting "pits impracticable," when the corner thus described is established; but when the corner "Stone, with mound of stone covered with earth," is constructed, the description will be modified as follows: strike out the words "Pits impracticable"; in place of "mound of stone, 2 ft. base, 1½ ft. high," write "mound of stone covered with earth, — ft. base, — ft. high," inserting in the blank spaces the dimensions of the mound given in paragraph 1, following the designation of each class of corners, pages 27 to 50. Mounds of stone, or of stone covered with earth must never be built *around* the corner stone, but separate. When stones are necessary to hold the corner stone upright and firm, they should be in addition to the witness mound, and not a part of it.

102. *Bearing Trees.*

Bearing trees marked as accessories to standard corners, either township, section, or quarter section, will be selected on the north side of base lines or standard parallels, and bearing trees referring to the closing corners on said lines, will be located on the south side; in general, the bearing trees referring to any particular closing corner, together with one pit and the mound belonging to such corner, will be located on the same side of the line closed upon, and on the side from which the surveys have been closed.

When the requisite number of trees can be found within 300 links of the corner point, two bearing trees will be marked and described for every standard or closing township or section corner, or corner common to two townships or sections, only; four for every corner common to four townships or four sections; one for a corner referring to one township or one section, only; two for every quarter section corner or meander corner, and four for each mile or half mile corner, or corner monument on a reservation or other boundary, not conforming to the system of rectangular surveying.

103. The limit of 300 links will not be held to prohibit the use of bearing trees or rocks beyond that distance. Where such objects are few but accessible, they are too useful as evidences of corners to be disregarded by a faithful deputy, even when several chains distant. In the surveys of 50 or 60 years ago, corners were often witnessed by trees 8 or 10 chains distant, with great advantage to subsequent retracements.

In case the prescribed number of trees can not be found within practicable distance, the deputy will state in his field notes, after describing those marked, "no other trees within limits," and add "dig pits — × — × — ins.," etc., or "raise a mound of stone, — ft. base, — ft. high, — of cor.," as prevailing conditions may require.

104. Bearing trees, being important accessories to the corners, will have their exact bearings from the true meridian taken with the instrument used in running the lines of survey; and the distance from the middle of each bearing tree to the middle point of the corner will be carefully measured, and recorded in the field notes.

105. As to the height or position of marks placed on bearing trees, practice differs in various localities. The custom of placing these important evidences high enough to insure their destruction when some woodman, ignorant or careless of the penalty of the law, cuts down the tree, is a direct violation of rules. A tree will be so marked that if inadvertently cut down its stump will retain evidence of its importance. Many surveyors have adopted the plan of placing all the marks at the height of 4 or 5 feet, except the letters B T, which are made on another blaze about one foot above the ground. The intent is commendable; but as a better rule, applicable to trees of every size, the following is now adopted: Place all figures and letters on that part of the tree which would probably remain as the stump; and make one plain blaze high on the same side, to attract notice in case of snow or dense undergrowth.

106. No tree less than 4 inches in diameter should be chosen for a witness, if larger ones are convenient; and if none over 3 inches are found, pits will be dug to witness the corner.

107. *Stones for corners.*

Stones 18 ins. long, or less, will be set with two-thirds of their length in the ground, and those more than 18 ins. long will have three-fourths of their length in the ground.

No stones measuring less than 504 cubic inches, or less than 12 ins. in length or three inches in thickness will be used for corners.

108. *Lines discontinued at Legal Corners.*

No mountainous lands, or lands not classed as surveyable, will be meandered, and all lines approaching such lands will be discontinued at the section or quarter-section corner nearest the unsurveyed land.

109. *Marks to be cut.*

All letters and figures on posts, trees, or stones, etc., will be cut into the object upon which they are placed. Arabic figures and plain letters will be used for all markings.

110. *Orientation of Corners.*

Corners referring to one, two, or four townships or sections, not identical with standard or closing corners, will be set with their faces directed NE. and SW., and NW. and SE., while all other corners will be set with their sides facing the cardinal points; except corners on boundaries of reservations and private land claims, which will be set squarely on line.

111. *Size of Posts, Mounds, etc.*

The sizes of wooden posts, mounds, and pits, noted in the foregoing descriptions, will be regarded as minimum, and their dimensions will be increased whenever practicable, except as to height of posts out of ground.

112. *Corner Materials.*

In establishing corners, the first preference will be given to durable stones when obtainable; then, posts; and lastly, mounds with stake in pit.

Wood of a perishable nature will not be used for posts or stakes.

113. *Instructions to be studied.*

Deputy surveyors will carefully read, study, and familiarize themselves with all instructions contained in this volume, and will instruct their assistants as to their duties before commencing work. An extra copy of this Manual may be furnished each deputy, for the use of his assistants.

INITIAL POINTS.

114. Initial points from which the lines of the public surveys are to be extended will 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 will be selected with great care and due consideration for their prominence and easy identification, and must be established astronomically.

An initial point should have a conspicuous location, visible from distant points on lines; it should be perpetuated by an indestructible monument, preferably a copper bolt firmly set in a rock ledge; and it should be witnessed by rock bearings, without relying on anything perishable like wood.

115. The initial point having been established the lines of public-land surveys will be extended therefrom. They are classified as follows:

Class 1. Base lines and standard parallels.

Class 2. Principal and guide meridians.

Class 3. Township exteriors (or meridional and latitudinal township boundaries).

Class 4. Subdivision and meander lines.

Only the base line and principal meridian can pass through the initial point.

BASE LINE.

116. From the initial point the base line will be extended east and west on a true parallel of latitude, by the use of transit or solar instruments, as may be directed by the surveyor general in his written special instructions. The transit will be used for the alinement of all important lines.

117. The direction of base lines will conform to parallels of latitude and will be controlled by true meridians; consequently the correct determination of true meridians by observations on Polaris at elongation is a matter of prime importance.

118. Certain reference lines, called tangents and secants, having a known position and relation to the required parallel of latitude, will be prolonged as straight lines. Two back and two fore sights are taken at each setting of the instrument, the horizontal limb being revolved 180° in azimuth between the observations, in one method, taking the mean of observations. Another method, called double back and fore sights, is still more exact, and therefore preferable. In this process the vertical cross-wire is fixed upon two transit points at some distance apart, in the rear, and then reversed to set one or two new points in

advance. This not only insures a straight line, if the transit is leveled, but also detects the least error of collimation.

119. Where solar apparatus is used in connection with a transit, the deputy will test the instrument, whenever practicable, by comparing its indications with a meridian determined by Polaris observations; and in all cases where error is discovered he will make the necessary corrections of his line before proceeding with the survey. All operations will be fully described in the field notes.

120. The proper township, section, and quarter-section corners will be established at lawful intervals, and meander corners at the intersection of the line with all meanderable streams, lakes, or bayous.

121. In order to detect errors and insure accuracy in measurement, two sets of chainmen will be employed; one to note distances to intermediate points and to locate topographical features, the other to act as a check. Each will measure 40 chains, and in case the difference is inconsiderable, the proper corner will be placed midway between the ending points of the two measurements; but if the discrepancy exceed 8 links on even ground, or 25 links on mountainous surface, the true distance will be found by careful re-chaining by one party or both.

122. The deputy will be present when each corner is thus established, and will record in the body of his field notes the distances to the same, according to the measurement by each set of chainmen.

To obviate collusion between the sets of chainmen, the second set should commence at a point in advance of the beginning corner of the first set, the initial difference in measurement thus obtained being known only to the deputy.

PRINCIPAL MERIDIAN.

123. This line shall conform to a true meridian and will be extended from the initial point, either north or south, or in both directions, as the conditions may require, by the use of transit or solar instruments, as may be directed by the surveyor general in his special written instructions. The methods used for determination of directions, and the precautions to be observed to secure accuracy in measurement, are fully stated above under the title "Base Line," and will be complied with in every particular.

124. 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.

STANDARD PARALLELS.

125. Standard parallels, which are also called correction lines, shall be extended east and west from the principal meridian, at intervals of 24 miles north and south of the base line, in the manner prescribed for running said line, and all requirements under the title "Base Line" will be carefully observed. (See page 55.)

126. Where standard parallels have been placed at intervals of 30 or 36 miles, regardless of existing instructions, and where gross irreg-

ularities require additional standard lines, from which to initiate new, or upon which to close old surveys, an intermediate correction line should be established to which a local name may be given, e. g., "Cedar Creek Correction Line;" and the same will be run, in all respects, like the regular standard parallels.

GUIDE MERIDIANS.

127. Guide meridians shall be extended north from the base line, or standard parallels, at intervals of 24 miles east and west from the principal meridian, in the manner prescribed for running the principal meridian, and all the provisions for securing accuracy of alignment and measurement, found or referred to under the titles Base Line and Principal Meridian, will apply to the survey of said guide meridians. (See page 55.)

128. When existing conditions require that such guide meridians shall be run south from the base or correction lines, they will be initiated at properly established corners on such lines, marked as closing corners.

129. Where guide meridians have been improperly placed at intervals greatly exceeding the authorized distance of 24 miles, and standard lines are required to limit errors of old, or govern new surveys, a new guide meridian may be run from a standard, or properly established closing corner, and a local name may be assigned to the same, e. g., "Grass Valley Guide Meridian". These additional guide meridians will be surveyed in all respects like regular guide meridians.

TOWNSHIP EXTERIORS.

130. Whenever practicable, the township exteriors in a block of land 24 miles square, bounded by standard lines, will be surveyed successively through the block, beginning with those of the southwestern township.

131. The meridional boundaries of townships will have precedence in the order of survey and will be run from south to north on true meridians, with permanent corners at lawful distances; the latitudinal boundaries will be run from east to west on random or trial lines, and corrected back on true lines.

The falling of a random, north or south of the township corner to be closed upon, will be carefully measured, and, with the resulting true return course, will be duly recorded in the field notes.

132. Should it happen, however, that such random intersects the meridian of the objective corner, north or south of said corner, or falls short of, or overruns the length of the south boundary of the township by more than three chains (due allowance being made for convergence), said random, and, if necessary, all the exterior boundaries of the township, will be retraced and remeasured to discover and correct the error.

When running random lines from east to west, temporary corners will be set at intervals of 40.00 chains, and proper permanent corners will be established upon the true line, corrected back in accordance with these instructions, thereby throwing the excess or deficiency against the west boundary of the township, as required by law.

133. Whenever practicable, the exterior boundaries of townships belonging to the west range, in a tract or block 24 miles square, will

first be surveyed in succession, through the range, from south to north; and in a similar manner, the other three ranges will be surveyed in regular sequence.

134. In cases where impassable obstacles occur and the foregoing rules can not be complied with, township corners will be established as follows:

In extending the south or north boundaries of a township to the west, where the southwest or northwest corners can not 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 can not 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. Allowance for the convergency of meridians will be made whenever necessary.

METHOD OF SUBDIVIDING.

135. The exterior boundaries of a full township having been properly established so far as possible, the subdivision thereof will be made as follows:

At or near the southeast corner of the township, a true meridian will be determined by Polaris or solar observations, and the deputy's instrument will be tested thereon; then from said corner the first mile of the east and south boundaries will be retraced, if subdivisions and survey of the exteriors have been provided for in separate contracts; but, if the survey of the exterior and subdivisinal lines are included in the same contract, the retracements referred to will be omitted. All discrepancies resulting from disagreement of bearings or measurements will be carefully stated in the field notes.

136. The meridional sectional lines will be made parallel to the range line or east boundary of the township, by applying to the bearing of the latter a small correction, dependent on the latitude, taken from the following table, which gives, to the nearest whole minute, the convergency of two meridians 6 miles long and from 1 to 5 miles apart; and supplies directly the deviation of meridional section lines west of north, when the range line is a true meridian. Add the correction to the bearing of the range line, if the same is west of north, but subtract when it bears east of north.

TABLE II.—*Corrections for Convergency within a Township.*

| Latitude. | Correction to be applied to bearing of range lines at a distance of— | | | | |
|----------------|---|----------|----------|----------|----------|
| | 1 mile. | 2 miles. | 3 miles. | 4 miles. | 5 miles. |
| ° ° | / | / | / | / | / |
| 30 to 35 | 1 | 1 | 2 | 2 | 3 |
| 35 to 40 | 1 | 1 | 2 | 3 | 3 |
| 40 to 45 | 1 | 2 | 2 | 3 | 4 |
| 45 to 50 | 1 | 2 | 3 | 4 | 5 |
| 50 to 55 | 1 | 2 | 3 | 5 | 6 |
| 55 to 60 | 1 | 3 | 4 | 5 | 7 |
| 60 to 65 | 2 | 3 | 5 | 7 | 8 |
| 65 to 70 | 2 | 4 | 6 | 8 | 10 |

Example.—Latitude, 47° . Range line bears $N. 0^{\circ} 2' E.$; then parallel meridional section lines will be run as follows:

From the corner for sections—

35 and 36, $N. 0^{\circ} 1' E.$

34 and 35, north.

33 and 34, $N. 0^{\circ} 1' W.$

32 and 33, $N. 0^{\circ} 2' W.$

31 and 32, $N. 0^{\circ} 3' W.$

137. After testing his instrument on the true meridian thus determined, the deputy will commence at the corner to sections 35 and 36, on the south boundary, and run a line parallel to the range line, establishing at 40.00 chains, the quarter-section corner between sections 35 and 36, and at 80.00 chains the corner for sections 25, 26, 35, and 36.

138. From the last-named corner, a random line will be run eastward, without blazing, parallel to the south boundary of section 36, to its intersection with the east boundary of the township, placing at 40.00 chains from the point of beginning, a post for temporary quarter-section corner. If the random line intersects said township boundary exactly at the corner for sections 25 and 36, it will be blazed back and established as the true line, the permanent quarter-section corner being established thereon, midway between the initial and terminal section corners.

139. When the objective corner is in sight from the starting corner, or the deputy has evidence of its location to prove that a different random course would fall closer to the corner, he may use such changed course for his random. A line may be run as a "random for distance only," when the course is certain.

140. If the random intersects said township boundary to the north or south of said corner, the falling (see "Limits," page 66) will be carefully measured, and from the data thus obtained, the true return course will be calculated, and the true line blazed and established and the position of the quarter-section corner determined, as directed above.

The details of the entire operation will be recorded in the field notes.

141. Having thus established the line between sections 25 and 36, from the corner for sections 25, 26, 35, and 36, the west and north boundaries of sections 25, 24, 13, and 12, will be established as directed for those of section 36; with the exception that the random lines of said north boundaries will be run parallel to the established south boundaries of the sections to which they belong, instead of the south boundary of section 36; e. g., the random line between sections 24 and 25 will be run parallel to the established south boundary of section 25, etc.

142. Then, from the last established section corner, i. e., the corner of sections 1, 2, 11, and 12, the line between sections 1 and 2 will be projected northward, on a random line, parallel to the east boundary of the township, setting a post for temporary quarter-section corner at 40.00 chains, to its intersection with the north boundary of the township. If the random intersects said north boundary exactly at corner for sections 1 and 2, it will be blazed back and established as the true line, the temporary quarter-section corner being established permanently in its original position, and the fractional measurement thrown into that portion of the line between said corner and the north boundary of the township.

If however, said random intersects the north boundary of the town-

ship, to the east or west of the corner for sections 1 and 2, the consequent falling will be carefully measured, and from the data thus obtained the true return course will be calculated^a and the true line established, the permanent quarter-section corner being placed upon the same at 40.00 chains from the initial corner of the random line, thereby throwing the fractional measurement in that portion lying between the quarter-section corner and the north boundary of the township.

143. When the north boundary of a township is a base line or standard parallel, the line between sections 1 and 2 will be run parallel to the range line as a true line, the quarter-section corner will be placed at 40.00 chains, and a closing corner will be 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, will be carefully measured and noted as a connection line.

144. Each successive range of sections progressing to the west, until the fifth range is attained, will be surveyed in a similar manner; then, from the section corners established on the west boundary of said range of sections, random lines will be projected to their intersection with the west boundary of the township, and the true return lines established as prescribed for the survey of the first or most eastern range of sections, with the exception that on the true lines thus established the quarter-section corners will be established at 40.00 chains from the initial corners of randoms, the fractional measurements being thereby thrown into those portions of the lines situated between said quarter-section corners and the west boundary of the township.

145. The following general requirements are reiterated for emphasis:

The random of a latitudinal section line will always be run parallel to the south boundary of the section to which it belongs, and with the true bearing of said boundary; and when a section has no linear south boundary, the random will be run parallel to the south boundary of the range of sections in which it is situated, and fractional true lines will be run in a similar manner.^b

146. The deputy is not required to complete the survey of the first range of sections from south to north before commencing the survey of the second or any subsequent range of sections, but the corner on which any random line closes shall 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 will be established by running the latitudinal section line as a true line, with a true bearing, determined as above directed for random lines, setting the quarter section corner at 40.00 chains and the section corner at 80.00 chains.^c

147. Quarter-section corners, both upon meridional and latitudinal section lines, will be established at points 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

^a See Table XI and rules, pages 118 and 119.

^b See Plate III, between sections 7 and 18, and 17 and 20.

^c See Plate III, between sections 8 and 17.

to law, on the extreme tier or range of quarter sections, as the case may be.

148. Where by reason of impassable objects only a portion of the south boundary of a township can be established, an auxiliary base line (or lines, as the case may require) will be run through the portion which has no linear south boundary, first random, then corrected, connecting properly-established corresponding section corners (either interior or exterior) and as far south as possible; and from such line or lines, the section lines will be extended northwardly in the usual manner, and any fraction south of said line will be surveyed in the opposite direction from the section corners on the auxiliary base thus established. (See Plate II, figs. 3, 4, and 5.)

149. Where by reason of impassable objects or other reasons no part of the south boundary of a township can be regularly established, the subdivision thereof will proceed from north to south and from east to west, thereby throwing all fractional measurements and areas against the west boundary, and the meanderable stream or other boundary limiting the township on the south.

If the east boundary is without regular section corners and the north boundary has been run eastwardly as a true line, with section corners at regular intervals of 80.00 chains, the subdivision of the township will be made from west to east, and fractional measurements and areas will be thrown against the irregular east boundary.

150. When the proper point for the establishment of a township or section corner is inaccessible, and a witness corner can be erected upon each of the two lines which approach the same, at distances not exceeding twenty chains therefrom, said witness corners will be properly established, and the half miles upon which they stand will be recognized as surveyed lines.

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

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

151. Where impassable precipices, deep canyons, or lands otherwise quite unsurveyable, prevent the extension of regular lines, deputies are not authorized to set meander corners, nor to meander the line separating lands that can be traversed from those that can not. In place of meandering, they are to set witness corners on line, near the intersection of section lines with the brink or foot of the impassable cliffs, or at the margin of the impracticable marsh, to represent an inaccessible regular section or quarter-section corner if within twenty chains. Such quarter sections thus marked may be platted as surveyed.

152. Where a large or desirable tract is found to have its accessible section lines too short to justify the erection of such witness corners, and to render it regularly surveyed, offset lines may be run on lines of legal subdivision, far enough to show, by necessary witness corners, the 40-acre tracts that would otherwise have been excluded from survey.

The topographic sketches of mesas and impassable canyon regions, returned by deputies, will show as nearly as practicable the location of these features and their margins; and where possible the corners on opposite sides of a canyon should be connected by triangulation at least once in each township.

MEANDERING.

153. The running of meander lines has always been authorized in the survey of public lands fronting on large streams and other bodies of water, but does not appear to have been proper in other cases. The mere fact that an irregular or sinuous line must be run, as in case of a reservation boundary, does not entitle it to be called a meander line except where it closely follows a stream or lake shore. The legal riparian rights connected with meandered lines do not apply in case of other irregular lines, as the latter are strict boundaries.

154. Lands bounded by waters are to be meandered at mean high-water mark. This term has been defined in a State decision (47 Iowa, 370) in substance as follows: High water mark in the Mississippi River is to be determined from the river bed; and that only is river bed which the river occupies long enough to wrest it from vegetation.

In another case (14 Penn. St. 59) a bank is defined as the continuous margin where vegetation ceases, and the shore is the sandy space between it and low-water mark.

Numerous decisions in State and U. S. Supreme Courts, assert the principle that meander lines are not boundaries defining the area of ownership of tracts adjacent to waters. The general rule is well set forth (10 Iowa, 549) by saying that in a navigable stream, as the Des Moines River in Iowa, high-water mark is the boundary line. When by action of the water the river bed changes, high-water mark changes and ownership of adjoining land changes with it. The location of meander lines does not affect the question.

155. Inasmuch as it is not practicable in public-land surveys to meander in such a way as to follow and reproduce all the minute windings of the high-water line, the U. S. Supreme Court has given the principles governing the use and purpose of meandering shores, in its decision in a noted case (*R. R. Co. v. Schurmeier*, 7 Wallace, 286-7) as follows:

Meander lines are run in surveying fractional portions of the public lands bordering on navigable rivers, not as boundaries of the tract, but for the purpose of defining the sinuosities of the banks of the stream, and as the means of ascertaining the quantity of land in the fraction subject to sale, which is to be paid for by the purchaser. In preparing the official plat from the field notes, the meander line is represented as the border line of the stream, and shows to a demonstration that the water-course, and not the meander line as actually run on the land, is the boundary.

In cases where the deputy finds it impossible to carry his meander line along mean high-water mark, his notes should state the distance therefrom, and the obstacles which justify the deviation.

156. 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 will be universally used to distinguish the two banks of a river or stream.

157. Navigable rivers, as well as all rivers not embraced in the class denominated "navigable," the right-angle width of which is three chains and upwards, will be meandered on both banks, at the ordinary mean high-water mark, by taking the general courses and distances of their sinuosities, and the same will 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, except that streams which are less than three chains wide and which are so deep,

swift and dangerous as to be impassable through the agricultural season, may be meandered, where good agricultural lands along the shores require their separation into fractional lots for the benefit of settlers. But such meander surveys shall be subject to rejection if proved unnecessary by field inspection.

158. Shallow streams, without any well-defined channel or permanent banks, will not be meandered; except tide-water streams, whether more or less than three chains wide, which should be meandered at ordinary high-water mark, as far as tide-water extends.

At every point where either standard, township, or section lines intersect the bank of a navigable stream, or any meanderable shore, corners will be established at the time of running these lines. Such corners are called meander corners, and the deputy will commence at one of these corners, follow the bank or boundary line, and take the bearing and measure the length of each course, from the beginning corner to the next meander corner.

159. All courses reported are to be compass courses, taken or counted from the meridian, and not from a latitudinal line; and "transit angles" showing only the amount of deviation from the preceding course, are not allowed in field notes of meanders.

160. For convenience of testing by traverse, the courses of meander lines should be given by the nearest quarter degree. As meandered lines are not strict boundaries, this method will give results with approximate accuracy for good closings within the limits of a section. Meander lines will be examined in the field as well as rectangular lines, before acceptance.

161. All meanders should be traversed before leaving the vicinity, and if misclosure is found, indicating error in measurement or in reading courses, the lines must be re-meandered.

162. The crossing distance between meander corners on same line, and the true bearing and distance between corresponding meander corners, will be ascertained by triangulation or direct measurement, in order that both shores may be protracted. The particulars will be given in the field notes.

163. For convenience of platting and computation, the deputy is required to use in meanders distances having whole chains, or multiples of ten links, with odd links only in closing distances.

164. The meanders of all lakes, navigable bayous, and deep ponds of the area of twenty-five acres and upwards, will be commenced at a meander corner and continued, as above directed for navigable streams; from said corner, the courses and distances of the entire margin of the same, and the intersections with all meander corners established thereon, will be noted.

165. All streams falling into the river, lake, or bayou will be noted, and the width at their mouths stated; also, the position, size, and depth of springs, whether the water be pure or mineral; also, the heads and mouths of all bayous; all islands, rapids, and bars will be noted, with intersections to their upper and lower ends, to establish their exact situation. The elevation of the banks of lakes, bayous, and streams, the height of falls and cascades, and the length and fall of rapids will be recorded in the field notes.

166. To meander a lake or deep pond lying entirely within the boundaries of a section, two lines will be run from the two nearest corners on different sides of such lake or pond, the courses and lengths

of which will be recorded, and if coincident with unsurveyed lines of legal subdivisions, that fact will also be stated in the field notes, and at each of the points where said lines intersect the margin of the pond or lake, a special meander corner will be established as above directed.

A special meander corner is one established on a line of legal subdivision, not a standard, township, or section line.

167. 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 notes.

168. Meander lines will not be established at the segregation line between dry and swamp or overflowed land, but at the ordinary high-water mark of the actual margin of the rivers or lakes on which such swamp or overflowed lands border.

169. The precise relative position of an island, in a township made fractional by a river or lake in which the island is situated, will be determined by triangulation from a special and carefully measured base line, initiated upon the surveyed lines, on or near the lake or river bank on the mainland, so as to connect by course and distance on a direct line, the meander corner on the mainland with the corresponding point on the island, where the proper meander corner will be established.

170. In making the connection of an island lying entirely within a section, with the mainland, a special base will be measured from the most convenient meander corner, and from such base, the location of an auxiliary meander corner (that is, one not on a line belonging to the system of rectangular surveying; see page 48) will be determined by triangulation, at which the meanders of the island will be initiated.

171. In the survey of lands bordering on tide waters, meander corners may be temporarily set at the intersection of the surveyed lines with the line of mean high tide, but no monument should be placed in a position exposed to the beating of waves and the action of ice in severe weather. In all such cases, the rule given in section 90 must be observed, by establishing a witness corner on line at a secure point near the true point for the meander corner.

172. The field notes of meanders will show the dates on which the work was performed, as illustrated in the specimen notes, page 186. The field notes of meanders will state and describe the corner from which the meanders commenced, and upon which they closed, and will 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 meandered. The utmost care will be taken to pass no object of topography, or change therein, without giving a particular description thereof in its proper place in the notes of the meanders.

SUMMARY OF OBJECTS AND DATA INTERSECTED BY THE LINE OR IN
ITS VICINITY, TO BE NOTED.

173. 1. The precise course and length of every line run, noting all necessary offsets therefrom, with the reason for making them, and method employed.

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 intersects the boundary lines of every reservation, town site, donation claim, Indian allotment, settler's claim, improvement, or rancho; prairie, bottom land, swamp, marsh, grove, and windfall, with the course of the same at all points of intersection; also, the distances at which the line begins to ascend, arrives at the top, begins to descend, and reaches 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. Also, distance to and across large ravines, their depth and course.

6. Intersections by line of water objects. All rivers, creeks, and smaller streams of water which the line crosses; the distances measured on the true line to the bank first arrived at, the course down stream at 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, hilly, or mountainous.

8. The soil—whether rocky, stony, sandy, clay, etc., and also 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 streams flowing from them.

12. Lakes and ponds—describing their banks and giving their height, and whether it be pure or stagnant, deep or shallow.

13. Improvements. Towns and villages; houses or cabins, fields, or other improvements with owners' names; mill sites, forges, and factories, U. S. mineral monuments, and all corners not belonging to the system of rectangular surveying; will be located by bearing and distance, or by 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 that can be obtained respecting these objects, whether they be on the line or not, will appear in the general description.

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, remarkable crags, 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 magnetic declination will be incidentally noted at all points of the lines being surveyed, where any material change in the same indicates the probable presence of iron ores; and the position of such points will be perfectly identified in the field notes.

PREScribed LIMITS FOR CLOSINGS AND LENGTHS OF LINES.

174. If in running a random township exterior, such random exceeds or falls short of its proper length by more than three chains, allowing for convergence, or falls more than three chains to the right or left of the objective point (or shows a proportionate error for lines of greater or less length than six miles), it will be re-run, and if found correctly run, so much of the remaining boundaries of the township will be retraced, or resurveyed, as may be found necessary to locate cause of misclosure.

175. Every meridional section line, except those which terminate upon a fractional side of a township, will be 80 chains in length, without allowance of 50 links per mile for difference of measure, or any other allowance beyond a small reasonable discrepancy according to the nature of the surface, to be determined after examination.

176. The random meridional or latitudinal lines through a tier or range of fractional sections shall fall within 50 links of the objective corners, and a greater falling will indicate negligence or error.

177. The actual lengths of meridional section lines through a fractional north or south tier of sections shall be within 150 links of their theoretical length. The latter will be determined from the given lengths of meridional boundaries on the east and the west range lines.

178. Each latitudinal section line, except in a fractional east or west range of sections, shall be within 50 links of the actual distance established on the governing north or south boundary of the township for the width of the same range of sections.

179. The north boundary and the south boundary of any section, except in a fractional range, shall be within 50 links of equal length.

180. The meanders within each fractional section or between any two successive meander corners, or of an island or lake in the interior of a section, should close by traverse within a limit to be determined by allowing five-eighths of a link for each chain of such meander line. This rule does not apply to irregular boundaries of reservations or private claims, except as far as the same are natural water boundaries. The total misclosure of meanders will not be permitted to exceed 150 links, except in large private land claims, which are governed by a different rule and limit. (See section 153.)

181. In closing upon accepted surveys, when irregularities beyond the allowable limits are developed, either in the length or direction of the closing lines, closing corners will be set, with quarter-section corners at 40 chains from the last interior section corner;

182. And, in general, when conditions are met which result in a random line being defective, either in length or direction, such procedure will be adopted as will secure the greatest number of new rectangular legal subdivisions, without disturbing the condition of accepted surveys.

FIELD NOTES.

183. The proper blank books for original field notes will be furnished by the surveyor general, and in such books the deputy surveyor

will make a faithful, distinct, and minute record of everything 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, full and complete topographical sketches of all standard and exterior lines, drawn to the usual scale for township exteriors. These "original field notes" are not necessarily the entries made in the field, in the deputy's pocket note books called tablets; but they are to be fully and correctly written out in ink, from such tablets, for the permanent record of the work. Tablets should be so fully written as to verify the original field notes whenever the surveyor general requires them for inspection.

184. A full description of all corners belonging to old surveys, from which the lines of new surveys start, or upon which they close, will in all cases be furnished the deputy from the surveyor general's office, when authority is given for commencing work; then, if the old corners are found to agree with said descriptions, the deputy will describe any one of them in this form, "which is a — firmly set, marked and witnessed as described by the surveyor general;" but, should a corner not answer the description supplied, the deputy will give a full description of such corner and its accessories, following the proper approved form given in these instructions.

185. A full description of each corner established under any one contract will be given once only; subsequent reference to such corner will be made in the form, "heretofore described," or "the corner of sections 2, 3, 10, and 11," as the case may require.

In all cases where a corner is reestablished, the field notes will describe fully the manner in which it is done.

186. The field notes of the survey of base, standard, and meridian lines will 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 character of townships on each side of the lines run.

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

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

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

189. With the field notes of the survey of base lines and standard parallels, and principal and guide meridians forming a tract 24 miles square (see page 20 and Plate II), including those of the township exteriors therein, the deputy will submit a diagram of the lines surveyed, drawn to a scale of half an inch to one mile, upon which will be written the true bearings and lengths of all surveyed lines, except the lengths of those which are actually 40.00 or 80.00 chains. These diagrams will exhibit all water courses, with the direction of each

indicated by an arrow head pointing down stream; also, the intersection of the lines with all prairies, marshes, swamps, ravines, lakes, ponds, mountains, hills, and all other natural or artificial topographical features mentioned in the field notes, to the fullest extent possible.

190. With the special instructions for making subdivisional surveys of townships into sections, the deputy will be furnished by the surveyor general with blank township diagrams drawn to a scale of one inch to forty chains, upon which the true bearings and lengths of the township and section lines, from which the surveys are to be projected, or upon which they are to close, will be carefully marked; and on such diagrams 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 of intersection therewith, but also the directions and relative positions of such objects between the lines, or within each section, as far as practicable, so that every topographical feature may be properly completed and connected in the showing.

191. Triangulations, offsets, or traverses, made to determine distances that can not be directly measured, such as those over deep streams, lakes, impassable swamps, cañons, etc., will be made on the random lines (see pages 24 and 121), when random lines are run. All particulars will be fully stated in the field notes.

192. The exhibition of every mile of surveying, whether on standard, township, or subdivision lines, and the meanders in each section, will be complete in itself, and will be separated from other records by a black line drawn across that part of the page containing the body of notes. The description of the surface, soil, minerals, timber, undergrowth, etc., on each mile of line will follow the notes of survey of such line, and not be mingled with them.

Particular care will be taken to record at the end of each mile the number of chains of mountainous land, heavily timbered land, or land covered with dense undergrowth. (See section 395.)

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

193. Near the end of the field notes of exteriors and immediately before the "general description," the deputy surveyor will add, in the form shown in specimen field notes (page 155), a tabular statement of the latitude and departure of all boundary lines of the township, derived from a traverse table, and will give the totals, and the errors in latitude and departure; said errors shall in no case exceed three chains, the prescribed limit for the falling of the random north boundary of a township. If a part or the whole of one or more boundaries is made up of meander lines, the northings, southings, eastings, and westings of the full section lines, nearest said meanders, will replace the missing N., S., E., or W. township lines, as the case may require, thereby presenting the errors of said boundaries of a closed survey.

194. 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 another contract, the deputy will use the bearings and distances supplied by the surveyor general, in connection with those of his own lines; and, if errors exceed the allowance of three chains, specified in paragraph 1 of the "Prescribed Limits", the deputy will determine by retracement where the error occurs, correct the same before he leaves the field, and place the table in his original field notes.

195. Besides the ordinary notes taken on line (and which will always be written down on the spot, leaving nothing to be supplied by memory), 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, settlements, etc.

196. Following the general description of the township will be placed "A list of the names of the individuals employed to assist in running, measuring, and marking the lines and corners described in the foregoing 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.

197. The forms of official oaths required to be taken by deputy surveyors and assistants, and attached to their field notes, are exemplified in the specimen field notes, pages 144 and 145.

There may be several books of one class of lines covered by one set of oaths, which must distinctly specify the work they are intended to cover. When the contract comprises several books of returns, they, as well as transcripts of the same, are to be lettered in proper sequence, A, B, etc., on the title pages. Any book not containing the affidavits must show by a final note where to find the oaths covering that portion of the contract, as "Final affidavits in book D."

198. When the work of two deputies is recorded in the returns under one contract, each book must show clearly what lines were surveyed by each deputy. Wherever one deputy's work ceases and another begins in the same book, the name of the former must be inserted at the end of his part of the notes.

199. The final oath of the deputy surveyor will be taken before the U. S. surveyor general for the State or Territory in which the survey is executed, or before any other officer authorized by the laws of the United States or by the municipal authorities, to administer land oaths, except notaries public.

It is preferable that both preliminary and final oaths 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 will submit to the proper surveyor general, a full written report of the circumstances which required his stated action.

200. The deputy will transmit the field notes duly attested and the required sketches to the surveyor general at the earliest practicable date after completion of his work in the field. Said original field notes will be filed in the office of the surveyor general as a part of its permanent records, subject only to the direction of the Commissioner of the General Land Office; and no changes whatever will be made in said original field notes, after they have been filed in the surveyor general's office, without permission of the Commissioner.

The delivery of the field notes and sketches to the surveyor general's office for examination, constitutes the filing of the deputy's returns, which must at that time include his final oath. The surveyor general will record the date of such filing. (See page 15.)

201. The field notes, each book bearing the written approval of the surveyor general, will be substantially bound in volumes of suitable size and retained in the surveyor general's office. Certified transcripts of said field notes will be prepared at the earliest practicable date, as follows:

202. The field notes of the survey of base lines and standard parallels, of principal and guide meridians, of township exteriors, and of subdivision and meander lines, will be written in separate books. A complete set of preliminary and final oaths will be attached to the field notes of each class of lines. (See page 55.) No adhesive material of any kind will be used to fasten leaves or covers. Cut or mutilated leaves, or slips, will not be inserted.

203. The field notes of subdivisions will be written in a separate book for each township; the preliminary oaths of the assistants employed in making said subdivisions will be prefixed to the first book, and their final oaths will be attached to the last book of the series, arranged in the order of dates.

204. The first or title page of each book of field notes will describe the subject matter of the same, the locus of the survey, by whom surveyed, number and date of contract, and the dates of commencement and completion of the work.

205. The second page of each book of field notes will contain the names and duties of the assistants employed on the surveys recorded therein; the index will be placed on the same or following page.

206. Whenever a new assistant is employed, or the duties of any one of them changed, such fact will be stated in an appropriate entry immediately preceding the notes taken under such changed arrangements.

207. No abbreviations or contractions of words are allowable, except as enumerated on page 26 or as shown in the specimen field notes.

208. All transcripts of field notes, made out as herein directed, will be written on official field-note paper, foolscap size (pages $13\frac{1}{2} \times 8\frac{1}{2}$ inches), in a bold, legible hand, or type-written, preserving the marginal spaces intact for binding, and as nearly as possible without erasures or interlineations; such transcripts of any series of surveys, included in one account forwarded to the General Land Office, will be securely put up for mailing, at the office of the surveyor general, prior to transmission.

SPECIAL INSTRUCTIONS TO DEPUTY SURVEYORS.

209. 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 will not consist of directing attention to certain paragraphs in this Manual, reiteration of its requirements, and printed directions of a general nature; but they will in all cases 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, full advice as far as practicable what to do in case the surveys on the ground are not as represented in the old notes.

210. 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, and provide for his use one or more diagrams, drawn to a scale of one inch or one-half inch to one mile, 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, or blue prints or tracings therefrom. In no case must the deputy be sent into the field without full and accurate information in regard to all irregularities on the records which will affect the extent or accuracy of his survey.

SPECIMEN FIELD NOTES.

[See Plates II and III.]

211. Specimen field notes Nos. 1, 2, 3, 4, and 5, illustrate, respectively, the method and order to be followed in the survey of standard parallels, guide meridians, and township exteriors; resurvey of township exteriors; and the subdivision of a township into sections and quarter sections.

The attention of every deputy surveyor is particularly directed to these specimens, as indicating not only the method by which his work will be conducted, but also the form, order, language, etc., in which his field notes will be prepared for the office of the surveyor general, and such specimens will be deemed a part of these instructions; and any departure from their details, in cases where the circumstances are analogous in practice, will be regarded as a violation of his contract and oath.

DIAGRAM OF TOWNSHIP EXTERIORS.

212. The title, certificate, and remarks on Plate II, with the specimen field notes Nos. 1, 2, and 3, will fully explain the drawing designated "Township Exteriors."

In all cases the course and length of each township boundary will be clearly stated on the diagram of exteriors; and when any township boundary entered on the diagram, surveyed under the current contract or a prior one, departs from the true meridian or proper latitude curve, or falls short or exceeds its proper length, by an amount in excess of the prescribed limits of 21' of arc and three chains to six miles, the actual position and extent of such township boundary will be graphically exhibited on the diagram, as well as by bearing and length recorded in the field notes. Where exteriors are surveyed or resurveyed in connection with subdivision work, a separate diagram of such exteriors is required.

SPECIMEN TOWNSHIP PLAT.

213. Plate III illustrates the subdivision of a township into sections and quarter sections; the record of said subdivision being given in detail in specimen field notes No. 5.

214. Each township plat will be prepared in triplicate. One plat, considered the original, will be retained as the record in the office of the surveyor general; the duplicate will be transmitted to the General Land Office; and the triplicate, after acceptance and permission given by the Commissioner, will be filed in the United States land office of the proper district. These plats will not be altered or added to, and any changes (beyond correction of clerical errors) authorized by the Commissioner, will be shown upon a supplemental plat or diagram, prepared in triplicate.

215. The plats will be prepared as nearly as possible in accordance with the specimen plat designated "Plate III." The use of all fluids, except a preparation of India ink of good quality, will be avoided by the draughtsman in delineations relating to the public surveys. All lines, figures, etc., will be sharply defined. All lettering on the plats will be clear and sharp in outline and design, and *black*; 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.

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

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

216. Plats will not be trimmed. A margin of three inches for binding will be preserved on the left-hand side of each plat. Each plat will be certified by the surveyor general, with table annexed, according to the form on Plate III, and will exhibit the area of public land, water surface, townsite, private land claims, and mineral claims, with the total area of the township.

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 names of natural features will be correctly given according to accepted usage. Surveyors are not authorized to report names of their own selection, but will give those in use, or leave the lake, stream, or peak unnamed. The "U. S. Board on Geographic Names" is the authority upon these matters.

217. Topography, such as ridges, valleys, streams, dry runs, acequias, trails, plateaus, marshes, etc., will if possible be connected across sections. All water ditches or acequias will be shown and designated as such, without reference to ownership. Timbered areas, large or small, will not be left blank like open country.

218. Dry runs will be shown by broken or dotted lines, and actual water courses by continuous lines. Where it is difficult for the deputy to decide whether to consider it a water course or not, the words "dry run," "water in holes," or other explanation may be inserted, as the location of water in a dry country is an important feature. The former

practice of representing dry swales by full black lines like those used for running streams will not be continued.

219. Where heavy topographical details are to be drawn, first insert the figures and letters, and avoid obscuring them by subsequent marks.

Draftsmen should not lose sight of the fact that their work is to be reproduced at this office in the form of photolithographic copies for all future applicants; and that imperfect characters, weak lines, and diluted india ink are not compatible with good copying by that process. Use dense black ink in all instances, and avoid brush shading.

220. Where a surveyed line between sections is broken into two or more portions by intervening corners, the fractional distances will be fully given. Leave no such distance to be computed by the reader. This need not, however, apply where a connection distance is shown at a closing corner on township line.

221. The table at bottom of plat will be filled out, so as to show how and when each exterior line was surveyed, as well as the subdivisions, thus: "S. Boundary," "W. Boundary," and "N. and E. Boundary," may fill three lines describing work under three separate contracts.

The number of the contract will always be conspicuously shown on the plat, and on the title page of transcripts. Its frequent omission is a source of annoyance. See table in Plate III.

Lines not actually run, but extended by offsetting around impassable obstacles, are to be dotted or broken lines, as shown on sections 16, 21, and 22, in the specimen plat.

222. Township plats will show the complete condition of all their exteriors, including all closing and standard corners, connecting distances, offsets, and topography. A line common to two townships will be drawn with equal completeness for both, as far as approved surveys permit.

A township rendered fractional by an adjacent reservation or private land grant, will have the intervening boundary properly lettered, and the mile posts and connecting distances shown. The blank area will show its proper designation.

223. Where a fractional portion of a township is newly surveyed, the condition of adjacent areas will be clearly shown by words lettered thereon, such as these: "Unsurveyed," "U. S. Forest Reserve," "Rancho San Luis," "Surveyed by James Jones, 1877," "Lava Bed," or other explanation.

On such supplementary plats, areas previously surveyed will have the sections and lots drawn in blank, to show the contact of old and new work.

224. The line of demarcation, between areas previously counted in total acreage surveyed and the new surveys, will be distinctly shown. A light diagonal shading with black ink is recommended, to distinguish such a line.

225. Meanders will not be left without any index whatever in field notes and transcripts. They should be traced on the index diagram, and properly marked with page numbers. See note on page 160.

226. The use of small circles on plats, at any of the angles of surveyed lines, has been prohibited, and will not be permitted. Although distinctive marks of that sort are shown on some of the explanatory diagrams of this Manual, yet they are not desired in any kind of plats for official record, under the general rule forbidding useless ornamentation.

227. The meander corners within any township were formerly all numbered consecutively on the plat. The lists of meanders, formerly placed in the margin, made such numbering useful for convenient reference. These lists not being now used, the consecutive numbers are no longer required.

228. As a general rule, a quarter section is returned as surveyed land when three of its regular corners have been legally established. The following exceptions are made to this rule:

When no authority had been given for the subdivision of that township or part of township, as in the case of the extreme quarter sections at the corners.

Where there is no corner opposite one of the three corners to which the protracting line can be connected.

229. When the land forms part of a fractional section where areas can not be accurately computed without the survey of other boundaries of the section, as in section 2 when it has its north and east but not its west line established.

When undetermined corners of the sections are in mountainous regions pronounced unsurveyable in the returns, or where witness corners have been substituted for true corners of the tract, at a distance greater than 10 chains.

FRACTIONAL LOTS.

230. The subdivision of fractional sections into lots is performed in the drafting division of the several offices, and not by the surveyor. Skill and judgment are required, to produce these lots in the most convenient and equitable form for both the purchaser and the Government. In addition to former rules, the following are now given:

231. Avoid needlessly small subdivisions.

Avoid giving to lots a long shore line with small width. Therefore apportion the privileges of water front among as many lots as regular division lines will permit, and let the longer direction extend back from the shore rather than along the water.

232. Instead of making as many full forty-acre tracts as possible, leaving small fractions of a few acres along the shore or other boundary, attach such marginal strips to the forties, making tracts of 45, 50, or 55 acres. But when the area of a fractional lot would equal or exceed 60 acres, it should be divided. No lot should lie partly in two sections.

233. The subdivision of fractional sections into regular lots (as near as may be) will be so laid down on the official township plat in broken black lines as to admit of giving to each a specific designation by word description, if possible, according to its relative position in the fractional section, as per examples on Plate III; or by a number, in all cases where the lot can not properly be designated as a quarter quarter. Those fractional lots which are not susceptible of being described according to relative local position will be numbered in a regular series; those bordering on the closing boundaries of a township to be numbered progressively from east to west or from north to south, in each regular 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.

234. To secure a uniform system for numbering lots of fractional sections, including those above specified, imagine the section divided by three equidistant parallel latitudinal lines into four strips or tiers, numbered from north to south; then, beginning with the eastern lot of the north tier, call it No. 1, and continue the numbering west through the tier, then east in the second, west in the third, and east in the fourth tier. A lot extending north and south through two, or part of two tiers, will be numbered in the tier containing its greater area. In case any tier is without numbered lots, the numbering will be continued in the next tier to the south. (Plate III, section 18.)

This method of numbering will apply to any part of a section, regardless of the relative situation of a part or parts surveyed and lotted under a prior contract; in this case the lot numbers will be a continuation of the series already initiated.

A section that has been partly surveyed at different times should have no duplication of lot numbers.

235. When, by reason of irregular surveys or from other causes, the length of a township from south to north exceeds the lawful length of 480.00 chains, or the width from east to west exceeds 480.00 chains minus the proper convergency, to such extent as to require two or more tiers of lots along the north boundary, or two or more ranges of lots along the west boundary, as the case may be, the entire north or west portions of said sections beyond the quarter corner will be properly lotted, and to each lot will be assigned its proper number; and in such cases the area of each lot will be stated on the plat.

In case the length or width of the township falls so far short of legal dimensions as to eliminate the north or west half of any section situated as above specified, that part of the section remaining will be treated in a similar manner.

236. In a regular township (Plate III) the southeast quarter of the northwest quarter of section 6 will have its proper area in acres (40) inserted in all cases. The half quarter sections in north tier and west range of sections will exhibit their proper areas in acres (80); while the areas of quarter sections will be omitted, except as follows:

237. When two lines of legal subdivision of either 160, 80, or 40 acre tracts intersect each other on or so near a meander or boundary line that the ordinary inaccuracies of drawing would leave the areas of said tracts in doubt, the plats will, for the sake of clearness and a full showing of the facts, exhibit the proper areas of such quarter, half-quarter, and quarter-quarter sections. See examples, Plate III, in sections 13, 17, 25, and 35.

TRANSCRIPTS.

238. Transcripts of field notes should have a proper heading on each page. Instead of the perplexing title, "Exterior Boundaries of T. 12 N., R. 4 W.," specify on each page thus: "West Boundary," or "N. Bdy. of T. 12 N., R. 4 W."

239. The index diagram of exteriors will show lines drawn in their true directions, as on page 152; thus, range lines will not be shown horizontally.

240. Where corrections in the field have been permitted, care will be exercised that field notes thereof be added to former field notes with proper dates, explanations, and additional oaths.

241. The sheets of each book are to be firmly bound together. But eyelets or clasps which prevent separating sheets without injury, are not to be used in documents or official correspondence.

A series of books under one contract should be lettered on the title page, A, B, etc., in their proper and consecutive order of dates; and in subsequent correspondence it will be convenient to refer to each book by its letter.

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

Printed blank forms of such notes are 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 supplemental blank form.

COMPUTATION OF THE AREAS OF LOTS ADJOINING THE BOUNDARIES OF TOWNSHIPS.

243. In regular townships, the tracts of land in each section adjoining the north and west boundaries of such townships, in excess of the regularly subdivided 480 acres (except in section 6), will, in general, be in the form of trapezoids, 80.00 chains in length by about 20 chains in width.

On the plats of such townships, each of said tracts will be divided into four lots, by drawing broken lines at intervals of 20.00 chains, parallel to the ends of the tracts, which will be regarded as parallel to each other.

With the exception of section 6, the south boundaries of sections of the north tier, when within prescribed limits, will be called 80.00 chains.

When the above-named conditions obtain, the areas of the lots in any one tract (except in section 6) may be determined, as follows:

Divide the difference between the widths of the ends of the tract by 4; if 3 remains, increase the hundredth figure of the quotient by a unit; in all other cases disregard the fraction; call the quotient thus obtained, "d"; then, taking the end widths of the tract in chains and decimals of a chain, the areas of the lots, in acres, will be:

Of the smallest lot: twice the width of the lesser end, plus "d";

Of the largest lot: twice the width of the greater end, minus "d";

Of the smaller middle lot: sum of the widths of the ends, minus "d";

Of the larger middle lot: sum of the widths of the ends, plus "d".

A check on the computation may be had by multiplying the sum of the widths of the ends of the tract by 4; the product should agree exactly with the total area of the four lots.

The proper application of the above rules will always give areas correct to the nearest hundredth of an acre; and, as the use of fractions is entirely avoided, the method is recommended for its simplicity and accuracy.

Example 1. (See Plate III, section 31.)

The $\frac{1}{4}$ difference of latitudinal boundaries is 0.034 chains; consequently, "d" is .04 chains; then,

$$\begin{array}{r} 18.35 \times 2 \quad +.04 = 36.74 \text{ acres, the area of lot 1;} \\ 18.50 \times 2 \quad -.04 = 36.96 \text{ acres, the area of lot 4;} \\ 18.50 + 18.35 \quad -.04 = 36.81 \text{ acres, the area of lot 2;} \\ 18.50 + 18.35 \quad +.04 = 36.89 \text{ acres, the area of lot 3;} \end{array}$$

Check: $[18.35 + 18.50] \times 4 = 147.40$ acres, the area of the four lots.

The arithmetical operations are here written in detail, for the purpose of illustration; but the practical computer will perform all the work mentally.

244. Section 6. (See Plate II, figs. 6 and 7; and Plate III.) The areas of lots 5, 6, and 7 may be obtained by the foregoing rules in all cases, except when the township closes on a base line or standard parallel; also, the area of lot 4, provided both meridional boundaries are 80.00 chains in length; when the last condition obtains, the areas of lots 1, 2, and 3 will be equal, and each will contain 40.00 acres.

In any case where the west boundary of sec. 6, is 80.00 chains, and the east boundary either greater or less than 80.00 chains, the areas of lots 1, 2, 3, and 4 will be computed as follows:

Refer to figures 6 and 7 and determine the difference, "q", between the east boundaries of lots 1 and 4 by the following proportion:

N. bdy. sec. 6.: diff. of meridional bdrs. sec. 6.: 60 chs.: q; then will E. bdy. lot 4 = E. bdy. lot 1 \pm q; in which, "q" will be added when the east boundary of sec. 6 is less than 80.00 chains (fig. 7.); but subtracted when said east boundary is greater than 80.00 chains (fig. 6).

Now take one third of "q," and add it to the shorter east boundary of lots 1 or 4, as conditions may require, and thereby determine the length of one of the meridional boundaries of lot 2; to which, again add "one third of q," and thus obtain the length of the opposite side of lot 2. The areas of lots 1, 2, and 3, in acres, will be found by taking the sum of their respective meridional boundaries, expressed in chains and decimals of a chain.

The area of lot 4 may be had by multiplying its mean width by its mean length.

Finally, to test the entire work, multiply the sum of the latitudinal boundaries by 4, and to the product add the area of the small triangle C A B, if the east boundary is greater than 80.00 chains (fig. 6); but subtract the area of said small triangle if the east boundary is less than 80.00 chains (fig. 7). These operations, correctly performed, will give the true area of the section, which should agree exactly with the total area of its legal subdivisions, obtained as directed in the preceding paragraphs.

Example 2. (See Plate II, figs. 6 and 7, and Plate III.)

Compute areas of lots 5, 6, and 7 of sec. 6, as directed in paragraph 1, and illustrated by the example; then write:

$$\begin{array}{r} \text{chs.} \quad \text{chs.} \quad \text{chs.} \quad \text{chs.} \\ 77.75 : 0.05 :: 60.00 : 0.0386 = q; \quad \frac{1}{3} q = 0.0129 \\ \text{chs.} \quad \text{chs.} \quad \text{chs.} \\ 20.0500 - 0.0386 = 20.01, \text{ the E. bdy. of lot 4;} \\ 20.0114 + 0.0129 = 20.02, \text{ the E. bdy. of lot 3;} \\ 20.0243 + 0.0129 = 20.04, \text{ the E. bdy. of lot 2;} \end{array}$$

Then, for the areas of lots 1, 2, 3, and 4, we have:

| chs. | chs. | acres. | |
|---|--------------------------------|--------|---|
| 20.05 | +20.04 | ..... | = 40.09, the area of lot 1; |
| 20.04 | +20.02 | ..... | = 40.06, the area of lot 2; |
| 20.02 | +20.01 | ..... | = 40.03, the area of lot 3; |
| $\frac{20.00+20.01}{2}$ | $\times \frac{17.75+17.78}{2}$ | | = 35.54, the area of lot 4. |
| Also | $[17.78+17.87] \times 3$ | | = 106.95, the area of lots 5, 6, and 7. |
| Area of regular subdivisions | = | 360.00 | |
| <hr style="width: 50%; margin: 0 auto;"/> | | | |
| Total | .... | = | <u>622.67</u> , the area of sec. 6. |

| chs. | chs. | |
|--------------|----------------|--|
| Check: 77.87 | +77.75 | $\times 4 = 622.48$ |
| 77.75 | $\times 0.025$ | = 0.19, the area of triangle C A B (fig. 6). |

Total....=622.67, which agrees with the area of section 6, before determined.

245. The area in acres of a tract 40.00 chains long, adjoining north or west township boundaries (except in NW. $\frac{1}{4}$ sec. 6), is equal to the sum of its parallel boundaries (expressed in chains and decimals thereof) multiplied by 2; e. g., the area of lots 6 and 7 (Plate II, fig. 6), is $[17.87+17.81] \times 2 = 71.36$ acres.

The area in acres of a tract 60.00 chains long, situated as above described (excluding lot 4, of sec. 6), may be found by multiplying the sum of its parallel boundaries (expressed in chains and decimals of a chain) by 3; e. g., fig. 6; south boundary lot 4=17.78 chs.; area of lots 5, 6, and 7 is $[17.78+17.87] \times 3 = 106.95$ acres. (See example 2.)

The area in acres of quarter sections adjoining north and west township boundaries (excluding NW. $\frac{1}{4}$ sec. 6), may be obtained by multiplying the sum of their parallel boundaries (taken in chains and decimals of a chain), by 2; e. g., the area of SW. $\frac{1}{4}$ sec. 6 (fig. 6), is $[37.87+37.81] \times 2 = 151.36$ acres.

The area in acres of any section along the north and west boundaries of regular townships (except sec. 6) may be had by multiplying the sum of its parallel boundaries (expressed in chains and decimals of a chain) by 4; e. g., the area of sec. 1 (Plate III) is $[80.00+79.77] \times 4 = 639.08$ acres.

Subdivisions closing irregularly to the south or east exterior boundary are to be computed by similar methods.

EXPLANATIONS OF ARTICLES ON PAGES 80 to 86, WITH GENERAL DEFINITIONS OF A "RETRACEMENT" AND A "RESURVEY."

246. When new surveys are to be initiated or closed upon the lines of old surveys, which although reported to have been executed correctly, are found to be actually defective in alinement, measurement, or position, it is manifest that the employment of the regular methods prescribed for surveying normal township exteriors and subdivisions would result in extending the imperfections of the old surveys into the new, thereby producing irregular townships bounded by exterior lines not in conformity with true meridians or parallels of latitude, and containing trapezium-shaped sections which may or may not contain 640 acres each, as required by law.

247. Therefore, in order to extend such new surveys without incorporating therein the defects of prior erroneous work, special methods, in harmony as far as practicable with the following requirements, should be employed, viz:

The establishment of township boundaries conformable to true meridian and latitude lines.

The establishment of section boundaries by running two sets of parallel lines governed respectively by true meridians and parallels of latitude, and intersecting each other approximately at right angles at such intervals as to produce tracts of square form containing 640 acres each.

The reduction to a minimum of the number of fractional sections in a township, and consequently of the amount of field and office work.

248. Such special methods are based upon certain limits of allowable error in the alinement, measurement, and position of old township boundaries, as prescribed in the following article entitled "Definitions of Defective Township Boundaries," which will be carefully determined and rectifications made, if necessary, under the provisions of the article entitled "Retracement or Resurvey of Township Lines and Linear Boundaries not Established in Conformity with the Rectangular System of Surveying," page 80, prior to the execution of new surveys under the methods prescribed by the article entitled "Methods of Executing New Surveys, when Initiated or closed upon Defective old Surveys," page 82, and illustrated on Plate VI, by figures 1 to 15; on Plate VII, figures 1 to 7, and on Plate VIII.

249. In order to prevent any misunderstanding relative to the modus operandi indicated by the terms "retracement" and "resurvey," the following definitions of the same are here presented:

The retracement of a township boundary, or other line of survey, consists in the determination of the true bearings and distances between the successive corners along the entire length of such a line; and the data thus obtained will be embodied in the field notes together with detailed particulars of the methods employed.

The resurvey of a township boundary or other line of survey consists of a retracement of such a line accompanied by the reconstruction of defective original corners and the establishment thereon of all the necessary new corners; and the detailed particulars of the entire operations will be embodied in the field notes.

DEFINITIONS OF DEFECTIVE TOWNSHIP BOUNDARIES.

250. Upon retracement thereof, an old township boundary may be found to be defective in one or all of three qualifications, viz: alinement, measurement, and position, as follows:

In alinement: when any portion thereof deviates more than twenty-one minutes of arc from a true meridian or latitude line.

251. In measurement: when the length of the whole boundary or some portion thereof, between two successive corners, is proved to be greater or less than the distance certified in the preceding survey, at a rate exceeding 25 links to the half mile.

252. In position: when the corners originally established on such a boundary can not be connected with the corners on the opposite regu-

larly established boundary, by lines which do not deviate more than twenty-one minutes of arc from true meridian or latitude lines.

253. The limits prescribed in the foregoing paragraphs are to be considered only in determining the necessity of resurveying old township boundaries when new surveys are to be initiated or closed upon the same, and will not be construed in any way as establishing limits of allowable error in the execution of new surveys.

RETRACEMENT OR RESURVEY OF TOWNSHIP LINES AND LINEAR BOUNDARIES NOT ESTABLISHED IN CONFORMITY WITH THE RECTANGULAR SYSTEM OF SURVEYING.

254. If in subdividing a township, it is found that any boundary thereof is defective in excess of the limits of allowable error prescribed in the article entitled "Definitions of Defective Township Boundaries," above, or that the corners originally established thereon had been incorrectly marked, or have been obliterated, the deputy surveyor will resurvey so much of said boundaries as may be necessary.

255. Such necessity is often doubtful until proved by retracement. In connecting new surveys with accepted lines, when misclosure appears, the presumption is in favor of accepted work instead of new lines. A deputy must first examine and remeasure his own lines for possible error; and if he finds them accurate, and is willing to confide the result to a strict inspection thereof, he is to retrace the older work to find the cause of the misclosure. Such retracements and resurveys receive special attention in the inspection; and if their necessity and accuracy are corroborated by the examiner, and approved by the Commissioner, the deputy will be allowed compensation. (See 27 L. D. 79.)

256. When subdivisional lines have not been closed upon either side of, or mineral claims tied to, a township boundary, it will be corrected (if necessary), in point of alinement, as well as measurement, by establishing regular new corners at lawful distances (minus the northing or plus the southing of the south boundary; or minus the westing or plus the easting of the east boundary), from said boundaries respectively (as the case may be), upon a right line connecting the proper township corners, provided said line does not deviate more than twenty-one minutes of arc from a true meridian or latitude line (as the case may be). (See Plate VI, figs. 1, 2, 3.)

But, if the bearing of said line exceeds the limit prescribed above, the new corners will be placed on a line run due north or west, from the southeast corner of the township, to intersection with the township or range line (as the case may be), where a closing corner will be established, and the old township corner properly changed to a corner common to two townships.

The old corners on all township boundaries rectified under the provisions of this paragraph will be destroyed. (See Plate VI, figs. 4 and 5.)

257. Where subdivisional lines have been closed upon one side of, or mineral claims tied to, a township boundary prior to the subdivision of the township on the other side, its alinement will not be changed; all obliterated old corners will be reestablished in their original places; new regular corners common to two townships, sections, or quarter sec-

tions, will be established upon it at lawful distances (minus the northing or plus the southing of the south boundary; or minus the westing or plus the easting of the east boundary), from said boundaries respectively (as the case may be), marked with reference to the township being subdivided, and the marks on the old corners upon such boundary which refer to the new work will be effaced.

Marks on bearing trees will be corrected (if necessary) to indicate the township, range, and section in which they stand, but the mounds will remain as originally established. (See Plate VI, figs 6 and 7.)

258. Where subdivisinal lines have been closed upon one side of, or mineral claims tied to, the northern portion of a range line prior to the subdivision of the township on the other side (see section 257), while upon the southern portion of the same such attachments have not been made on either side (see section 256), said southern portion will be resurveyed and proper new corners established thereon, at lawful distances from the south boundary, as follows:

If the bearing of said southern portion does not deviate more than twenty-one minutes of arc from a true meridian line, it will be rectified under the provisions of the first clause of section 256, and the rectifications will be continued on the northern portion under the provisions of section 257. (See Plate VI, fig. 8.)

If, however, said bearing exceeds the specified limit, from the northern terminal corner of said southern portion, the range line will be extended due south on a random to its intersection with the south boundary, where a corner common to two townships will be established, all the necessary changes made in the markings on the original corner common to four townships situated in its immediate vicinity, and regular new corners placed upon the respective portions of the entire range line as specified in the foregoing clause. (See Plate VI, fig. 9.)

259. Similar cases involving the rectification of the northern portion of a range line when the southern portion of the same can not be rectified in bearing, will be treated in conformity with the rules prescribed in the foregoing clauses, with the exception, that where such northern portion deviates more than twenty-one minutes of arc from a true meridian line, its alinement will be rectified by extending the same from its southern terminal corner, due north on a true line to its intersection with the north boundary, where a proper closing corner will be established and the necessary corrections applied to the old corner common to four townships in its immediate vicinity, so as to change it to a corner common to two townships. (See Plate VI, figs. 10, 11, and 12.)

In the treatment of latitudinal township lines the rule prescribed in the foregoing clauses will be applied, observing, however, that the stated designations north or south will correspond in such cases to west or east, respectively.

260. When subdivisinal lines have been closed upon one or both sides of, or mineral claims tied to, the northern and southern portions of a range line, while the middle portion thereof is free from such attachments, said portion will be resurveyed and new regular corners will be established thereon at intervals of forty chains from its southern terminal corner, upon a right line connecting the original terminal corners thereof, the fractional measurement being thrown against the northern terminal corner. (See Plate VI, figs. 13, 14, and 15.)

In such cases all the original corners, excepting the terminal corners, of the portion of the lines thus resurveyed, will be destroyed.

The rectification of the middle portions of latitudinal township lines, on which the conditions specified above obtain, will be executed in a similar manner, observing; however, that the designations north or south in the foregoing clauses will in such cases correspond to west or east, respectively.

261. Under the foregoing paragraphs, the fact that mineral claims have been tied to a defective township boundary as therein specified, will act as a bar to the rectification of such a boundary in alinement, only when the number of claims involved is great; while in cases where a few such claims have been connected with a few of the corners on such a boundary, said boundary will be rectified in alinement and new corners placed thereon, care being taken, however, to perpetuate in a proper manner such old corners as are found to be connected with the claims; and the methods employed to accomplish the same, together with the bearings and distances of such old corner from the new, will be briefly recorded in the field notes.

262. New corners on defective township boundaries must be established by an actual survey of such lines, and in no case will such corners be established from data acquired in running lines closing upon the same.

263. In the retracement or resurvey of base lines, standard parallels, principal meridians and guide meridians, two sets of chainmen will be employed, while for similar work on township lines, not of the character specified above, only one set of chainmen is required, and in cases where conditions such as specified in section 257 obtain, the bearings and distances between successive old corners and the connections of all new corners with the nearest old corners, will be carefully determined and recorded in the field notes.

Regarding restoration of lost corners, by private and county surveyors, see page 191.

264. When township or subdivisional lines intersect the boundaries of confirmed private land claims, or any other linear boundaries established at variance with the rectangular system of surveying, as much of said boundaries will be retraced as may be necessary, temporary stakes being set at intervals of ten chains thereon, and also at each angle formed by a change in the direction of the same.

All obliterated boundary corners will be reestablished in their original places, and the regular surveys will be closed upon the retraced line as prescribed for "closings" in page 60.

METHODS OF EXECUTING NEW SURVEYS, WHEN INITIATED OR CLOSED UPON OLD SURVEYS, AND EXPLANATION OF FIGURES ON PLATE VI.

265. Such methods are illustrated by the several figures on Plate VI, the rectification of the lines of old surveys, and the establishment of new township exterior and subdivisional lines connected with such old lines, being based upon the rules prescribed in the article entitled "Retracement or Resurvey of Township Lines," etc., page 80.

In considering the several cases, the probable obtaining conditions relative to a range line have been adopted in order to reduce the number of figures on said plate, and, to curtail also as much as practi-

cable, the amount of reiterative verbal explanation; it being definitely understood, however, that whatever conditions may obtain relative to a latitudinal line similar to those illustrated and explained in extenso in the cases relative to the range line, the necessary rectifications will be made by the application of similar methods, subject, however, to the proper modifications due to the difference in the direction of the respective lines.

The character of such modifications, when not obvious, are expressed in detail under the various clauses of the several paragraphs of the article on retracements referred to above.

It will also be clearly understood that, in order to avoid unnecessary structural complications, the figures on Plate VI exhibit only the positions of township and section corners after rectification, while in actual practice the quarter section corners will also be properly affected.

266. Fig. 1. The east boundary is assumed as irregular in bearing and defective in measurement; the township corners on the same, however, being susceptible of connection by a line not deviating more than twenty-one minutes of arc from a true meridian line.

It will be rectified under the rules prescribed by clause 1, section 256, while from the proper corners the west and north boundaries will be established in the regular manner, as well as the subdivisions within the exteriors thus rectified and established.

267. Fig. 2. The east boundary defective in measurement. It will be rectified under clause 1, section 256, while the west and north boundaries will be established, and the subdivisions executed in the regular manner.

268. Fig. 3. The east boundary defective in position. Since the south boundary deviates from a true east and west line by more than twenty-one minutes of arc, said east boundary will be rectified under clause 1, section 256; the west and north boundaries will be established in the regular manner; and the subdivisions will be executed from north to south, and from east to west, commencing at the corner of sections 1, 2, 35, and 36, and closing the fractional measurements on the south and west boundaries, as such closings are made in regular subdivisions on the north and west boundaries.

269. Fig. 4. The east boundary defective in alinement. It will be rectified under clause 2, section 256; while the west and north boundaries will be established, and the subdivisions executed, in the regular manner.

270. Fig. 5. The east boundary defective in alinement and measurement. It will be rectified under clause 2, section 256; the west boundary will be established in the regular manner, while from the corner common to two townships on the rectified east boundary, the north boundary will be run west on random and east on true line, permanent corners common to sections and quarter sections of the township to be subdivided being established on the same.

The subdivisions will be executed in the regular manner.

271. Fig. 6. The south and east boundaries being defective in alinement, measurement, and position, will be rectified under clause 1, section 257; the west boundary will be established in the regular manner, and the north boundary by east on random, and west on true line, throwing the fractional measurement against the old east boundary;

while the subdivisions will be executed from north to south, and from west to east, commencing at the corner of sections 5, 6, 31, and 32, and closing the fractional measurements on the old south and east boundaries, as such closings are made in regular subdivisions on the north and west boundaries.

272. Fig. 7. The north, south, east, and west boundaries being defective in alinement, measurement, and position. The south and east boundaries will be rectified under clause 1, section 257; while the west and north boundaries will be retraced for length and bearing, any obliterated old corners being reestablished in their original places.

273. The subdivisions will be executed as follows:

From the corners of sections 35 and 36, and 25 and 36, the lines between said sections will be extended due north and west, respectively, to their mutual intersection, where the corner of sections 25, 26, 35 and 36, will be established.

From said corner, the line between sections 26 and 35, 27 and 34, 28 and 33, 29 and 32, and 30 and 31 will be projected due west on a true line to its intersection with the west boundary of the township, where a closing corner will be established. A line thus run is termed a

SECTIONAL CORRECTION LINE;

and when such an auxiliary line, thus projected, intersects its objective limiting line in such proximity to its objective corner that the accessories of the two corners would interfere, that portion of the auxiliary line situated between the last-established section corner and the limiting line will be changed in alinement to close upon the corner found, thus avoiding placing two corners in close proximity.

274. From the initial point of the sectional correction line, which, in this case, is the corner of sections 25, 26, 35, and 36, the line between sections 25 and 26, 23 and 24, 13 and 14, 11 and 12, and 1 and 2, will be projected north on a true line to its intersection with the north boundary, where a closing corner will be established. A line thus established is termed a

SECTIONAL GUIDE MERIDIAN.

South of the sectional correction line, and east of the sectional guide meridian, the subdivisions will be closed upon the south and east boundaries by random and true lines, throwing the fractional measurements against the same, as such closings are made in regular surveys on the north and west boundaries; while that portion of the township situated to the north and west respectively, of said auxiliary lines, will be subdivided in the regular manner, the parallelism of the latitudinal section lines being referred to the sectional correction line, and that of the meridional section lines to the sectional guide meridian.

Closings on the west and north boundaries will be made by random and true lines, when the fallings are less than 50 links per mile, and by true lines run to closing corners when the fallings exceed said limit.

275. Fig. 8. The east boundary defective in measurement, the northern portion of the same being unchangeable, while the southern portion admits of rectification.

The east boundary will be rectified under clause 2, section 257, the west and north boundaries will be established, and the subdivisions executed, in the regular manner.

276. Fig. 9. The east boundary defective in alinement and measurement, the northern portion thereof being unchangeable, while the southern portion of the same admits of rectification.

The east boundary will be rectified under clause 3, section 258, the south boundary, under clause 1, section 257; the west boundary will be established in the regular manner; while the north boundary will be run east on random, and west on true line, throwing the fractional measurement against the east boundary.

The subdivisions will be executed from south to north, and from west to east, closing the fractional measurements on the north and east boundaries, as such closings are made in regular surveys, on the north and west boundaries.

277. Fig. 10. The east boundary defective in measurement, the southern portion thereof being unchangeable, while the northern portion admits of rectification.

The east boundary will be rectified under clause 4, section 258; while the west and north boundaries will be established, and the subdivisions executed in the regular manner.

278. Fig. 11. The east boundary defective in alinement and measurement, the southern portion thereof being unchangeable, while the northern portion admits of rectification.

The east boundary will be rectified under clause 1, section 259; the west boundary will be established in the regular manner; the north boundary by east on true line to closing corner, the fractional measurement being thrown against the old east boundary; while the subdivisions will be executed from north to south, and from west to east, the fractional measurements being thrown against the old south and east boundaries, as such closings are made in regular surveys against the north and west boundaries.

279. Fig. 12. The east boundary defective in measurement; the northern and southern portions thereof being unchangeable, while the middle portion admits of rectification.

The east boundary will be rectified under clause 1, section 260, the west and north boundaries will be established, and the subdivisions executed in the regular manner.

280. Fig. 13. The east boundary defective in alinement and measurement; the northern and southern portions thereof being unchangeable; while the middle portion admits of rectification.

The east boundary will be rectified under clause 1, section 260; the west boundary will be established in the regular manner; the north boundary by west on random and east on true line, the fractional measurement being thrown against the old east boundary; while the subdivisions will be executed from south to north and from east to west, closing the fractional measurements against the east, north and west boundaries.

281. Fig. 14. The east boundary defective in alinement and measurement; the northern and southern portions thereof not admitting of rectification in any way, since subdivisional surveys have been closed upon both sides of the same; while the middle portion admits of rectification in measurement.

The east boundary will be rectified under clause 1, section 260; the west boundary will be established in the regular manner, the township corner at the end of six miles thereon being temporarily established.

From said temporary corner, the fractional north boundary will be run east on random to the nearest old established corner on the same, at which point if the falling of the random is within 50 links per mile, said boundary will be corrected westward on true line, setting corners common to the sections and quarter sections on the north, at regular intervals from the initial point of the true line, and throwing the consequent fractional measurement in its normal place against the new west boundary, while the temporary township corner previously established thereon will be made permanent.

If, however, the falling defined above exceeds the stated limit from the last established corner of the old surveys, the fractional north boundary will be projected due west to its intersection with the west boundary, at which point the proper township corner will be permanently established, and the temporary corner destroyed.

In establishing the corners on said north boundary under the latter procedure, the requirements prescribed in the former relative to the allowance for fractional measurement will be strictly observed.

In subdividing, the methods prescribed under Fig. 6 will be applied as far as practicable. The details of the case under consideration are clearly exhibited by fig. 14.

282. Fig. 15. All of the boundaries are assumed to be defective in alinement, measurement, and position; also portions of each as being closed upon by subdivisive surveys and consequently unchangeable relative to the old surveys, while other portions of the same being free from such attachments, admit of rectification.

This figure is constructed on a larger scale than those explained in the preceding paragraphs, in order to illustrate in detail the modus operandi to be pursued in rectification, under the rules of the article on retracements applicable to each of the obtaining conditions, and also in subdividing within the rectified exteriors.

HIATUSES AND OVERLAPS.

283. The several figures on Plate VII illustrate in detail the methods to be employed in connecting the unsurveyed portions of two or more township boundaries, when four of such fractional lines, upon being projected toward each other in the direction of the cardinal points by lines not deviating more than 21 minutes of arc from true meridian or latitudinal lines, do not form a common intersection.

Said methods, in addition to the reasons embodied in the article entitled "Explanations of Articles," etc., page 78, are based upon the following desiderata, viz:

1. The adjustment of such township boundaries so as to maintain section 36 in a condition theoretically and practically perfect, according to the requirements of the rectangular system of surveying.

2. That in accomplishing the above, the resultant fractional excess or deficiency (which for brevity of explanation is termed "the rectangular fraction") will be thrown into, or taken out of section 6, whenever practicable.

3. That all incidental fractional measurements developed in the establishment of township boundaries or subdivisional lines by such methods shall be thrown against the old surveys whenever practicable.

284. In considering said methods it will be observed that the conditions to be dealt with are either hiatuses or overlaps, the former possessing three characteristic features, which are named as follows:

Simple hiatus. See figures 1 and 2, Plate VII.

Meridional hiatus. See figure 3.

Latitudinal hiatus. See figure 4; while overlaps are shown by figure 5.

As the application of said methods, when the conditions exhibited obtain, gives similar results with but few exceptions, which will be specifically detailed hereafter, the condition represented by A, figure 3, will be considered and the method of connection described as an example, upon the following assumptions, viz:

That, of the boundaries of townships 1 and 2 north, ranges 3 and 4 west, those portions indicated by broken lines are unsurveyed;

That it is required to connect said portions in order to complete the subdivisions in one or more of the townships.

Beginning at the established terminal corners on the south and east boundaries of T. 2 N., R. 4 W., blank lines will be projected due east and due south, respectively, with temporary stakes at intervals of ten chains, to an intersection, which point will be marked by a temporary stake;

Then, from the established terminal corners on the west and north boundaries of T. 1 N., R. 3 W., true lines will be projected due north and due west, respectively, with regular corners for two sections and quarter sections, to an intersection, which point will be marked by a temporary stake;

Then, by proper measurements, the character of the resulting condition will be determined, and by comparison with diagrams A, of the figures on Plate VII, the particular method of connection will be obtained and applied.

285. Said condition in the case under consideration, it will be observed, is a meridional hiatus; therefore, from the temporary stake marking the intersection of the extended south and east boundaries of T. 2 N., R. 4 W., which will be replaced by a permanent corner (common to two townships) for T. 1 N., R. 3 W., and T. 2 N., R. 4 W., the south boundary of the latter will be extended due east to its intersection with the west boundary of the former, where a corner for (one township only) T. 1 N., R. 4 W., will be permanently established;

Then, from the corner for T. 1 N., R. 3 W., and T. 2 N., R. 4 W., the south and east boundaries of the latter will be corrected back west and north, respectively, on true lines, establishing regular corners common to two quarter sections and sections of said township, to the initial points of the blank lines, against which the resulting fractional measurements will be thrown, while the stakes temporarily established on the blank lines at intervals of ten chains will be destroyed;

Then, from the stake temporarily marking the intersection of the north and west boundaries of T. 1 N., R. 3 W., which will be destroyed, the former boundary will be extended due west to its intersection with the east boundary of T. 2 N., R. 4 W., where a proper closing corner

will be established, the resulting fractional measurement thrown against the same, and the distance to the nearest corner on said boundary carefully determined and recorded in the field notes.

Thus section 36 is made full, serving as a perfect base on which to initiate the subdivisive work in T. 2 N., R. 4 W.; the rectangular fraction, which in this case indirectly represents an excess, is incorporated in section 6, which being lotted on two sides in its normal condition, absorbs the excess without deranging materially those portions of the same usually defined as regular subdivisions; while the unsurveyed portions of the entire group of townships are arranged in such a manner as to admit of completing the subdivisive work therein on the approved rectangular basis.

Relative to incorporating an excess in, or supplying a deficiency from, section 6, simple hiatuses are noted as exceptions to the general rule; therefore, when such hiatuses are square, or longer meridionally (see 1, diagrams A, fig. 1), the rectangular fraction will be taken out of section 31, and incorporated in section 1; but if the length thereof (see 1, diag. A, fig. 2) lie in a latitudinal direction, said rectangular fraction will be taken out of section 1 and incorporated in section 31.

286. If the surveys contemplated, within a group of four townships, consist of the completion of the southeast unsurveyed portion of the northwest township only, the method detailed in the foregoing paragraphs will be employed in all particulars, with the exception that the extension of the north and west boundaries of the southeast township will be omitted; but the completion of the unsurveyed portions of any of the other three demands of the deputy surveyor the performance of the whole operation, and the complete connection of all the boundaries.

When, of four township boundaries whose directions tend to an approximate common point, two of the same have been carried to a mutual intersection, and are closed upon by subdivisive and other lines (see section 257), the unsurveyed portion of the remaining boundaries will be connected with them by the application of these methods, sufficiently modified to preserve intact the prior subdivisive surveys.

FRAGMENTARY SUBDIVISION.

287. Plate VIII illustrates the general methods to be employed in the execution of fragmentary subdivisions within townships, portions of which have been subdivided from fractional township boundaries extended from various directions and not connected with each other.

These conditions obtain to a large extent in mountainous regions, where in accordance with the existing provisions, relative to the survey of agricultural lands, in the acts of Congress making appropriations for public-land surveys, such surveys are extended along the valley and bottom lands, leaving the mountainous areas unsurveyed at the time of the execution of the original work; but which, at a later date, in view of other considerations are placed under contract for survey.

288. It is obvious that the number and character of such cases would be too great and varied to be considered in detail; therefore, when the deputy surveyor meets with a case which is not covered exactly by these instructions, or the special instructions from the surveyor general, his thorough understanding of the preceding articles on this subject, and of the conditions illustrated on Plates V and VII, it is expected will point out to him the proper method to be employed.

It is possible, however, that cases may arise so complex in their character as to produce a feeling of doubt relative to the proper solution of the problem; in which case he will at once communicate with this office through the surveyor general, submitting information, by letter and diagrams, of the exact condition as found by him, and the necessary instructions will be forwarded as soon as practicable.

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

289. The system of rectangular surveying, authorized by law May 20, 1785, was first employed in the survey of United States public lands in the State of Ohio.

The boundary line between the States of Pennsylvania and Ohio, known as "Ellicott's line," in longitude $80^{\circ} 32' 20''$ west from Greenwich, is the meridian to which the first surveys are referred. The townships east of the Scioto River, in the State of Ohio, are numbered from south to north, commencing with No. 1 on the Ohio River, while the ranges are numbered from east to west, beginning with No. 1 on the east boundary of the State, except in the tract designated "U. S. military land," in which the townships and ranges are numbered, respectively, from the south and east boundaries of said tract.

290. During the period of one hundred and seventeen years since the organization of the system of rectangular surveying, numbered and locally-named principal meridians and base lines have been established, as shown by the following tabular exhibit. These bases and meridians may all be found by examining the large wall map of the United States, published by the General Land Office. They are also severally shown upon the various official State maps.

TABLE III.—Meridians and base lines of United States surveys.

| Principal meridians. | Governing surveys (wholly or in part) in States of— | Longitude W. from Greenwich. | | | Runs near— | Base line. | Latitude N. | | | Runs near or with— |
|--------------------------|--|------------------------------|----|----|---|--------------------------|-------------|----|----------------|------------------------------|
| | | ° | ' | " | | | ° | ' | " | |
| First..... | Ohio..... | 84 | 48 | 50 | State line..... | | | | Findlay, Ohio. | |
| Second..... | Indiana and Illinois..... | 86 | 28 | 00 | Lebanon and Indianapolis..... | | 38 | 28 | 20 | Salem, Ind. |
| Third..... | Illinois..... | 89 | 10 | 15 | Cairo..... | | 38 | 28 | 20 | Centralia. |
| Fourth..... | Wisconsin and Minnesota..... | 90 | 28 | 45 | Platteville, Wis..... | | 42 | 30 | 00 | State line, Wis. |
| Fifth..... | Illinois..... | 90 | 28 | 45 | Rock Island, Ill..... | | 40 | 00 | 30 | Beardstown, Ill. |
| | Arkansas, Missouri, Iowa, South Dakota, North Dakota, and Minnesota..... | 91 | 03 | 42 | Powhatan, Ark., and Du- buque, Iowa..... | | 34 | 44 | 00 | Little Rock. |
| Sixth..... | Kansas, Nebraska, Wyoming, Colorado, and South Dakota..... | 93 | 23 | 00 | Wichita, Kans., and Colum- bus, Neb..... | | 40 | 00 | 00 | On State line. |
| Michigan..... | Michigan..... | 84 | 22 | 24 | Lansing..... | Michigan..... | 42 | 26 | 30 | Detroit. |
| Tallahassee..... | Florida..... | 84 | 16 | 42 | Tallahassee..... | Tallahassee..... | 30 | 28 | 00 | Tallahassee. |
| St. Stephens..... | Alabama and Mississippi..... | 88 | 02 | 00 | Mobile..... | St. Stephens..... | 31 | 00 | 00 | State line. |
| Huntsville..... | Alabama..... | 86 | 34 | 45 | Huntsville..... | Huntsville..... | 35 | 00 | 00 | North State line. |
| Choctaw..... | Mississippi..... | 90 | 14 | 45 | Jackson, Miss..... | Choctaw..... | 31 | 54 | 40 | Hazelhurst. |
| Chickasaw..... | do..... | 89 | 15 | 00 | Holly Springs..... | Chickasaw..... | 34 | 59 | 00 | Old Tennessee bound- ary. |
| Washington..... | do..... | 91 | 09 | 15 | Natchez..... | St. Stephens..... | 31 | 00 | 00 | State line. |
| St. Helena..... | Louisiana..... | 91 | 09 | 15 | Baton Rouge..... | do..... | 31 | 00 | 00 | Do. |
| Louisiana..... | do..... | 92 | 24 | 15 | Alexandria..... | do..... | 31 | 00 | 00 | Do. |
| New Mexico..... | New Mexico and Colorado..... | 106 | 53 | 40 | Socorro..... | New Mexico..... | 34 | 15 | 25 | Socorro. |
| Navajo..... | New Mexico and Arizona..... | 108 | 32 | 45 | | Navajo..... | 35 | 45 | 00 | |
| Salt Lake..... | Utah..... | 111 | 54 | 00 | Salt Lake City..... | Salt Lake..... | 40 | 46 | 04 | Salt Lake City. |
| Utah..... | do..... | 109 | 57 | 30 | | Utah..... | 40 | 26 | 20 | |
| Boise..... | Idaho..... | 116 | 24 | 15 | Boise City..... | Boise..... | 43 | 22 | 31 | Idaho Falls. |
| Mount Diablo..... | California and Nevada..... | 121 | 54 | 48 | San Jose..... | Mount Diablo..... | 37 | 51 | 30 | San Francisco. |
| Humboldt..... | California..... | 124 | 08 | 00 | Eureka..... | Humboldt..... | 40 | 25 | 12 | Cape Mendocino. |
| San Bernardino..... | do..... | 116 | 56 | 15 | San Diego..... | San Bernardino..... | 34 | 7 | 10 | San Bernardino. |
| Willamette..... | Oregon and Washington..... | 122 | 44 | 20 | Portland, Ore..... | Willamette..... | 45 | 31 | 00 | Portland, Ore. |
| Black Hills..... | South Dakota..... | 104 | 03 | 00 | Wyoming boundary..... | Black Hills..... | 44 | 00 | 00 | Rapid City. |
| Montana..... | Montana..... | 111 | 38 | 50 | Helena..... | Montana..... | 45 | 46 | 43 | Billings. |
| Gila and Salt River..... | Arizona..... | 112 | 17 | 25 | Phoenix..... | Gila and Salt River..... | 33 | 22 | 40 | Phoenix. |
| Indian..... | Oklahoma and Indian Territory..... | 97 | 14 | 30 | Guthrie..... | Indian..... | 34 | 30 | 00 | Duncan. |
| Cimarron..... | Oklahoma Territory..... | 103 | 00 | 00 | New Mexico boundary..... | Cimarron..... | 36 | 30 | 00 | Texas boundary. |

DISUSE OF MAGNETIC NEEDLE SURVEYS.

291. The strict requirement that all lines of public surveys must be run by courses derived from the true local meridian, independently of the magnetic needle, and subject to close tests by field inspection, renders the data and discussion of magnetic declinations no longer necessary in the Manual. The scientific information heretofore published had apparent value to surveyors required to restore ancient lines; but even in such work there is often wide opportunity for error, from lack of full understanding of the former customs.

292. While some of the early surveyors were exact and faithful men, competent to observe Polaris with the plain compass and note the correct local variation, others probably obtained the figures for declination by hearsay and from distant places; hence implicit reliance can not be placed on calculations based on the presumed change of variation.

An additional reason for considering these matters of magnetic declination less important in old surveys, is that the rules for restoring lost lines and corners place chief importance upon the finding and identification of material evidence in the field, with less regard to theoretical courses.

METHODS OF OBTAINING A TRUE MERIDIAN.

293. The work of every deputy surveyor or examiner depends for its correctness upon his using a correct meridian, which can be obtained only by careful observance of the following instructions. They include astronomical tables, adapted from data heretofore supplied by the Coast and Geodetic Survey, and brought down to dates in the twentieth century.

The accuracy with which the meridian may be determined depends chiefly upon the instruments at command and upon the ability and care of the observer in using them. It rests with him to select the proper instrument, the proper method and time for observing. The instruments ordinarily in the hands of the surveyor are sufficiently described in books on surveying or in catalogues of instrument makers. The method to be followed will depend greatly upon circumstances. Thus the sun or the pole star may be observed for azimuth; local time may be had by the method of equal altitudes of the sun, for which the latitude of the place need only to be known roughly. Observations of the pole star for the true azimuth are generally preferred, since no great precision in the local time is required. Tables and explanatory remarks have been inserted to facilitate the use of this method, and will serve for the period 1901 to 1910.

294. The table given in the Manual of 1894 for times of elongation and culmination at 24 dates of the year 1893, with a system of corrections for other years and dates, is now omitted. All the necessary data therein given can now be obtained from the upper culmination table on page 101 in the form already familiar but revised and extended for the present decade.

295. For correct and rapid use of these tables, it is indispensable that the surveyor have clear comprehension of the outlines of the astronomical facts involved, and the terms used in dealing with them, such as the following:

The earth's annual motion around the sun.

Its diurnal motion upon its axis.

The apparent opposite motion of Polaris and other circumpolar stars about the north-polar point in the heavens. (See figure 1 on page 97.)

Mean solar time, derived from successive apparent passages of the sun across the local meridian, and averaged or equalized for the year to remove irregularities caused by the earth's varying distances from the sun, often shown in almanacs under the head, "sun fast" or "sun slow."

Equation of time, as tabulated in the ephemeris.

Sidereal time, measured by the astronomical day of 23 hrs. 56.1 min., the interval between two successive passages of a fixed star across the local meridian.

The civil day, beginning at midnight, and its relation to the astronomical day which begins at noon. The former counts twelve hours twice over, the latter numbers the hours up to 24, and lasts twelve hours after the civil day of the same date is ended.

The culminations of Polaris.

The elongations of Polaris.

The azimuth of Polaris or its apparent distance east or west from the polar point, measured by a horizontal angle at the place of observation.

The hour-angle azimuth of Polaris, at those times when it is neither at elongation nor culmination.

The meridian of any locality. Since any line not coinciding with the true meridian is not a meridian, the use of the word true is superfluous, and generally avoided.

Reduction of standard time to local mean time by difference of longitude.

296. These essentials are presumed to have been acquired in preparatory studies; therefore it is the purpose of the Manual to simplify the work, omit all technicalities requiring a full knowledge of astronomy, and present the method, with two new and compact tables adapted to common clock time, with such plain directions for use that any person of ordinary intelligence can understand and apply them.

297. 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.

298. The Civil Day, according to the customs of society, commences at midnight and comprises twenty-four hours from one midnight to the next following. The hours are counted from 12 to 12 from midnight to noon, after which they are again reckoned from 12 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.

299. 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^a, astronomical time; and January 9, 2 o'clock a. m., civil time, is January 8, 14^a, astronomical time.

300. 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 initials 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 past, 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.

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.

The change can be made mentally, no written work being required. Table V 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 rules and examples, and correspondingly increase the chances for error.

301. The general use of telescopic instruments makes it far easier to determine a meridian, than formerly when the open-sight compass was almost the only obtainable instrument. In those days it was required that the deputy ascertain for himself by observation what was the true north line, and then observe and record the "variation" of his needle from the north. Instructions for the process have been an important part of the early manuals, and surveyors of integrity faithfully observed them. Similar directions are here given.

TO DETERMINE A MERIDIAN WITHOUT A TELESCOPE.

302. Attach a plumb line to a support situated as far above the ground as practicable, such as the limb of a tree, a piece of board nailed or otherwise fastened to a telegraph pole, a house, barn, or other building, affording a clear view north and south.

The plumb bob may consist of some weighty material, such as a brick, a piece of iron or stone, weighing four to five pounds, which will hold the plumb line vertical, fully as well as one of finished metal.

Strongly illuminate the plumb line just below its support by a lamp or candle, care being taken to obscure the source of light from the view of the observer by a screen.

For a peep sight, cut a slot about one-sixteenth of an inch wide in a thin piece of board, or nail two strips of tin, with straight edges, to a square block of wood, so arranged that they will stand vertical when the block is placed flat on its base upon a smooth horizontal rest, which will be placed at a convenient height south of the plumb line and firmly secured in an east and west direction, in such a position that, when viewed through the peep sight, Polaris will appear about a foot below the support of the plumb line.

The position may be practically determined by trial, the night preceding that set for the observation.

About thirty minutes before the time of elongation, as obtained from the table, bring the peep sight into the same line of sight with the plumb line and Polaris.

To reach elongation, the star will move off the plumb line to the east for eastern elongation, or to the west for western elongation, therefore by moving the peep sight in the proper direction, east or west, as the case may be, keep the star on the plumb line until it appears to remain stationary, thus indicating that it has reached its point of elongation.

The peep sight will now be secured in place by a clamp or weight, with its exact position marked on the rest, and all further operations will be deferred until the next morning.

By daylight, place a slender rod at a distance of two or three hundred feet from the peep site, and exactly in range with it and the plumb line; carefully measure this distance.

Take from the table on page 95 the azimuth of Polaris corresponding to the latitude of the station and year of observation; find the natural tangent of said azimuth and multiply it by the distance from the peep sight to the rod; the product will express the distance to be laid off from the rod exactly at right angles to the direction already determined (to the west for eastern elongation or to the east for western elongation), to a point, which with the peep sight, will define the direction of the meridian with sufficient accuracy for the needs of local surveyors.

TO ESTABLISH A MERIDIAN AT ELONGATION BY TELESCOPIC INSTRUMENT.

303. Set a stone, or drive a wooden peg, firmly in the ground, and upon the top thereof make a small distinct mark.

About thirty minutes before the time of the eastern or western elongation of Polaris, obtained from the table, set up the transit firmly, with its vertical axis exactly over the mark, and carefully level the instrument.

Illuminate the cross wires by the light from a suitable lantern, the rays being directed into the object end of the telescope by an assistant; while great care will be taken, by perfect leveling, to insure that the line of collimation describe a truly vertical plane.

Place the vertical wire upon the star, which, if it has not reached its elongation, will move to the right for eastern, or to the left for western elongation.

While the star moves toward its point of elongation, by means of the tangent screw of the vernier plate it will be repeatedly covered by the vertical wire, until a point is reached where it will appear to remain on the wire for some time, then leave it in a direction contrary to its former motion; thus indicating the time of elongation.

Then while the star appears to thread the vertical wire, depress the telescope to a horizontal position; five chains north of the place of observation, set a stone or drive a firm peg, upon which by a strongly illuminated pencil or other slender object, exactly coincident with the vertical wire, mark a point and drive a tack in the line of sight thus determined; then, to eliminate possible errors of collimation or imperfect verticality of the motion of the telescope, quickly revolve the vernier plate 180° , direct the glass at Polaris and repeat the observation; if it gives a different result, find and mark the middle point between the two results. This middle point, with the point marked

by the plumb bob of the transit, will define on the ground the trace of the vertical plane through Polaris at its eastern or western elongation, as the case may be.

By daylight, lay off to the east or west, as the case may require, the proper azimuth taken from the following table; the instrument will then define the meridian, which may be permanently marked for future reference.

The magnetic declination may be obtained from a true meridian, as follows: Take the magnetic bearing of the true meridian; then the angle expressed by said magnetic bearing will be the observed magnetic declination, named like the departure if the bearing is taken from the south needle-point, but the reverse if from the north.

TABLE IV.—Azimuths of Polaris when at elongation for any year from 1900 to 1910, inclusive, and for any latitude from 25° to 72° north.

| Latitude. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. | 1908. | 1909. | 1910. |
|-----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| | ° / | ° / | ° / | ° / | ° / | ° / | ° / | ° / | ° / | ° / | ° / |
| 25 | 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 |
| 26 | 21.8 | 21.5 | 21.1 | 20.8 | 20.5 | 20.1 | 19.8 | 19.4 | 19.1 | 18.7 | 18.4 |
| 27 | 22.5 | 22.2 | 21.9 | 21.5 | 21.2 | 20.8 | 20.5 | 20.1 | 19.8 | 19.4 | 19.1 |
| 28 | 23.3 | 23.0 | 22.6 | 22.2 | 21.9 | 21.6 | 21.3 | 20.9 | 20.5 | 20.1 | 19.8 |
| 29 | 24.1 | 23.8 | 23.4 | 23.0 | 22.7 | 22.4 | 22.1 | 21.7 | 21.3 | 20.9 | 20.5 |
| 30 | 1 24.9 | 1 24.6 | 1 24.2 | 1 23.9 | 1 23.5 | 1 23.1 | 1 22.8 | 1 22.4 | 1 22.1 | 1 21.7 | 1 21.3 |
| 31 | 25.8 | 25.5 | 25.1 | 24.7 | 24.4 | 24.0 | 23.6 | 23.2 | 22.9 | 22.5 | 22.2 |
| 32 | 26.7 | 26.4 | 26.0 | 25.6 | 25.3 | 24.9 | 24.5 | 24.1 | 23.8 | 23.4 | 23.1 |
| 33 | 27.7 | 27.3 | 27.0 | 26.6 | 26.2 | 25.9 | 25.5 | 25.1 | 24.7 | 24.3 | 24.0 |
| 34 | 28.7 | 28.4 | 28.0 | 27.6 | 27.2 | 26.9 | 26.5 | 26.1 | 25.7 | 25.3 | 25.0 |
| 35 | 1 29.8 | 1 29.4 | 1 29.0 | 1 28.7 | 1 28.3 | 1 27.9 | 1 27.5 | 1 27.1 | 1 26.8 | 1 26.4 | 1 26.0 |
| 36 | 30.9 | 30.5 | 30.1 | 29.8 | 29.4 | 29.0 | 28.6 | 28.2 | 27.9 | 27.5 | 27.1 |
| 37 | 32.1 | 31.7 | 31.3 | 30.9 | 30.5 | 30.1 | 29.7 | 29.3 | 29.0 | 28.6 | 28.2 |
| 38 | 33.4 | 33.0 | 32.6 | 32.2 | 31.8 | 31.4 | 31.0 | 30.6 | 30.2 | 29.8 | 29.4 |
| 39 | 34.7 | 34.3 | 33.9 | 33.5 | 33.1 | 32.7 | 32.3 | 31.8 | 31.4 | 31.0 | 30.6 |
| 40 | 1 36.0 | 1 35.6 | 1 35.2 | 1 34.8 | 1 34.4 | 1 34.0 | 1 33.6 | 1 33.2 | 1 32.8 | 1 32.4 | 1 32.0 |
| 41 | 37.5 | 37.1 | 36.7 | 36.2 | 35.8 | 35.4 | 35.0 | 34.6 | 34.2 | 33.8 | 33.4 |
| 42 | 39.0 | 38.6 | 38.2 | 37.7 | 37.3 | 36.9 | 36.5 | 36.0 | 35.6 | 35.2 | 34.8 |
| 43 | 40.6 | 40.2 | 39.8 | 39.3 | 38.9 | 38.5 | 38.1 | 37.6 | 37.2 | 36.8 | 36.3 |
| 44 | 42.3 | 41.8 | 41.4 | 41.0 | 40.5 | 40.1 | 39.7 | 39.2 | 38.8 | 38.4 | 37.9 |
| 45 | 1 44.0 | 1 43.6 | 1 43.2 | 1 42.7 | 1 42.3 | 1 41.8 | 1 41.4 | 1 40.9 | 1 40.5 | 1 40.1 | 1 39.6 |
| 46 | 45.9 | 45.5 | 45.0 | 44.6 | 44.2 | 43.7 | 43.2 | 42.7 | 42.3 | 41.9 | 41.4 |
| 47 | 47.9 | 47.4 | 46.9 | 46.5 | 46.0 | 45.6 | 45.1 | 44.6 | 44.2 | 43.7 | 43.3 |
| 48 | 49.9 | 49.5 | 49.0 | 48.6 | 48.1 | 47.7 | 47.2 | 46.7 | 46.3 | 45.8 | 45.3 |
| 49 | 52.1 | 51.7 | 51.2 | 50.7 | 50.2 | 49.8 | 49.3 | 48.8 | 48.4 | 47.9 | 47.4 |
| 50 | 1 54.4 | 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 |
| 51 | 56.9 | 56.4 | 55.9 | 55.4 | 54.9 | 54.4 | 54.0 | 53.5 | 53.0 | 52.5 | 52.0 |
| 52 | 59.5 | 59.0 | 58.5 | 58.0 | 57.5 | 57.0 | 56.4 | 55.9 | 55.4 | 54.9 | 54.4 |
| 53 | 2 02.2 | 2 01.7 | 2 01.2 | 2 00.7 | 2 00.2 | 59.6 | 59.1 | 58.6 | 58.1 | 57.6 | 57.1 |
| 54 | 06.1 | 04.6 | 04.1 | 03.5 | 03.0 | 2 02.5 | 2 02.0 | 2 01.5 | 2 00.9 | 2 00.4 | 59.9 |
| 55 | 2 08.3 | 2 07.8 | 2 07.2 | 2 06.6 | 2 06.1 | 2 05.6 | 2 05.0 | 2 04.4 | 2 03.9 | 2 03.4 | 2 02.8 |
| 56 | 11.6 | 11.0 | 10.5 | 09.9 | 09.4 | 08.8 | 08.2 | 07.7 | 07.1 | 06.6 | 06.0 |
| 57 | 15.1 | 14.5 | 14.0 | 13.4 | 12.8 | 12.2 | 11.7 | 11.1 | 10.5 | 10.0 | 09.4 |
| 58 | 18.8 | 18.2 | 17.6 | 17.1 | 16.5 | 15.9 | 15.3 | 14.7 | 14.2 | 13.6 | 13.0 |
| 59 | 22.8 | 22.2 | 21.6 | 21.0 | 20.4 | 19.8 | 19.2 | 18.6 | 18.0 | 17.4 | 16.8 |
| 60 | 2 27.1 | 2 26.5 | 2 25.9 | 2 25.2 | 2 24.6 | 2 24.0 | 2 23.4 | 2 22.8 | 2 22.1 | 2 21.5 | 2 20.9 |
| 61 | 31.7 | 31.1 | 30.4 | 29.8 | 29.1 | 28.5 | 27.9 | 27.2 | 26.6 | 25.9 | 25.3 |
| 62 | 36.7 | 36.0 | 35.4 | 34.7 | 34.1 | 33.4 | 32.7 | 32.1 | 31.4 | 30.8 | 30.1 |
| 63 | 42.1 | 41.4 | 40.7 | 40.0 | 39.3 | 38.6 | 38.0 | 37.3 | 36.6 | 35.9 | 35.2 |
| 64 | 47.8 | 47.1 | 46.4 | 45.7 | 45.0 | 44.3 | 43.6 | 42.9 | 42.2 | 41.5 | 40.8 |
| 65 | 2 54.1 | 2 53.4 | 2 52.6 | 2 51.9 | 2 51.2 | 2 50.4 | 2 49.7 | 2 49.0 | 2 48.3 | 2 47.5 | 2 46.8 |
| 66 | 3 00.9 | 3 00.1 | 59.4 | 58.6 | 57.9 | 57.1 | 56.3 | 55.6 | 54.8 | 54.1 | 53.3 |
| 67 | 08.3 | 07.5 | 3 06.7 | 3 05.9 | 3 05.1 | 3 04.4 | 3 03.6 | 3 02.8 | 3 02.0 | 3 01.2 | 3 00.4 |
| 68 | 16.4 | 15.6 | 14.8 | 13.9 | 13.1 | 12.3 | 11.5 | 10.7 | 09.8 | 09.0 | 08.2 |
| 69 | 25.3 | 24.4 | 23.6 | 22.7 | 21.9 | 21.0 | 20.1 | 19.3 | 18.4 | 17.6 | 16.7 |
| 70 | 3 35.2 | 3 34.3 | 3 33.4 | 3 32.5 | 3 31.6 | 3 30.6 | 3 29.7 | 3 28.8 | 3 27.9 | 3 27.0 | 3 26.1 |
| 71 | 46.1 | 45.1 | 44.2 | 43.2 | 42.3 | 41.3 | 40.3 | 39.4 | 38.4 | 37.5 | 36.5 |
| 72 | 58.2 | 57.2 | 56.2 | 55.2 | 54.2 | 53.2 | 52.1 | 51.1 | 50.1 | 49.1 | 48.1 |

TO ESTABLISH A MERIDIAN AT CULMINATION OF POLARIS.

304. A very close approximation to a meridian may be had by remembering that Polaris very nearly reaches the meridian when it is in the same vertical plane with the star Delta (δ) in the constellation Cassiopeia. The vertical wire of the transit should be fixed upon Polaris, and occasionally brought down to the star Delta, to observe its approach to the same vertical line. When both stars are seen upon the wire, Polaris is very near the meridian. A small interval of time (as 3.7 min. in 1901) will then be allowed to pass, while Delta moves rapidly east and Polaris slightly west to the actual meridian. At that moment the cross wire should be placed upon Polaris, and the meridian firmly marked by stakes and tack-heads.

305. This method is practicable only when the star Delta is below the pole 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) Cassiopeiæ is on the meridian below Polaris and the pole, 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 will be used in precisely the same manner.

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

The diagram, drawn to scale, exhibits the principal stars of the constellations Cassiopeia and Great Bear, with Delta (δ) Cassiopeiæ, Zeta (ζ) Ursæ Majoris (also called Mizar), and Polaris on the meridian, represented by the straight line; Polaris being at lower culmination.

This method is given in Lalande's Astronomy and was practiced by Andrew Ellicott, in 1785, on the Ohio and Pennsylvania boundary.

306. In the above process, the interval of waiting time may be found for the proper year from the following data:

| | | |
|------------------------|-----------------------|---------------------------|
| For Zeta Urs. Maj----- | { 1901.....3.0 min. } | } annual increase 0.35 m. |
| | { 1910.....6.1 " } | |
| For Delta Cass | { 1901.....3.7 min. } | } annual increase 0.33 m. |
| | { 1910.....6.7 " } | |

The diagram held perpendicular to the line of sight directed to the pole, with the right hand side of the page uppermost, 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

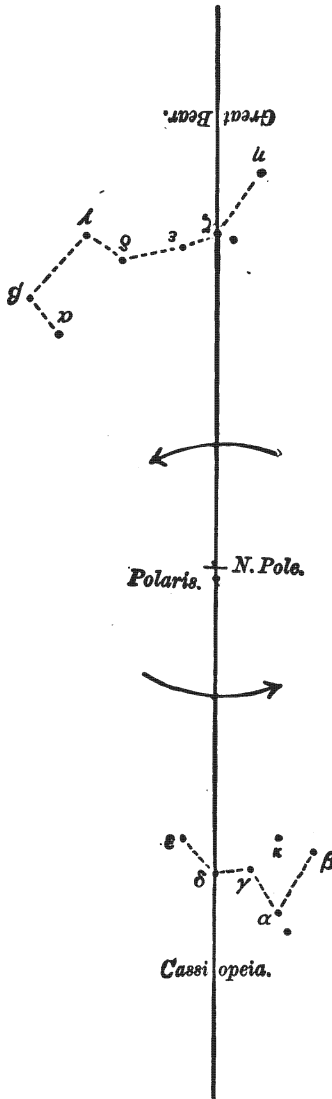


FIG. 1.

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 star nearest to the end star of the handle of the dipper.

TO FIX A MERIDIAN AT OTHER TIMES, BY HOUR ANGLE.

307. The annexed diagram (fig. 2) will show in their proper relation the various aspects of Polaris in its daily apparent motion around the north-polar point.

This must be carefully studied, as the illustration of Table V, for finding at any hour the hour angle and azimuth of Polaris, and the resulting meridian, at times when more direct methods are not available.

308. Hour Angle of Polaris.—In fig. 2 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 of Polaris

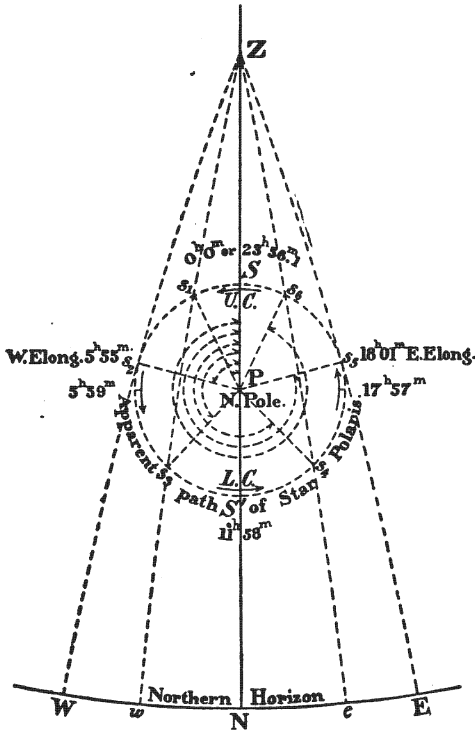


FIG. 2.

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 covers the star on the meridian.

When Polaris crosses the meridian it is said to culminate; above the pole (at S), the passage is called the Upper Culmination, in contradistinction to the Lower Culmination (at S').

309. In the diagram,—which the surveyor may better understand by holding it up perpendicular to the line of sight when he looks toward the pole,—Polaris is supposed to be on the meridian, where it will be about noon on April 10th of each year. The star appears to revolve

around the pole, in the direction of the arrows, once in every $23^{\text{h}} 56^{\text{m}}.1$ 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 $5^{\text{h}} 59^{\text{m}}$, one half in $11^{\text{h}} 58^{\text{m}}$, and three quarters in $17^{\text{h}} 57^{\text{m}}$. 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 meridian (at S), to the west, around the circle from $0^{\text{h}} 0^{\text{m}}$ to $23^{\text{h}} 56^{\text{m}}.1$, and may have any value between the limits named. The hour angles, measured by the arcs $Ss_1, Ss_2, Ss_3, Ss_4, Ss_5$, and Ss_6 , are approximately $1^{\text{h}} 8^{\text{m}}, 5^{\text{h}}, 55^{\text{m}}, 9^{\text{h}} 4^{\text{m}}, 14^{\text{h}} 52^{\text{m}}, 18^{\text{h}} 01^{\text{m}}$, and $22^{\text{h}} 48^{\text{m}}$ respectively; their extent is also indicated graphically by broken fractional circles about the pole.

310. Suppose the star observed at the point S_3 ; the time it was at S, (the time of upper culmination), taken from the time of observation, will leave the arc Ss_3 , or the hour angle at the instant of observation; similar relations will obtain when the star is observed in any other position; therefore, in general:

Subtract the time of Upper Culmination from the correct local mean time of observation; the remainder will be the Hour Angle of Polaris expressed in time, or the "argument for table VII."

The observation will be made as directed on page 94, modified as follows: there will be no waiting for the star to reach elongation; the observation may be made at any instant when Polaris is visible, the exact time being carefully noted.

TABLE V.

311. This table gives, in "Part I," the local mean time of the upper culmination of Polaris, on the 1st and 15th of each month, for the years 1901 to 1910, inclusive. The times decrease, in each year, to April 10, when they become zero; then, commencing at $23^{\text{h}} 56^{\text{m}}.1$, the times again decrease until the following April, and so on, continuously. The quantity in the column marked "Diff. for 1 day" is the decrease per day during the interval of time against which it stands, and answers for all the years marked in the table. For any intermediate date, the "Diff. for 1 day" will be multiplied by the days elapsed since the preceding tabular date, and the product subtracted from the corresponding time, to obtain the required time of upper culmination for the date under consideration. The table answers directly for 108° west longitude. The results of using it for other longitudes will contain an amount of error hardly appreciable, as the correction for longitude cannot exceed one-tenth of a minute of time for each 9 degrees of longitude. 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, 1904.

| | |
|--|--------|
| | h. m. |
| Astron. time, U. C. of Polaris, 1904, March 1..... | 2 47.0 |
| Red. for 2 days is $3^{\text{m}}.94 \times 2 = 7^{\text{m}}.9$ (Part II) Subtract..... | 7.9 |
| Local mean time U. C. of Polaris, 1904, March 3..... | 2 39.1 |

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

| | h. m. |
|--|--------|
| Astron. time, U. C. of Polaris, 1904, March 15..... | 1 51.9 |
| Red. for 12 days is $3^m.94 \times 12 = 47^m.3$, add..... | 47.3 |
| Local mean time U. C. of Polaris, 1904, March 3..... | 2 39.2 |

In this case the two results are practically identical. If the computation is made both ways, the results will check each other.

312. Part II has been inserted to save the surveyor the little trouble of making multiplications; thus, for the above example, look in Part II, under the proper tabular difference, $3^m.94$, and opposite the 3d or 17th day of the month in the left hand column is the correction $7^m.9$.

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 tabulated time of culmination, in which case $23^h 56^m.1$ will be added, to make the subtraction possible.

2. Required, for a station in long. 90° west, the time of U. C. of Polaris for April 14, 1906:

| | h. m. |
|---|---------|
| Astron. time, U. C. of Polaris, 1906, April 1 (Part I)..... | 0 47.9 |
| Add..... | 23 56.1 |
| Sum..... | 24 44.0 |
| Reduction to April 14, (Part II), subtract..... | 51.1 |
| Local mean time, U. C. of Polaris, April 14..... | 23 52.9 |

Working from a following 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 long. 90° west, the time of U. C. of Polaris for April 10, 1903:

| | h. m. |
|--|---------|
| Astron. time, U. C. of Polaris, 1903, April 15 (Part I)..... | 23 48.5 |
| Reduction for 5 days (Part II), add..... | 19.6 |
| Sum..... | 24 8.1 |
| Subtract..... | 23 56.1 |
| Local mean time, U. C. of Polaris, 1903, April 10..... | 0 12.0 |

313. The surveyor should be careful to correctly employ Part II, Table V. When the table is used in regular order, the "Reduction" may be taken from Part II with the argument, "Day of the month" in left hand column, or "Number of days elapsed" in right hand column, as may be preferred. ("Argument", the quantity on which another quantity in a table depends.) In example 2, Part II, may be entered in with the argument 13 days elapsed (from 1st to 14th) in right hand column; then the reduction, $51^m.1$, results, as above written; but, when working from a following date (example 3), the day of the month in left hand column can not be used.

Mistakes are often made by using the wrong column in Part I; as a matter of course, the time should always be taken out for the current year.

TABLE V.—Local mean (astronomical) time of the upper culmination of Polaris, computed for longitude 108° (7 h. 12m.) west of Greenwich.

[The time on line with any date in Part I is the hours and minutes elapsed (common watch time) since the preceding noon.

| Part I. | | | | | | | | | |
|---------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|------------------|
| Date. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. | 1908. | Diff. for 1 day. |
| | <i>h. m.</i> | <i>h. m.</i> | <i>h. m.</i> | <i>h. m.</i> | <i>h. m.</i> | <i>h. m.</i> | <i>h. m.</i> | <i>h. m.</i> | <i>m.</i> |
| Jan. 1 | 6 39.5 | 6 41.0 | 6 42.4 | 6 43.9 | 6 41.4 | 6 42.8 | 6 44.3 | 6 45.7 | 3.95 |
| 15 | 5 44.2 | 5 45.7 | 5 47.1 | 5 48.6 | 5 46.1 | 5 47.5 | 5 49.0 | 5 50.4 | 3.95 |
| Feb. 1 | 4 37.1 | 4 38.6 | 4 40.0 | 4 41.5 | 4 39.0 | 4 40.4 | 4 41.9 | 4 43.3 | 3.95 |
| 15 | 3 41.9 | 3 43.4 | 3 44.8 | 3 46.3 | 3 43.8 | 3 45.2 | 3 46.7 | 3 48.1 | 3.95 |
| Mar. 1 | 2 46.6 | 2 48.1 | 2 49.5 | 2 47.0 | 2 48.5 | 2 49.9 | 2 51.4 | 2 48.9 | 3.94 |
| 15 | 1 51.5 | 1 53.0 | 1 54.4 | 1 51.9 | 1 53.4 | 1 54.8 | 1 56.3 | 1 53.8 | 3.94 |
| Apr. 1 | 0 44.6 | 0 46.1 | 0 47.5 | 0 45.0 | 0 46.5 | 0 47.9 | 0 49.4 | 0 46.8 | 3.94 |
| 15 | 23 45.6 | 23 47.1 | 23 48.5 | 23 46.0 | 23 47.5 | 23 48.9 | 23 50.4 | 23 47.8 | 3.93 |
| May 1 | 22 42.8 | 22 44.3 | 22 45.7 | 22 43.2 | 22 44.7 | 22 46.1 | 22 47.6 | 22 45.1 | 3.93 |
| 15 | 21 47.8 | 21 49.3 | 21 50.7 | 21 48.2 | 21 49.7 | 21 51.1 | 21 52.6 | 21 50.1 | 3.92 |
| June 1 | 20 41.2 | 20 42.7 | 20 44.1 | 20 41.6 | 20 43.1 | 20 44.5 | 20 46.0 | 20 43.5 | 3.92 |
| 15 | 19 46.4 | 19 47.9 | 19 49.3 | 19 46.8 | 19 48.3 | 19 49.7 | 19 51.2 | 19 48.7 | 3.91 |
| July 1 | 18 43.8 | 18 45.3 | 18 46.7 | 18 44.2 | 18 45.7 | 18 47.1 | 18 48.6 | 18 46.1 | 3.91 |
| 15 | 17 49.0 | 17 50.5 | 17 51.9 | 17 49.4 | 17 50.9 | 17 52.3 | 17 53.8 | 17 51.3 | 3.92 |
| Aug. 1 | 16 42.4 | 16 43.9 | 16 45.3 | 16 42.8 | 16 44.3 | 16 45.7 | 16 47.2 | 16 44.7 | 3.92 |
| 15 | 15 47.6 | 15 49.1 | 15 50.5 | 15 48.0 | 15 49.5 | 15 50.9 | 15 52.4 | 15 49.9 | 3.92 |
| Sept. 1 | 14 41.0 | 14 42.5 | 14 43.9 | 14 41.4 | 14 42.9 | 14 44.3 | 14 45.8 | 14 43.3 | 3.92 |
| 15 | 13 46.1 | 13 47.6 | 13 49.0 | 13 46.5 | 13 48.0 | 13 49.4 | 13 50.9 | 13 48.4 | 3.93 |
| Oct. 1 | 12 43.3 | 12 44.8 | 12 46.2 | 12 43.7 | 12 45.2 | 12 46.6 | 12 48.1 | 12 45.6 | 3.93 |
| 15 | 11 48.3 | 11 49.8 | 11 51.2 | 11 48.7 | 11 50.2 | 11 51.6 | 11 53.1 | 11 50.6 | 3.93 |
| Nov. 1 | 10 41.4 | 10 42.9 | 10 44.3 | 10 41.8 | 10 43.3 | 10 44.7 | 10 46.2 | 10 43.7 | 3.93 |
| 15 | 9 46.4 | 9 47.9 | 9 49.3 | 9 46.8 | 9 48.3 | 9 49.7 | 9 51.2 | 9 48.7 | 3.94 |
| Dec. 1 | 8 43.3 | 8 44.8 | 8 46.2 | 8 43.7 | 8 45.2 | 8 46.6 | 8 48.1 | 8 45.6 | 3.94 |
| 15 | 7 48.1 | 7 49.6 | 7 51.0 | 7 48.5 | 7 50.0 | 7 51.4 | 7 52.9 | 7 50.4 | 3.95 |

| Part I—Continued. | | | | | Part II. | | | | | | |
|-------------------|--------------|--------------|--------------|------------------|---|-----------|-----------|-----------|-----------|----------------------|----|
| Date. | 1909. | 1910. | 1911. | Diff. for 1 day. | Reduction of tabular times to <i>intermediate dates</i> . | | | | | | |
| | <i>h. m.</i> | <i>h. m.</i> | <i>h. m.</i> | <i>m.</i> | Subtract the reduction when computing from a <i>preceding</i> , or add it when working from a <i>following date</i> . | | | | | | |
| | | | | | Reduction. Arg.—“Diff. for 1 day.” | | | | | No. of days elapsed. | |
| | | | | | <i>m.</i> | <i>m.</i> | <i>m.</i> | <i>m.</i> | <i>m.</i> | | |
| | | | | | 3.91. | 3.92. | 3.93. | 3.94. | 3.95. | | |
| Jan. 1 | 6 43.2 | 6 44.7 | 6 46.1 | 3.95 | | | | | | | |
| 15 | 5 47.9 | 5 49.4 | 5 50.8 | 3.95 | | | | | | | |
| Feb. 1 | 4 40.8 | 4 42.3 | 4 43.7 | 3.95 | | | | | | | |
| 15 | 3 45.6 | 3 47.1 | 3 48.5 | 3.95 | | | | | | | |
| Mar. 1 | 2 50.3 | 2 51.8 | 2 53.2 | 3.94 | | | | | | | |
| 15 | 1 55.2 | 1 56.7 | 1 58.1 | 3.94 | | | | | | | |
| Apr. 1 | 0 48.3 | 0 49.8 | 0 51.2 | 3.94 | | | | | | | |
| 15 | 23 49.3 | 23 50.8 | 23 52.2 | 3.93 | | | | | | | |
| May 1 | 22 46.5 | 22 48.0 | 22 49.4 | 3.93 | | | | | | | |
| 15 | 21 51.5 | 21 53.0 | 21 54.4 | 3.92 | | | | | | | |
| June 1 | 20 44.9 | 20 46.4 | 20 47.8 | 3.92 | | | | | | | |
| 15 | 19 50.1 | 19 51.6 | 19 53.0 | 3.91 | | | | | | | |
| July 1 | 18 47.5 | 18 49.0 | 18 50.4 | 3.91 | | | | | | | |
| 15 | 17 52.7 | 17 54.2 | 17 55.6 | 3.92 | | | | | | | |
| Aug. 1 | 16 46.1 | 16 47.6 | 16 49.0 | 3.92 | | | | | | | |
| 15 | 15 51.3 | 15 52.8 | 15 54.2 | 3.92 | | | | | | | |
| Sept. 1 | 14 44.7 | 14 46.2 | 14 47.6 | 3.92 | | | | | | | |
| 15 | 13 49.8 | 13 51.3 | 13 52.7 | 3.93 | | | | | | | |
| Oct. 1 | 12 47.0 | 12 48.5 | 12 49.9 | 3.93 | | | | | | | |
| 15 | 11 52.0 | 11 53.5 | 11 54.9 | 3.93 | | | | | | | |
| Nov. 1 | 10 45.1 | 10 46.6 | 10 48.0 | 3.93 | | | | | | | |
| 15 | 9 50.1 | 9 51.6 | 9 53.0 | 3.94 | | | | | | | |
| Dec. 1 | 8 47.0 | 8 48.5 | 8 49.9 | 3.94 | | | | | | | |
| 15 | 7 51.8 | 7 53.3 | 7 54.7 | 3.95 | | | | | | | |
| | | | | | 2 or 16 | 3.9 | 3.9 | 3.9 | 3.9 | 3.9 | 1 |
| | | | | | 3 or 17 | 7.8 | 7.8 | 7.9 | 7.9 | 7.9 | 2 |
| | | | | | 4 or 18 | 11.7 | 11.8 | 11.8 | 11.8 | 11.8 | 3 |
| | | | | | 5 or 19 | 15.6 | 15.7 | 15.7 | 15.8 | 15.8 | 4 |
| | | | | | 6 or 20 | 19.5 | 19.6 | 19.6 | 19.7 | 19.7 | 5 |
| | | | | | 7 or 21 | 23.5 | 23.5 | 23.6 | 23.6 | 23.7 | 6 |
| | | | | | 8 or 22 | 27.4 | 27.4 | 27.5 | 27.6 | 27.6 | 7 |
| | | | | | 9 or 23 | 31.3 | 31.4 | 31.4 | 31.5 | 31.6 | 8 |
| | | | | | 10 or 24 | 35.2 | 35.3 | 35.4 | 35.5 | 35.5 | 9 |
| | | | | | 11 or 25 | 39.1 | 39.2 | 39.3 | 39.4 | 39.5 | 10 |
| | | | | | 12 or 26 | 43.0 | 43.1 | 43.2 | 43.3 | 43.4 | 11 |
| | | | | | 13 or 27 | 46.9 | 47.0 | 47.2 | 47.3 | 47.4 | 12 |
| | | | | | 14 or 28 | 50.8 | 51.0 | 51.1 | 51.2 | 51.3 | 13 |
| | | | | | 29 | 54.7 | 54.9 | 55.0 | 55.2 | 55.3 | 14 |
| | | | | | 30 | 58.6 | 58.8 | 58.9 | 59.1 | 59.2 | 15 |
| | | | | | 31 | 62.6 | 62.7 | 62.9 | 63.0 | 63.2 | 16 |

Applications of Tables V and VII.

4. Required the Hour Angle and Azimuth of Polaris, for a station in latitude 46° N., longitude 90° W., at 8^h 24^m p. m., November 7, 1910.

| | | | |
|--|----|-------------------|----------|
| | h. | m. | |
| Astronomical time of observation, 1910, Nov. 7..... | 8 | 24.0 | |
| Equivalent to time of Nov. 6..... | 32 | 24.0 | |
| | h. | m. | |
| Astron. time, U. C. Polaris, Nov. 1 (Table V, Part I)... | 10 | 46.6 | |
| Reduction to Nov. 6 ^a (Part II), subtract | | ^b 19.7 | |
| Astron. time, U. C. Polaris, Nov. 6..... | 10 | 26.9, subtract.. | °10 26.9 |
| Hour Angle of Polaris, at observation | | 21 | 57.1 |
| Subtract from..... | | °23 | 56.1 |
| Time Argument for Table VII | | 1 | 59.0 |
| Azimuth of Polaris, at observation..... | | 0° | 51' E. |

5. Required the Hour Angle and Azimuth of Polaris, for a station in latitude 41° 12' N., longitude 94° W., at 6^h 16^m a. m., Nov. 19, 1901.

| | | | |
|--|----|------------------|--------|
| | h. | m. | |
| Astronomical time of observation, 1901, Nov. 18..... | 18 | 16.0 | |
| | h. | m. | |
| Astron. time, U. C. Polaris, Nov. 15 (Table V, Part I)... | 9 | 46.4 | |
| Reduction to Nov. 18 (Part II), subtract..... | | 11.8 | |
| Astron. time, U. C. Polaris, Nov. 18..... | 9 | 34.6, subtract.. | 9 34.6 |
| Hour Angle of Polaris, at observation, and Time Argument for Table VII.. | | °8 | 41.4 |
| Azimuth of Polaris, at observation (Table VII), 74 ^l or..... | | °1° | 14' W. |

^aBy reference to the above table, the surveyor will observe that the times, between Nov. 1 and 15, are greater than 8^h 24^m; consequently, the culmination for one day earlier, Nov. 6, will be used; see directions on page 99; also, section 313.

^bFrom Part II, Table V, opposite 6th day of month, and under "3.94^m."

^cTo subtract, take 1 day from Nov. 7, and add its equivalent, 24^h, to 8^h 24^m, making, Nov. 6, 32^h 24^m (which is the time expressed by Nov. 7, 8^h 24^m); then subtract in the usual manner.

^dSee last clause of footnote, page 104.

^eIn case the Hour Angle comes out greater than 11^h 58^m, subtract it from 23^h 56.1^m; see example 4, above.

^fThe Hour Angle being less than 11^h 58^m, the Azimuth is west; see precepts, top of Table VII.

DIFFERENT OBSERVATIONS OF POLARIS.

314. To establish the meridian of any station, and test the accuracy of courses derived from the sun, the deputy must use one or more of the following methods:

1. By upper culmination.
2. By lower culmination.
3. By east elongation.
4. By west elongation.

5. By hour-angle observation, at some point in any of the quadrants included between these four points.

The exact local mean time of lower culmination or of either elongation will be deduced from Table V above, as follows.

FOR EAST ELONGATION.

315. Find the time of upper culmination for the given day and year and subtract 5^h 55^m, unless this brings the time within the preceding astronomical day; in which case, instead of the subtraction, add 18^h 1^m.

FOR WEST ELONGATION.

316. Find the time of upper culmination and add 5^h 55^m, unless this brings the time within the succeeding astronomical day; in which case, instead of the addition, subtract 18^h 1^m.

FOR LOWER CULMINATION.

317. Find the time of upper culmination, and add or subtract 11^h 58^m, as may be found necessary to bring the result on the desired astronomical day.

Where the resulting time comes in daylight, another method must be chosen, to render the star visible, or the hour-angle table must be used. The following schedule of methods may be useful in selecting a process. The dates specified are the earliest and latest available.

TABLE VI.—Times suitable for various observations.

| Obs. for— | Astr. day. | Time of upper culmination. | Add or sub. | Time of observation. |
|---------------------|------------|----------------------------|--------------|---------------------------|
| | 1901. | <i>H. M.</i> | <i>H. M.</i> | <i>H. M.</i> |
| Eastern elongation. | Apr. 12 | 0 1.5—past noon..... | +18 1 | 18 2.5—morning twilight. |
| | Apr. 13 | 23 53.6—near noon..... | -5 55 | 17 58.6—morning twilight. |
| | Oct. 15 | 11 48.5—near midnight..... | -5 55 | 5 53.5—early evening. |
| Western elongation. | Oct. 15 | 11 48.5—near midnight..... | +5 55 | 17 43.5—morning twilight. |
| | Apr. 12 | 0 1.5—past noon..... | +5 55 | 5 56.5—early evening. |
| | Apr. 13 | 23 53.6—near noon..... | -18 1 | 5 52.6—early evening. |
| Lower culmination. | Jan. 15 | 5 44.4—early evening..... | +11 58 | 17 42.4—morning twilight. |
| | July 15 | 17 49.2—early morning..... | -11 58 | 5 51.2—early evening. |

FOR HOUR-ANGLE OBSERVATIONS. (TABLE VII.)

318. 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 for 11 years, computed for average values of the

north polar distance of the star—the arguments being the hour angle (or $23^{\text{h}} 56^{\text{m}}.1$, minus the hour angle, when the latter exceeds $11^{\text{h}} 58^{\text{m}}$), which is termed the time Argument;^a and the latitude of the place of observation. The table is so extended that azimuths may be taken out by mere inspection and all interpolation avoided, except such as can be performed mentally.

The hours of the “time arguments” are placed in the columns headed “Hours,” on left of each page. The minutes of the time arguments will be found in the columns marked “m.,” under the years for which they are computed, and they are included between the same heavy zigzag lines which inclose the hours to which they belong.

The time arguments are given to the nearest half minute; the occurrence of a period after the minutes of any one of them, indicates that its value is 0.5^{m} greater than printed, the table being so arranged to economize space.

319. The table will be used as follows: *Find the HOURS of the time argument in the left-hand column of either page; then, between the heavy lines which inclose the hours, find the MINUTES in the column marked at the top with the current year. 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 each page.* Thus, for 1904, time argument, $0^{\text{h}} 43^{\text{m}}$, latitude 36° ; find 0^{h} on left-hand page and under 1904, find 43^{m} , on ninth line from the top, and on same line with the minutes, under latitude 36° , is the azimuth $0^{\circ} 17'$. For 1908, time argument $9^{\text{h}} 33\frac{1}{2}^{\text{m}}$, lat. 48° , the azimuth is $1^{\circ} 1\frac{1}{2}'$, found on the 21st line from top of right-hand page.

If the exact time argument is not found in the table, the azimuth should be proportioned to the difference between the given and tabular values of said argument.

The table has been arranged to give the azimuths by simple inspection. No written arithmetical work is required, all being performed 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 top of either page, where the difference of azimuths, for 2° difference of latitude, amounts to 4 or 5 minutes of arc.

320. The attention of the surveyor is directed to the fact that he should always use one day of twenty-four hours as the unit, when he subtracts the time of culmination from the time of observation. See example 4, page 102. In any case when the time of upper culmination, taken from Table V, for the given date, would be numerically greater than the astronomical time of observation, the former time will be taken out for a date one day earlier than the date of observation. The surveyor will decide when such condition exists by comparing the time

^aThe vertical diameter SS' , fig. 2, divides the apparent path of Polaris into two equal parts, and for the star at any point s_e on the east side, there is a corresponding point s_w on the west side of the meridian, for which the azimuth Nw , is equal to the azimuth Ne . The arc $Ss_eS'_s_w$, taken from the entire circle (or $23^{\text{h}} 56^{\text{m}}.1$), leaves the arc Ss_w , and its equal, Ss_e , expressed in time, may be used to find, from Table VII, the azimuth Nw , which is equal to Ne .

The hour angles entered in Table VII include only those of the west half of the circle ending at S' , and when an hour angle greater than $11^{\text{h}} 58^{\text{m}}$ results from observation, it will be subtracted from $23^{\text{h}} 56^{\text{m}}.1$, and the remainder will be used as the “time argument” for the table. The surveyor should 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 meridian, as noted at top of Table VII. See examples below Table V, page 102.

given in the table with his astronomical time of observation. See example 4 and explanations in footnotes, page 102.

321. The watch time to be used when making observations on Polaris at all times except elongation should be as accurate as can be obtained. Looking at Table VII, near the top of page 106, the surveyor will observe, that for a difference of four minutes in the time argument, there is a change of about two minutes in azimuth; consequently, to obtain the azimuth to the nearest whole minute of arc, the local mean time, upon which all depends, should be known within two minutes. When the surveyor uses a solar instrument, he can readily determine the time for himself during the afternoon before observing Polaris, or in 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, page 149. When the surveyor uses standard railroad time, he will 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 $6^{\circ} 45'$, the equivalent in time will be 27 minutes. The difference of longitude may be taken from a good map. The number of seconds taken from the 5th column of Table XII, (opposite the proper latitude), multiplied by the number of ranges, will give the correction for longitude in seconds of time. The correction will be subtracted from the standard railroad time of observation, when the surveyor's station is west, or added when east of the standard meridian, as the case may require, to obtain local time. It is immaterial where the surveyor obtains the standard time, provided he gets it right; a result which will be gained most easily by a direct personal comparison at a telegraph office.

322. The following Table VII thus enables the surveyor to obtain the hour angle and azimuth of Polaris at any hour and minute from 1901 to 1911 inclusive, in latitudes 30° to 50° , thus combining in two pages the essentials which under ordinary methods would require twenty. This condensed table was first given in the Manual of 1890, for dates which are now past. It has now been extended to a date 11 years later, with a slight change of plan.

TABLE VII.—Azimuths of Polaris

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

| STAR AND AZIMUTH. | | | | | | | | | | | | POLARIS above THE POLE. | | | | | | | | | | | | | | | | | | | | | | |
|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---|----|----|----|----|----|----|----|----|-----|-----|----|----|----|----|----|----|----|----|----|-----|-----|-----|
| 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 . | | | | | | | | | | | | To determine the true meridian, the azimuth will 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 . | | | | | | | | | | | | | | | | | | | | | | |
| Time argument, the star's hour angle (or 23 ^h 56 ^m .1 minus the star's hour angle), for the year— | | | | | | | | | | | | Azimuths for latitude— | | | | | | | | | | | | | | | | | | | | | | |
| Hours. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. | 1908. | 1909. | 1910. | 1911. | 30 | 32 | 34 | 36 | 38 | 40 | 42 | 44 | 46 | 48 | 50 | | | | | | | | | | | | |
| h. | m. | m. | m. | m. | m. | m. | m. | m. | m. | m. | m. | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | | | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 |
| 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 19 | 19 | 19 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |
| 22 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 27 | 27 | 27 | 27 | 28 | 28 | 28 | 28 | 28 | 29 | 29 | 29 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 |
| 32 | 32 | 32 | 32 | 33 | 33 | 33 | 33 | 33 | 34 | 34 | 34 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| 37 | 37 | 37 | 37 | 38 | 38 | 38 | 38 | 38 | 39 | 39 | 39 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| 42 | 42 | 42 | 42 | 43 | 43 | 43 | 43 | 43 | 44 | 44 | 44 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| 47 | 47 | 47 | 47 | 48 | 48 | 48 | 48 | 48 | 49 | 49 | 49 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| 52 | 52 | 52 | 52 | 53 | 53 | 53 | 53 | 53 | 54 | 54 | 54 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 |
| 53 | 53 | 53 | 53 | 54 | 54 | 54 | 54 | 54 | 55 | 55 | 55 | 56 | 56 | 56 | 56 | 56 | 56 | 56 | 56 | 56 | 56 | 56 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| 58 | 59 | 59 | 0 | 0 | 0 | 1 | 2 | 2 | 3 | 4 | 4 | 42 | 43 | 44 | 45 | 46 | 48 | 49 | 51 | 53 | 55 | 57 | 42 | 43 | 44 | 45 | 46 | 48 | 49 | 51 | 53 | 55 | 57 | 60 |
| 4 | 4 | 4 | 5 | 6 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 44 | 45 | 46 | 47 | 48 | 50 | 51 | 53 | 55 | 57 | 60 | 44 | 45 | 46 | 47 | 48 | 50 | 51 | 53 | 55 | 57 | 60 | 62 |
| 9 | 10 | 10 | 11 | 12 | 12 | 13 | 13 | 14 | 15 | 15 | 16 | 46 | 47 | 48 | 49 | 50 | 52 | 53 | 55 | 57 | 60 | 62 | 46 | 47 | 48 | 49 | 50 | 52 | 53 | 55 | 57 | 60 | 62 | 64 |
| 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 21 | 21 | 22 | 22 | 47 | 48 | 49 | 51 | 52 | 54 | 56 | 57 | 60 | 62 | 64 | 47 | 48 | 49 | 51 | 52 | 54 | 56 | 57 | 60 | 62 | 64 | 67 |
| 21 | 21 | 22 | 23 | 24 | 24 | 25 | 26 | 27 | 28 | 28 | 28 | 49 | 50 | 51 | 53 | 54 | 56 | 58 | 60 | 62 | 64 | 67 | 49 | 50 | 51 | 53 | 54 | 56 | 58 | 60 | 62 | 64 | 67 | 69 |
| 27 | 27 | 28 | 29 | 30 | 30 | 31 | 32 | 33 | 34 | 35 | 35 | 51 | 52 | 53 | 55 | 56 | 58 | 60 | 62 | 64 | 66 | 69 | 51 | 52 | 53 | 55 | 56 | 58 | 60 | 62 | 64 | 66 | 69 | 72 |
| 33 | 33 | 34 | 35 | 36 | 36 | 37 | 38 | 39 | 40 | 41 | 41 | 53 | 54 | 55 | 56 | 58 | 60 | 62 | 64 | 66 | 68 | 71 | 53 | 54 | 55 | 56 | 58 | 60 | 62 | 64 | 66 | 68 | 71 | 74 |
| 39 | 40 | 40 | 41 | 42 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 54 | 56 | 57 | 58 | 60 | 62 | 64 | 66 | 68 | 71 | 73 | 54 | 56 | 57 | 58 | 60 | 62 | 64 | 66 | 68 | 71 | 73 | 76 |
| 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 56 | 57 | 59 | 60 | 62 | 64 | 66 | 68 | 70 | 73 | 76 | 56 | 57 | 59 | 60 | 62 | 64 | 66 | 68 | 70 | 73 | 76 | 79 |
| 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 1 | 2 | 2 | 58 | 59 | 61 | 62 | 64 | 66 | 68 | 70 | 73 | 76 | 79 | 58 | 59 | 61 | 62 | 64 | 66 | 68 | 70 | 73 | 76 | 79 | 81 |
| 58 | 59 | 0 | 1 | 2 | 3 | 4 | 6 | 7 | 8 | 9 | 9 | 60 | 61 | 63 | 64 | 66 | 68 | 70 | 72 | 75 | 78 | 81 | 60 | 61 | 63 | 64 | 66 | 68 | 70 | 72 | 75 | 78 | 81 | 84 |
| 5 | 6 | 7 | 8 | 10 | 10 | 11 | 12 | 13 | 14 | 15 | 17 | 61 | 63 | 64 | 66 | 68 | 70 | 72 | 74 | 77 | 80 | 84 | 61 | 63 | 64 | 66 | 68 | 70 | 72 | 74 | 77 | 80 | 84 | 86 |
| 12 | 13 | 14 | 16 | 17 | 18 | 19 | 21 | 22 | 23 | 25 | 25 | 63 | 65 | 66 | 68 | 70 | 72 | 74 | 77 | 79 | 82 | 86 | 63 | 65 | 66 | 68 | 70 | 72 | 74 | 77 | 79 | 82 | 86 | 88 |
| 19 | 21 | 22 | 23 | 25 | 26 | 27 | 29 | 30 | 31 | 33 | 33 | 65 | 66 | 68 | 70 | 72 | 74 | 76 | 79 | 82 | 85 | 88 | 65 | 66 | 68 | 70 | 72 | 74 | 76 | 79 | 82 | 85 | 88 | 91 |
| 27 | 28 | 30 | 31 | 33 | 34 | 35 | 37 | 38 | 40 | 42 | 42 | 67 | 68 | 70 | 72 | 74 | 76 | 78 | 81 | 84 | 87 | 91 | 67 | 68 | 70 | 72 | 74 | 76 | 78 | 81 | 84 | 87 | 91 | 93 |
| 35 | 37 | 38 | 39 | 41 | 43 | 44 | 46 | 47 | 49 | 51 | 51 | 69 | 70 | 72 | 74 | 76 | 78 | 80 | 83 | 86 | 89 | 93 | 69 | 70 | 72 | 74 | 76 | 78 | 80 | 83 | 86 | 89 | 93 | 96 |
| 44 | 45 | 47 | 48 | 50 | 52 | 53 | 55 | 57 | 59 | 0 | 0 | 70 | 72 | 74 | 75 | 77 | 80 | 82 | 85 | 88 | 91 | 95 | 70 | 72 | 74 | 75 | 77 | 80 | 82 | 85 | 88 | 91 | 95 | 98 |
| 53 | 54 | 56 | 58 | 59 | 1 | 1 | 3 | 5 | 7 | 9 | 11 | 72 | 74 | 76 | 77 | 79 | 82 | 84 | 87 | 90 | 94 | 98 | 72 | 74 | 76 | 77 | 79 | 82 | 84 | 87 | 90 | 94 | 98 | 100 |
| 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 19 | 21 | 23 | 23 | 74 | 76 | 77 | 79 | 81 | 84 | 86 | 89 | 92 | 96 | 100 | 74 | 76 | 77 | 79 | 81 | 84 | 86 | 89 | 92 | 96 | 100 | 103 |
| 13 | 15 | 17 | 19 | 22 | 24 | 26 | 29 | 32 | 34 | 37 | 37 | 76 | 77 | 79 | 81 | 83 | 86 | 88 | 91 | 95 | 98 | 103 | 76 | 77 | 79 | 81 | 83 | 86 | 88 | 91 | 95 | 98 | 103 | 108 |
| 24 | 27 | 29 | 32 | 34 | 37 | 40 | 43 | 46 | 50 | 53 | 53 | 77 | 79 | 81 | 83 | 85 | 88 | 90 | 94 | 97 | 101 | 106 | 77 | 79 | 81 | 83 | 85 | 88 | 90 | 94 | 97 | 101 | 106 | 107 |
| 38 | 40 | 43 | 46 | 50 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

for the use of land surveyors.

minutes of time or of an hour angle indicates that its value is 0.5 greater than printed.]

| STAR AND AZIMUTH. | | | | | | | | | | | | POLARIS <i>below</i> THE POLE. | | | | | | | | | | | |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---|-----|-----|-----|-----|-----|-----|-----|------|------|------|--|
| W. of N. when hour angle is <i>less</i> than 11 ^h 58 ^m . E. of N. when hour angle is <i>greater</i> than 11 ^h 58 ^m . Time argument, the star's hour angle (or 23 ^h 56 ^m .1 minus the star's hour angle), for the year— | | | | | | | | | | | | To determine the true meridian, the azimuth will be laid off to the <i>east</i> when the hour angle is <i>less</i> than 11 ^h 58 ^m . and to the <i>west</i> when <i>greater</i> than 11 ^h 58 ^m . | | | | | | | | | | | |
| Hours. | | | | | | | | | | | | Azimuths for latitude— | | | | | | | | | | | |
| | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. | 1908. | 1909. | 1910. | 1911. | 30 | 32 | 34 | 36 | 38 | 40 | 42 | 44 | 46 | 48 | 50 | |
| h. | m. | m. | m. | m. | m. | m. | m. | m. | m. | m. | m. | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | |
| 6 | 34 | 28 | 20 | 9. | m. | m. | m. | m. | m. | m. | m. | 83 | 85 | 87 | 89 | 91. | 94 | 97 | 100 | 103. | 107. | 112 | |
| 7 | 56 | 52. | 48. | 45 | 40. | 34 | 27 | 18 | 8 | m. | m. | 81. | 83 | 85 | 87 | 89. | 92 | 95 | 98 | 101. | 105. | 109. | |
| | 26 | 23. | 21 | 18. | 16 | 13 | 10 | 7 | 4 | 0. | 57 | 79. | 81. | 83 | 85 | 87. | 90 | 93 | 96 | 99. | 103. | 107. | |
| | 87. | 35. | 33. | 31. | 29 | 26. | 24 | 21. | 19 | 16 | 13 | 76 | 77. | 79. | 81. | 83. | 86 | 88. | 91. | 95 | 98. | 102 | |
| | 48. | 46. | 44. | 42. | 40. | 38. | 36. | 34. | 32 | 29. | 27 | 74. | 76 | 77. | 79. | 81. | 84 | 86. | 89. | 92. | 96 | 100. | |
| | 58 | 56. | 55 | 53 | 51. | 49. | 47. | 45. | 43. | 41. | 39. | 72. | 74 | 76 | 77. | 79. | 82 | 84. | 87. | 90. | 94 | 97. | |
| 8 | 7. | 6 | 4 | 2. | 1 | 59. | 57. | 56 | 54 | 52. | 50. | 71 | 72. | 74 | 76 | 77. | 80 | 82. | 85. | 88. | 91. | 95 | |
| | 16 | 14. | 13 | 11. | 10 | 8. | 7 | 5. | 4 | 2. | 1 | 69 | 70. | 72 | 74 | 75. | 78 | 80. | 83 | 86 | 89 | 92 | |
| | 24 | 23 | 21. | 20 | 18. | 17. | 16 | 14. | 13 | 11. | 10 | 67. | 68. | 70. | 72 | 74 | 76 | 78. | 81 | 84 | 87 | 90 | |
| | 32 | 31 | 29. | 28 | 27 | 25. | 24 | 23 | 21. | 20. | 19 | 65. | 67 | 68. | 70 | 72 | 74 | 76. | 79 | 81. | 84. | 88 | |
| | 39 | 38. | 37 | 36 | 35 | 33. | 32. | 31 | 30 | 28. | 27. | 64 | 65 | 66. | 68 | 70 | 72 | 74. | 77 | 79. | 82. | 85 | |
| | 47 | 46 | 44. | 43. | 42. | 41. | 40 | 39 | 38 | 36. | 35. | 62 | 63. | 64. | 66. | 68 | 70 | 72 | 74. | 77. | 80 | 83 | |
| | 54 | 53 | 52 | 50. | 49. | 48. | 47. | 46. | 45. | 44. | 43 | 60. | 61. | 63 | 64. | 66 | 68 | 70 | 72. | 75 | 78 | 80. | |
| 9 | 0. | 59. | 58. | 57. | 56. | 55. | 54. | 53. | 52. | 51. | 50. | 58. | 59. | 61 | 62. | 64 | 66 | 68 | 70. | 73 | 75 | 78 | |
| | 7. | 6. | 5. | 4. | 3. | 2. | 1. | 1 | 0 | 59 | 58 | 57 | 58 | 59 | 60. | 62. | 64 | 66 | 68. | 70. | 73 | 76 | |
| | 13. | 13 | 12 | 11 | 10. | 9. | 8. | 7. | 6. | 5. | 5 | 55 | 56 | 57. | 59 | 60. | 62 | 64 | 66 | 68. | 71 | 73. | |
| | 20 | 19 | 18. | 17. | 17 | 16 | 15 | 14. | 13. | 12. | 11. | 53. | 54. | 55. | 57. | 58. | 60 | 62 | 64 | 66 | 68. | 71. | |
| | 26 | 25. | 24. | 24. | 23 | 22. | 21. | 20. | 20 | 19 | 18 | 51. | 52. | 53. | 55. | 56. | 58 | 60 | 62 | 64 | 66. | 68. | |
| | 32 | 31. | 31 | 30 | 29. | 28. | 28 | 27 | 26. | 25. | 24. | 49. | 50. | 52 | 53 | 54. | 56 | 58 | 59. | 62 | 64 | 66. | |
| | 38 | 37. | 37 | 36 | 35. | 35 | 34 | 33. | 32. | 32 | 31 | 48 | 49 | 50 | 51 | 52. | 54 | 55. | 57. | 59. | 61. | 64 | |
| | 44 | 43. | 43 | 42 | 41. | 41 | 40 | 39. | 38. | 38 | 37. | 46 | 47 | 48 | 49. | 50. | 52 | 53. | 55. | 57. | 59. | 61 | |
| | 50 | 49 | 48. | 48 | 47. | 47 | 46 | 45. | 45 | 44 | 43. | 44. | 45. | 46. | 47. | 48. | 50 | 51. | 53. | 55 | 57 | 59 | |
| | 55. | 55 | 54. | 54 | 53 | 52. | 52 | 51. | 51 | 50 | 49. | 42. | 43. | 44. | 45. | 46. | 48 | 49. | 51 | 53 | 55 | 57 | |
| 10 | 1 | 0. | 0 | 59. | 59 | 58. | 57. | 57 | 56. | 56 | 55. | 41 | 41. | 42. | 43. | 44. | 46 | 47. | 49 | 50. | 52. | 54. | |
| | 6. | 6 | 5. | 5 | 4. | 4 | 3. | 3 | 2. | 2 | 1 | 39 | 40 | 40. | 41. | 43 | 44 | 45. | 47 | 48. | 50 | 52 | |
| | 12 | 11. | 11 | 10. | 10 | 9. | 9 | 8. | 8 | 7. | 7 | 37. | 38 | 39 | 40 | 41 | 42 | 43. | 45 | 46. | 48 | 49 | |
| | 17 | 17 | 16. | 16. | 15. | 14. | 14 | 13. | 13 | 12. | 12. | 35. | 36 | 37 | 38 | 39 | 40 | 41 | 42. | 44 | 45 | 47. | |
| | 23 | 22. | 22 | 21. | 21 | 20. | 20 | 19. | 19. | 19 | 18. | 34 | 34. | 35 | 36 | 37 | 38 | 39 | 40. | 42 | 43. | 45 | |
| | 28 | 27. | 27. | 27 | 26 | 26 | 25. | 25 | 25 | 24. | 24 | 32 | 32. | 33. | 34 | 35 | 36 | 37 | 38. | 39. | 41 | 42. | |
| | 33. | 33 | 32. | 32 | 32 | 31. | 31 | 30. | 30 | 30 | 29. | 30 | 31 | 31. | 32 | 33 | 34 | 35 | 36 | 37. | 39 | 40 | |
| | 38. | 38 | 38 | 37. | 37 | 36. | 36. | 36 | 35. | 35 | 35 | 28. | 29 | 29. | 30. | 31 | 32 | 33 | 34 | 35. | 36 | 38. | |
| | 43. | 43. | 43 | 42. | 42 | 42 | 41. | 41. | 41. | 40. | 40 | 26. | 27 | 28. | 28. | 29 | 30 | 31 | 32 | 33 | 34 | 35. | |
| | 49 | 48. | 48 | 48 | 47. | 47. | 47 | 46. | 46. | 46 | 45. | 25 | 25. | 26 | 26. | 27 | 28 | 29 | 30 | 31 | 32 | 33 | |
| | 54 | 53. | 53 | 53 | 52. | 52. | 52 | 52 | 51. | 51 | 51 | 23 | 23. | 24 | 24. | 25. | 26 | 27. | 27. | 28. | 29. | 31. | |
| | 59 | 58. | 58 | 58 | 58. | 57. | 57. | 57 | 57 | 56. | 56 | 21. | 22 | 22. | 22. | 23 | 24 | 25 | 25. | 26. | 27. | 28. | |
| 11 | 4 | 3. | 3. | 3 | 2. | 2. | 2. | 2 | 2 | 1. | 1. | 19. | 20. | 20. | 21 | 21. | 22 | 22. | 23. | 24 | 25 | 26 | |
| | 9 | 8. | 8. | 8. | 8 | 8 | 7. | 7 | 7 | 7 | 6. | 18 | 18 | 18. | 19. | 19. | 20 | 20. | 21. | 22 | 23 | 23. | |
| | 14 | 13. | 13. | 13 | 13 | 13 | 12. | 12. | 12. | 12 | 12 | 16. | 16. | 17. | 17. | 18 | 18. | 19. | 20 | 20. | 21. | 21. | |
| | 19 | 18. | 18. | 18. | 18 | 18 | 17. | 17. | 17. | 17 | 17 | 14 | 14. | 15 | 15. | 15. | 16 | 16. | 17 | 17. | 18 | 19 | |
| | 24 | 23. | 23. | 23. | 23 | 23 | 22. | 22. | 22. | 22. | 22 | 12. | 12. | 13 | 13. | 13. | 14 | 14. | 15 | 15. | 16 | 16. | |
| | 28. | 28. | 28. | 28. | 28 | 28 | 28 | 28 | 27. | 27. | 27. | 10. | 11 | 11. | 11. | 11. | 12 | 12. | 13 | 13. | 14 | 14. | |
| | 33. | 33. | 33. | 33. | 33 | 33 | 33 | 33 | 33 | 32. | 32. | 9 | 9 | 9. | 9. | 9. | 10 | 10. | 10. | 11 | 11. | 12. | |
| | 38. | 38. | 38. | 38 | 38 | 38 | 38 | 38 | 38 | 37. | 37. | 7 | 7 | 7. | 7. | 8 | 8 | 8. | 8. | 9 | 9 | 9. | |
| | 43. | 43. | 43. | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 5. | 5. | 5. | 5. | 6 | 6 | 6. | 6. | 7 | 7 | 7. | |
| | 48. | 48. | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 3. | 3. | 3. | 4 | 4 | 4. | 4. | 4. | 4. | 4. | 4. | |
| | 53 | 53 | 53 | 53 | 53 | 53 | 53 | 53 | 53 | 53 | 53 | 2 | 2 | 2 | 2 | 2 | 2 | 2. | 2. | 2. | 2. | 2. | |
| | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

RELATIVE POSITIONS OF THE MERIDIAN AND POLARIS.

323. If the observation is made after in point of time and within $11^{\text{h}} 58^{\text{m}}$ of the culmination preceding, the star is obviously west of the true meridian and the azimuth must be laid off to the east. If the observation is made before in point of time and within $11^{\text{h}} 58^{\text{m}}$ of the culmination following, the star is obviously east of the meridian and the azimuth must be laid off to west.

A very good way to tell the position of Polaris as to being either west or east of the meridian, is accomplished by noticing the relative position of Polaris and the star Mizar in the handle of the "Great Dipper." These stars Mizar and Polaris are diametrically opposite each other on a line passing almost exactly through the pole of the earth's axis. Obviously if Mizar is in the eastern sky, Polaris is west of the meridian, etc.

The following four examples illustrate any difficulties in the use of the tables:

EVENING OBSERVATIONS.

324. February 20, 1903, at $7^{\text{h}} 42^{\text{m}}.5$ p. m. local mean time, I observe Polaris in position and mark the direction of the sight upon the ground. I notice that Mizar is in the eastern sky. Station in southern California, latitude 36° , longitude 117° .

| | | | |
|--|-----------|-----------|------|
| Time of observation | <i>h.</i> | <i>m.</i> | |
| | 7 | 42.5 | |
| From Table V, U. C. Polaris, February 15 | <i>h.</i> | <i>m.</i> | |
| | 3 | 44.8 | |
| Reduction to February 20 | 19.7 | 3 | 25.1 |
| Time elapsed since preceding culmination | 4 | 17.4 | |
| From Table VII corresponding azimuth is $81^{\circ}.5$. | | | |

February 21 I lay off the meridian $1^{\circ} 21'.5$ to the east of the line of sight of observation.

325. May 9, 1903, at $8^{\text{h}} 56^{\text{m}}.4$ p. m., local mean time, I observe Polaris in position and mark the line of sight upon the ground. I notice that Mizar is in the eastern sky. Station in northeastern Minnesota, latitude 48° , longitude 90° . The nearest culmination is that of May 8.

| | | | |
|--|-----------|-----------|------|
| Time of observation May 9, $8^{\text{h}} 56^{\text{m}}.4$, or May 8 | <i>h.</i> | <i>m.</i> | |
| | 32 | 56.4 | |
| From Table V, U. C., May 1 | <i>h.</i> | <i>m.</i> | |
| | 22 | 45.7 | |
| Reduction to May 8 | 27.5 | 22 | 18.2 |
| Time elapsed since preceding culmination | 10 | 38.2 | |
| From Table VII, corresponding azimuth is $36^{\circ}.5$. | | | |

May 10 I lay off the meridian $0^{\circ} 36'.5$ to the east of the line of observation of Polaris.

MORNING OBSERVATIONS.

326. May 10, 1903, at $5^{\text{h}} 13^{\text{m}}$ a. m., local mean time, or May 9, $17^{\text{h}} 13^{\text{m}}$ astronomical time, I observe Polaris in position and mark the line of sight upon the ground. I notice that Mizar is in the western sky. Station in northeastern Minnesota, latitude 48° , longitude 90° .

| | | | | |
|--|-----------|-----------|-----------|-----------|
| Time of observation, May 9 | <i>h.</i> | <i>m.</i> | <i>h.</i> | <i>m.</i> |
| | | | 17 | 13.0 |
| From Table V, U. C., May 1 | 22 | 45.7 | | |
| Reduction to May 9 | | -31.4 | 22 | 14.3 |
| Time to elapse to next following culmination | | | 5 | 1.3 |

From Table VII corresponding azimuth is 85'.5.

After daylight I lay off the meridian 1° 25'.5 to the west of the line of observation.

327. February 21, 1903, at 5^h 10^m a.m., local mean time, or February 20, 17^h 10^m, astronomical time, I observe Polaris in position and mark the line of sight upon the ground. I notice that Mizar is in the western sky. Station in southern California, latitude 36°, longitude 117°. The nearest culmination is on February 21.

| | h. | m. | h. | m. | h. | m. |
|---|----|-------|----|----|----|-----------|
| Time of observation, February 20..... | | | | | 17 | 10.0 |
| From Table V, U. C., February 15..... | 3 | 44.8 | | | | |
| Reduction to February 20..... | | -19.7 | | | | |
| | 3 | 25.1 | + | 24 | 0 | = 27 25.1 |
| Time to elapse to next following culmination..... | | | | | 10 | 15.1 |

From Table VII, corresponding azimuth is 38'.0.

After daylight I lay off the meridian 0° 38' to the west of the line of observation.

OBSERVATIONS AT ELONGATION.

328. Approximately 5^h 55^m later than the time of culmination Polaris reaches its maximum western azimuth, or western elongation. Eastern elongation occurs the same amount of time earlier than upper culmination.

When observing at elongation the time is not at argument, except to warn the observer of the approaching condition. In the observation the motion of the star is slowly followed until the maximum azimuth is actually observed to have been reached by the star receding. The line of sight of the maximum position in azimuth noticed in the observation is marked upon the ground.

329. In Table IV is tabulated the azimuth of Polaris when at elongation, for any date from 1901 to 1911, inclusive, and for any latitude between 30° and 50°, inclusive.

The following two examples illustrate observations made at elongation:

WESTERN ELONGATION.

330. March 10, 1903, I wish to observe Polaris at western elongation; my latitude is 40°.

| | h. | m. |
|-----------------------------------|----|-------|
| From Table V, U. C., March 1..... | 2 | 49.5 |
| Reduction to March 10..... | | -35.5 |
| Time to add until elongation..... | | +5 55 |
| Time of western elongation..... | 8 | 9 |

About 8 p. m. I commence observing the western progress of Polaris; when the star begins to recede, I mark the maximum position in azimuth upon the ground. From Table IV the corresponding azimuth is found to be 1° 34'.8. March 11, I lay off the meridian 1° 34'.8 to the east of the line of the observation.

EASTERN ELONGATION.

331. September 3, 1903, I wish to observe Polaris at eastern elongation; my latitude is 48°.

| | h. | m. |
|---------------------------------------|-----|-------|
| From Table V, U. C., September 1..... | 14 | 43.9 |
| Reduction to September 3..... | | - 7.9 |
| Time to subtract for elongation..... | - 5 | 55 |
| | 8 | 41 |

About 8^h 30^m I commence observing the eastern progress of Polaris; when the star begins to recede I mark the maximum position in azimuth upon the ground. From Table IV the corresponding azimuth is found to be 1° 48'.6. September 4 I lay off the meridian 1° 48'.6 to the west of the line of sight.

VERIFYING RESULTS OF SOLAR WORK.

332. Surveyors general and their deputies have sometimes failed to appreciate the requirements of the Manual on testing the adjustment of the solar compass and verifying the accuracy of its work. In some cases a wholly erroneous idea thereon has been entertained, making it necessary to instruct deputies that the adjustments of a solar compass are not proved correct by its own meridian; but that its meridian must be verified by proper Polaris observation, to render results reliable.

333. If a solar instrument standing unmoved, both forenoon and afternoon, gives an unvarying result, it is usually presumed to be accurately set, and all its parts in adjustment; but the requirement of a careful test of the solar by stellar observation, will be rigidly adhered to, in order to detect possible continuous error in the solar work, which would vitiate an extensive survey. A solar attachment may remain in good adjustment while the line of collimation is very erroneous. To make certain that the whole instrument remains in true adjustment, nothing will avail short of a meridian independently derived from the star, and proved by reversing.

These tests inserted in the field notes, according to the model in the specimen field notes, will be subject to verification by the final tests of the field examiner.

SURVEYING BASE LINES AND STANDARD PARALLELS BY OFFSETS FROM STRAIGHT LINES.

[See Plate I, fig. 5.]

334. The corners on a Base Line or Standard Parallel could be established from chords of the latitude curve, joining successive township corners; from a tangent to the true latitude curve at a point midway between the township corners; or from an intermediate straight line parallel to the lines above mentioned. In the first case, all the offsets would be measured south; in the second case, all offsets would be measured north; and, in both cases, the maximum offset, or greatest distance of the latitude curve from the reference lines, would be one-fourth of the greatest offset from a tangent six miles long, i. e., the offset found in table X, opposite the proper latitude, and in the column headed "3 miles;" while the initial bearings of the three lines, i. e., the angles K, M, and L, would be equal to each other; similar relations between the bearings at corresponding points, would obtain through a range.

The method of establishing corners on a true latitude curve by offsets from a line situated between and parallel to the chord and tangent, which was devised to meet a demand for short offsets, will now be described.

SECANT METHOD.

[See Plate I, figs. 1, 2, and 5.]

335. This method consists of running a connected series of straight lines, each six miles long, on such courses that any one of the lines will intersect the curve of the parallel of latitude in two points, sep-

arated by an interval of four miles; and, from the lines thus established, measuring north or south, as the case may be, to attain other required points on the latitude curve. For the sake of brevity, said straight lines will be called secants.

TABLE VIII.—Azimuths of the Secant, and Offsets, in feet, to the Parallel.

Arguments: latitude in left hand column and distance from starting point at top or bottom of the table.

| Latitude. | Azimuths and offsets at— | | | | | | | Deflection Angle and nat. tan. to Rad. 66 ft. |
|-----------|--------------------------|----------------------|-------------------|----------------------|----------------------|----------------------|---------------------------|---|
| | 0 miles. | ½ mile. | 1 mile. | 1½ miles. | 2 miles. | 2½ miles. | 3 miles. | |
| 30 | 89° 58'.5 1.93 N. | 89° 58'.7 0.87 N. | 89° 59'.0 0.00 | 89° 59'.2 0.67 S. | 89° 59'.5 1.15 S. | 89° 59'.7 1.44 S. | 90° (E. or W.) 1.54 S. | 3' 00".2 0.69 ins. |
| 31 | 89° 58'.4 2.01 N. | 89° 58'.6 0.91 N. | 89° 58'.9 0.00 | 89° 59'.2 0.70 S. | 89° 59'.5 1.20 S. | 89° 59'.7 1.50 S. | 90° (E. or W.) 1.60 S. | 3' 07".4 0.72 ins. |
| 32 | 89° 58'.4 2.09 N. | 89° 58'.6 0.94 N. | 89° 58'.9 0.00 | 89° 59'.2 0.73 S. | 89° 59'.5 1.25 S. | 89° 59'.7 1.56 S. | 90° (E. or W.) 1.67 S. | 3' 15".0 0.75 ins. |
| 33 | 89° 58'.3 2.17 N. | 89° 58'.5 0.97 N. | 89° 58'.8 0.00 | 89° 59'.1 0.76 S. | 89° 59'.4 1.30 S. | 89° 59'.7 1.62 S. | 90° (E. or W.) 1.73 S. | 3' 22".6 0.78 ins. |
| 34 | 89° 58'.2 2.25 N. | 89° 58'.5 1.01 N. | 89° 58'.8 0.00 | 89° 59'.1 0.79 S. | 89° 59'.4 1.35 S. | 89° 59'.7 1.69 S. | 90° (E. or W.) 1.80 S. | 3' 30".4 0.81 ins. |
| 35 | 89° 58'.2 2.33 N. | 89° 58'.5 1.05 N. | 89° 58'.8 0.00 | 89° 59'.1 0.82 S. | 89° 59'.4 1.40 S. | 89° 59'.7 1.75 S. | 90° (E. or W.) 1.87 S. | 3' 38".4 0.84 ins. |
| 36 | 89° 58'.1 2.42 N. | 89° 58'.4 1.09 N. | 89° 58'.7 0.00 | 89° 59'.0 0.85 S. | 89° 59'.4 1.46 S. | 89° 59'.7 1.82 S. | 90° (E. or W.) 1.94 S. | 3' 46".4 0.87 ins. |
| 37 | 89° 58'.0 2.51 N. | 89° 58'.3 1.13 N. | 89° 58'.6 0.00 | 89° 58'.9 0.88 S. | 89° 59'.3 1.51 S. | 89° 59'.7 1.89 S. | 90° (E. or W.) 2.01 S. | 3' 55".0 0.90 ins. |
| 38 | 89° 58'.0 2.61 N. | 89° 58'.3 1.17 N. | 89° 58'.6 0.00 | 89° 58'.9 0.91 S. | 89° 59'.3 1.56 S. | 89° 59'.7 1.95 S. | 90° (E. or W.) 2.08 S. | 4' 03".6 0.93 ins. |
| 39 | 89° 57'.9 2.70 N. | 89° 58'.2 1.21 N. | 89° 58'.6 0.00 | 89° 58'.9 0.94 S. | 89° 59'.3 1.62 S. | 89° 59'.7 2.02 S. | 90° (E. or W.) 2.16 S. | 4' 12".6 0.97 ins. |
| 40 | 89° 57'.8 2.79 N. | 89° 58'.1 1.25 N. | 89° 58'.5 0.00 | 89° 58'.9 0.98 S. | 89° 59'.3 1.68 S. | 89° 59'.7 2.10 S. | 90° (E. or W.) 2.24 S. | 4' 21".6 1.00 ins. |
| 41 | 89° 57'.7 2.89 N. | 89° 58'.0 1.30 N. | 89° 58'.4 0.00 | 89° 58'.8 1.02 S. | 89° 59'.2 1.74 S. | 89° 59'.6 2.17 S. | 90° (E. or W.) 2.32 S. | 4' 31".2 1.04 ins. |
| 42 | 89° 57'.7 3.00 N. | 89° 58'.0 1.35 N. | 89° 58'.4 0.00 | 89° 58'.8 1.05 S. | 89° 59'.2 1.80 S. | 89° 59'.6 2.25 S. | 90° (E. or W.) 2.40 S. | 4' 40".8 1.08 ins. |
| 43 | 89° 57'.6 3.11 N. | 89° 58'.0 1.40 N. | 89° 58'.4 0.00 | 89° 58'.8 1.08 S. | 89° 59'.2 1.86 S. | 89° 59'.6 2.33 S. | 90° (E. or W.) 2.48 S. | 4' 50".8 1.12 ins. |
| 44 | 89° 57'.5 3.22 N. | 89° 57'.9 1.45 N. | 89° 58'.3 0.00 | 89° 58'.7 1.12 S. | 89° 59'.2 1.93 S. | 89° 59'.6 2.41 S. | 90° (E. or W.) 2.57 S. | 5' 01".0 1.16 ins. |
| 45 | 89° 57'.4 3.33 N. | 89° 57'.8 1.50 N. | 89° 58'.3 0.00 | 89° 58'.7 1.16 S. | 89° 59'.1 2.00 S. | 89° 59'.5 2.49 S. | 90° (E. or W.) 2.66 S. | 5' 11".8 1.20 ins. |
| 46 | 89° 57'.3 3.44 N. | 89° 57'.7 1.55 N. | 89° 58'.2 0.00 | 89° 58'.6 1.21 S. | 89° 59'.1 2.07 S. | 89° 59'.5 2.59 S. | 90° (E. or W.) 2.76 S. | 5' 22".8 1.24 ins. |
| 47 | 89° 57'.2 3.57 N. | 89° 57'.6 1.61 N. | 89° 58'.1 0.00 | 89° 58'.6 1.25 S. | 89° 59'.1 2.14 S. | 89° 59'.5 2.67 S. | 90° (E. or W.) 2.86 S. | 5' 34".2 1.28 ins. |
| 48 | 89° 57'.1 3.70 N. | 89° 57'.5 1.66 N. | 89° 58'.0 0.00 | 89° 58'.5 1.30 S. | 89° 59'.0 2.22 S. | 89° 59'.5 2.78 S. | 90° (E. or W.) 2.96 S. | 5' 46".2 1.33 ins. |
| 49 | 89° 57'.0 3.82 N. | 89° 57'.5 1.72 N. | 89° 58'.0 0.00 | 89° 58'.5 1.34 S. | 89° 59'.0 2.30 S. | 89° 59'.5 2.87 S. | 90° (E. or W.) 3.06 S. | 5' 58".6 1.38 ins. |
| 50 | 89° 56'.9 3.96 N. | 89° 57'.4 1.78 N. | 89° 57'.9 0.00 | 89° 58'.4 1.39 S. | 89° 59'.0 2.38 S. | 89° 59'.5 2.97 S. | 90° (E. or W.) 3.17 S. | 6' 11".4 1.43 ins. |
| Latitude. | 6 miles. | 5½ miles. | 5 miles. | 4½ miles. | 4 miles. | 3½ miles. | 3 miles. | Deflection Angle and nat. tan. to Rad. 66 ft. |
| | Azimuths and offsets at— | | | | | | | |

336. The direction of the first secant will be determined at its initial point by observations on Polaris at elongation, and similar observations will be made at intervals not exceeding 18 miles; while observations by the method given on page 96 et seq., or on Polaris at elongation (as the deputy may prefer), will be taken every night when practicable, to guard against mistakes, detect errors, and check the direction of the line.

The principal advantage of this method, over that by offsets from a tangent, results directly from the proximity of the secant and the parallel of latitude, and the consequent reduced length of the maximum offsets; thereby limiting the cutting, which will contain both secant and parallel, to a single opening less than four feet in width; avoiding the necessity for clearing out roads for, and instrumentally laying off, the long offsets inseparable from the tangent method; and permitting the noting of topographical features on the lines actually run, a convenience not always attainable by the tangent method.

337. In any given case, the secant lines will bear such relation to the latitude curve, that points on said secants, at one and five miles from either end of any secant, will be coincident with two points on the latitude curve four miles apart; between which points the latitude curve will lie south of the secants; while the curve will lie north of the secant lines on the first and sixth miles; therefore, each secant will run south of secs. 31 and 36, in every range, and through all other sections on the north side of the base line or standard parallel, as the case may be. (See Plate I, figs. 1 and 2.)

Each secant, the azimuth and offsets thereof, and the corresponding part of the parallel, will be symmetrically divided by the middle meridian of each range, i. e., the bearings and offsets at equal distances on opposite sides of the central meridian will be equal; the bearings, which continually change, will always be north of east (or west), on the first three miles, and south of east (or west), on the last three miles of each secant. The changes of bearing should not be understood to imply a change of direction of any secant with respect to its initial direction; the change is due to the varying inclination of the meridians to the straight secant, i. e., the effect of convergency of meridians. (See third column of Table XII, and Plate I, figs. 1, 2, and 5.)

338. Employing the data provided by Table II, the practical application of the method herein outlined will be conducted in the field as follows:

Set up the carefully adjusted transit south of the township corner at which the survey will begin, and at a distance therefrom to be interpolated for the given latitude, from the column headed "0 miles." By observations on Polaris at elongation, determine and mark a true meridian, in accordance with directions on page 94.

Lay off the azimuth, found in the table under "0 miles," toward the east (or west), as the case may be, and remeasure the angle a sufficient number of times to secure an accurate result.

Produce the direction of the secant thus determined, a distance of six miles in a straight line, taking double back and fore sights at each setting of the instrument. At each half-mile and mile point, establish on the standard parallel the proper quarter section and section corners by offsets of correct length, north or south, as indicated in the table by the initial letters N. or S.

VIII.

The offsets being very short, their direction (perpendicular to the secant, without sensible error), may be determined by the eye; the length of offsets should be carefully measured.

At 6 miles on the secant, turn off to the north the proper deflection angle, given in the right-hand column of the table, thereby defining the direction of a new secant, from which points will be established on the parallel, as directed in preceding paragraph.

339. Applications of Table VIII.—The true bearing of the secant at each mile and half-mile point will be expressed by the tabular azimuth preceded by the initial meridional letter N., when the distance argument is found at the top of the table; but when said argument is found at the bottom of the table, the meridional letter S. will be placed before the azimuth; while the departure letter, E. or W., will be made to agree with the direction of the survey, east or west, as the case may require. The bearings will be taken from the table, to the nearest whole minute only, and entered at the beginning of each mile recorded in the field notes. The direction of the offsets or distances from the secant north or south to the base line or standard parallel, as the case may be, are indicated by the initial letters, N. or S. following the offsets.

Example 1.—Standard parallel run west, lat. 48° N.; dist. from initial point of secant, 2 miles; the bearing is N. $89^{\circ} 59'$ W., the offset, 2.22 ft. S.; at $5\frac{1}{2}$ miles the bearing is S. $89^{\circ} 57'$ W., the offset 1.66 ft. N. In all latitudes the bearing of the secant at 3 miles will be east or west, agreeing with the direction of the parallel.

The offsets may be interpolated for minutes of latitude, by simple proportion, as follows: *Multiply the difference between the offsets corresponding to the whole degrees of latitude, immediately preceding and following the given latitude, by the minutes, expressed in decimals of a degree, and add the product to the offset corresponding to the lesser latitude; the sum will be the offset required.*

Example 2.—(See Plate I, figs. 1 and 2.) Lat. $45^{\circ} 34'.5$; dist., 0 miles or 6 miles; the diff. between offsets in latitudes 45° and 46° , is 0.11 ft.; $34'.5 = 0^{\circ}.575$; $0.11 \times 0.575 = 0.06$ ft.; and, $3.33 + 0.06 = 3.39$ ft., the offset required. All offsets written in figs. 1 and 2 were thus computed. A similar method of interpolation may be applied to the data in the right-hand column.

Example 3.—Latitude $45^{\circ} 34'.5$; diff. of angles, is $0' 11''$; $11 \times 0.575 = 6''.3$; and $5' 11''.8 + 6''.3 = 5' 18''$, nearly; also, $0.04 \times 0.575 = 0.02$ ins.; and, $1.20 + 0.02 = 1.22$ ins. (See at D.)

340. The deputy should clearly understand from the foregoing rules and directions that the correct establishment of a standard parallel on a true latitude curve, by offsets from secant lines, will depend in the order of sequence upon careful attention to the following points:

1. *Accurate observations on Polaris at elongation, to determine a true meridian.*
2. *Close measurement of the azimuth angle, to define the initial direction of the secant.*
3. *Careful prolongation of the secant in a straight line.*
4. *Correct measurement of the deflection angle.*

341. With ordinary field instruments, usually reading to single minutes only, fractional parts of the "least count" are generally estimated by the eye. Greater accuracy may be attained by making use of a

linear measure to lay off deflection angles. Table VIII supplies the requisite data; "the natural tangent of the angle of deflection to a radius of one chain," inserted in the right-hand column, may be employed as follows:

Having taken a back sight at the 6-mile point on the secant, at exactly one chain in advance of the center of the instrument, place upon the ground in a horizontal position, and precisely at right angles to the line, a rule or scale divided into decimal parts of an inch; move the scale north or south until one of its principal lines appears coincident with the vertical wire; then, with the tangent screw of the vernier plate, carry the wire over the scale toward the north, the required distance, i. e., the length of tangent in the right-hand column. The readings of the vernier will check the measurement and guard against mistakes.

A piece of white paper with two fine parallel lines drawn across it, exactly the proper distance apart, pasted on a thin slip of wood (such as a piece of cigar box, 3 inches long by 1 inch wide), will make an accurate and very convenient and portable substitute for a rule or scale. Several copies may be prepared in advance to replace the original in case of loss.

342. To mark the direction of the new secant thus determined, set a flag on line, and as far in advance of the instrument as practicable. The direction will be verified by another similar observation, to be made after revolving the azimuth circle 180° .

Theoretically, it is immaterial whether the scale be placed above or below the level of the telescope, provided the horizontal distance from the center of the instrument is accurately one chain (66 ft.); practically, the most satisfactory result will be had on level ground, suitable for correct measurement of the distance.

343. The secant method, adapted to transit instruments exclusively, is recommended for its simplicity and accuracy, and the facility with which the line may be extended over rough mountainous land or through dense undergrowth; in deep valleys or canyons where the sun can not be observed in favorable positions; or anywhere during the continuance of adverse weather conditions and under circumstances when the use of solar apparatus would be, if not impossible, at least inconvenient and unreliable.

344. The true bearing of a line joining any two points on a standard parallel will be obtained from Table IX, by taking it from the column headed with one-half of the distance between said points. Example, (Plate I, fig. 2.) Required the bearing from corner of secs. 32 and 33, R. 22 E., to corner of secs. 32 and 33 E., R. 21 E. The latitude is $45^\circ 34'.5$, the distance 6 miles. Consequently, the azimuth from the column marked "3 miles" for the given latitude, is N. $89^\circ 57' 20''.9$ W., the required true bearing.

The Specimen Field Notes No. 1, page 141, exhibit the form for record of the survey of a standard parallel through two ranges, executed in accordance with these instructions, and the practical method of correcting the line when a small deviation from the true latitude curve has been detected by observations on Polaris at elongation.

Plate I, fig. 1, illustrates a theoretically correct survey of a standard parallel; exhibits the bearings along the secant and lengths of offsets; and the deflection angle (at D), and place for the scale or rule

required for measurement of the angle; while fig. 2 illustrates the method described in the field notes for correcting the line when error has been discovered. The topography is laid down on Plate II.

TANGENT METHOD.

[See Plate I, Fig. 3.]

345. This method consists in laying off from a true meridian, established by observations on Polaris at elongation, an angle of 90° , producing the direction thus determined, a distance of 6 miles, in a straight line, and measuring north therefrom, at half-mile intervals, distances of correct length, taken from Table X (interpolated if necessary), for the given latitude, to attain other points on the latitude curve passing through the tangential or initial point.

The azimuth or bearing of the tangent at successive mile points will be taken from Table IX to the nearest whole minute only, and will be inserted in the field notes, no interpolation being required, except when test sights are taken. The true bearing between two points on a standard parallel will be derived from Table IX by taking it in the column headed with one half the distance between said points. (See examples in the secant method, page 113.) The offsets at intervals of one mile are inserted in Table X; to obtain the length of offsets at the half-mile points, take one-fourth of the offset corresponding to twice the distance of the half-mile point from the tangential point.

This method is suitable for running standard parallels and latitudinal township lines in a level open country, where no intersections with topographical features will be required; but, in all cases the secant method will be found most convenient.

The specimen field notes No. 1, page 139, exhibit the form of record of the survey of a standard parallel through one range, executed by the tangent method, which notes, considered in connection with Plate I, fig. 3, will fully explain the process here outlined.

TABLE IX.—Azimuths of the Tangent to the Parallel.

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

| Latitude. | 1 mille. | | | 2 miles. | | | 3 miles. | | | 4 miles. | | | 5 miles. | | | 6 miles. | | |
|-----------|----------|----|------|----------|----|------|----------|----|------|----------|----|------|----------|----|------|----------|----|------|
| | o | ' | " | o | ' | " | o | ' | " | o | ' | " | o | ' | " | o | ' | " |
| 30 | 89 | 59 | 30.0 | 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 | 56.0 | 89 | 57 | 28.8 | 89 | 56 | 52.5 |
| 32 | 89 | 59 | 27.5 | 89 | 58 | 55.0 | 89 | 58 | 22.5 | 89 | 57 | 50.0 | 89 | 57 | 17.5 | 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 | 10.8 | 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. | | |
|-----------|----------|----|------|----------|----|------|----------|----|------|-----------|----|------|-----------|----|------|-----------|----|------|
| | o | ' | " | o | ' | " | o | ' | " | o | ' | " | o | ' | " | o | ' | " |
| 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 | 40.0 | 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 | 27.5 | 89 | 52 | 43.8 | 89 | 52 | 00.2 | 89 | 51 | 16.6 |
| 41 | 89 | 54 | 43.7 | 89 | 53 | 58.5 | 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 | 40.5 | 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 X.—*Offsets, in Chains, from Tangent to Parallel.*

| Latitude. | 1 mile. | 2 miles. | 3 miles. | 4 miles. | 5 miles. | 6 miles. |
|-----------|----------------|----------------|----------------|----------------|----------------|----------------|
| ° | <i>Chains.</i> | <i>Chains.</i> | <i>Chains.</i> | <i>Chains.</i> | <i>Chains.</i> | <i>Chains.</i> |
| 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. |
|-----------|----------------|----------------|----------------|----------------|----------------|----------------|
| ° | <i>Chains.</i> | <i>Chains.</i> | <i>Chains.</i> | <i>Chains.</i> | <i>Chains.</i> | <i>Chains.</i> |
| 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 |

SURVEY OF TOWNSHIP EXTERIORS BY THE SECANT OR TANGENT
METHODS.

346. When township lines are surveyed by either of these methods, three lines should be taken into account, as follows:

First: The directing or reference line, which will be the secant or tangent, as the case may be.

Second: The line of temporary corners set by proper offsets; which will be the random line.

Third: The true line or random line corrected for the falling in the usual manner, upon which the corners will be established.

By setting the temporary corners, including, as a matter of course, that of the objective township corner, all complications incidental to the combined falling and offset from the secant or tangent, will be eliminated.

347. The following table, showing the departure or falling at 80 chains distance, for any number of minutes up to 60, can also be used in finding the minutes of correction of a random course corresponding to the number of links of falling.

For distances less than one mile the links of falling must be proportionately increased; for example if the falling at 70 chains is 28 links, the correction of the course will be 14 minutes for 32 links.

For township exteriors and other long lines, the number of links of falling must be divided by the number of miles to bring the calculation to the basis of the table.

TABLE XI.—*Correction of Randoms—Links and Minutes of Arc, showing departure in running 80.00 chs. at any course from 1 to 60 minutes (or difference in latitude for 90° minus angle.)*

| Angle. | Departure. | Angle. | Departure. | Angle. | Departure. | Angle. | Departure. |
|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|
| <i>Minutes.</i> | <i>Links.</i> | <i>Minutes.</i> | <i>Links.</i> | <i>Minutes.</i> | <i>Links.</i> | <i>Minutes.</i> | <i>Links.</i> |
| 1 | 2½ | 16 | 37½ | 31 | 72½ | 46 | 107½ |
| 2 | 4½ | 17 | 39½ | 32 | 74½ | 47 | 109½ |
| 3 | 7 | 18 | 42 | 33 | 77 | 48 | 112 |
| 4 | 9½ | 19 | 44½ | 34 | 79½ | 49 | 114½ |
| 5 | 11½ | 20 | 46½ | 35 | 81½ | 50 | 116½ |
| 6 | 14 | 21 | 49 | 36 | 84 | 51 | 119 |
| 7 | 16½ | 22 | 51½ | 37 | 86½ | 52 | 121½ |
| 8 | 18½ | 23 | 53½ | 38 | 88½ | 53 | 123½ |
| 9 | 21 | 24 | 56 | 39 | 91 | 54 | 126 |
| 10 | 23½ | 25 | 58½ | 40 | 93½ | 55 | 128½ |
| 11 | 25½ | 26 | 60½ | 41 | 95½ | 56 | 130½ |
| 12 | 28 | 27 | 63 | 42 | 98 | 57 | 133 |
| 13 | 30½ | 28 | 65½ | 43 | 100½ | 58 | 135½ |
| 14 | 32½ | 29 | 67½ | 44 | 102½ | 59 | 137½ |
| 15 | 35 | 30 | 70 | 45 | 105 | 60 | 140 |

348. Table XI will be used to determine the return from the random course, by the following rules, the meridians being regarded as parallel:

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

When the random course is nearly east and west, take the sum of the random course and falling [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].

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.

349. On meridional section lines. If the random line intersects at the objective corner, the return course will be the random course reversed. When the random falls east or west of the objective corner, reverse its bearing; then take the sum of the reversed random bearing and the falling [in minutes of arc], if they are of the same name—that is, both east or both west—but their difference when of different names; in either case making the departure letter, E. or W., agree with that of the greater value. Should the difference come out zero, the return course will be south.

350. For traverse or tabular statement of boundaries of a township, as required in field notes, (see pages 68 and 155) the above table will also be used thus:

The departure for one mile (80.00 chs.) will be multiplied by the length of the course expressed in miles, to obtain the departure of a meridional township line; while practically the difference of latitude will be equal to the length of the line.

To determine the difference of latitude between the ends of latitudinal township boundaries, subtract the bearing from 90° , and with the remainder as an argument for the table, take out the difference of latitude from the column headed "Departure"; the departure will be equal to the length of the line. (See Boundaries, etc., page 155.)

CONVERGENCY OF MERIDIANS.

351. In preparing special instructions for proposed new surveys, as well as the tabular statements of exteriors, the amount of convergency is to be determined from the annexed table.

TABLE XII.—*Convergency of Meridians six miles long and six miles apart, and other relevant data, to latitude 70° north.*

| Lat- itude. | Convergency. | | Difference of longi- tude per range. | | Difference of latitude for— | |
|----------------|-----------------------|--------|---|--------------------------|--------------------------------|------------------|
| | On the parallel. | Angle. | In arc. | In time. | 1 mile in arc. | 1 Tp. in arc. |
| 0 | | | | | | |
| 30 | <i>Links.</i> 41.9 | ' 0 | ' 0.36 | <i>Seconds.</i> 24.02 | 0'.871 | 5'.225 |
| 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 | 0'.870 | 5'.221 |
| 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 | 0'.869 | 5'.217 |
| 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 | 0'.869 | 5'.212 |
| 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 | 86.4 | 6 12 | 8 4.83 | 32.32 | 0'.868 | 5'.207 |
| 51 | 89.6 | 6 25 | 8 15.17 | 33.01 | | |
| 52 | 92.8 | 6 39 | 8 26.13 | 33.74 | | |
| 53 | 96.2 | 6 54 | 8 37.75 | 34.52 | | |
| 54 | 99.8 | 7 9 | 8 50.07 | 35.34 | | |
| 55 | 103.5 | 7 25 | 9 3.18 | 36.22 | 0'.867 | 5'.202 |
| 56 | 107.5 | 7 42 | 9 17.12 | 37.14 | | |
| 57 | 111.6 | 8 0 | 9 31.97 | 38.13 | | |
| 58 | 116.0 | 8 19 | 9 47.83 | 39.19 | | |
| 59 | 120.6 | 8 38 | 10 4.78 | 40.32 | | |
| 60 | 125.5 | 8 59 | 10 22.94 | 41.52 | 0'.866 | 5'.198 |
| 61 | 130.8 | 9 22 | 10 42.42 | 42.83 | | |
| 62 | 136.3 | 9 46 | 11 3.38 | 44.22 | | |
| 63 | 142.2 | 10 11 | 11 25.97 | 45.73 | | |
| 64 | 148.6 | 10 38 | 11 50.37 | 47.36 | | |
| 65 | 155.0 | 11 8 | 12 16.82 | 49.12 | 0'.866 | 5'.195 |
| 66 | 162.8 | 11 39 | 12 45.55 | 51.04 | | |
| 67 | 170.7 | 12 13 | 13 16.88 | 53.12 | | |
| 68 | 179.3 | 12 51 | 13 51.15 | 55.41 | | |
| 69 | 188.7 | 13 31 | 14 28.77 | 57.92 | | |
| 70 | 199.1 | 14 15 | 15 10.26 | 60.68 | 0'.866 | 5'.193 |

352. The second column of Table XII contains the convergency of two meridians six miles long and six miles apart, measured on a parallel of latitude.

When the parallel of latitude passing through the south end of such meridians, and forming the south boundary of the township of which the meridians form the meridional boundaries, is coincident with a tabular latitude given in the first column, the required convergency will be obtained directly from the second column (Plate V, fig. 5); while for other than the tabular latitudes, it will be obtained by simple proportion (fig. 6).

The third column contains the angle of convergency. (abc, figs. 5 and 6.)

353. For the purpose of computing convergency within the boundaries of a regular township, said boundaries may be regarded as straight lines and the township a plane figure, generally a trapezoid;

the convergency of any rectangular part thereof, bounded by meridional and latitudinal section lines, will be determined, as follows:

Multiply the convergency for the township, determined as above directed, by the length of the tract in miles and decimals of a mile, divided by 6, and the product by the width of the tract divided by 6; the resulting product will be the convergency required. (See Plate V, fig. 5.)

354. To obtain the convergency of the meridional boundaries of any tract bounded by section lines, or other lines of legal subdivision, within a township, proceed as follows: Divide the tract into the least possible number of rectangular parts and compute the convergency for each tract; then, take the sum of the convergencies thus determined. (See example, Plate V, fig. 7.)

The convergency of two meridians of equal length, in the same latitude, is proportional to their distance apart; e. g., the convergency of two meridians 6 miles long, separated by 5 ranges, latitude 38° , is $56.8 \text{ lks} \times 5 = 2.84 \text{ chains}$.

355. Convergency of meridians in the same latitudes, and not exceeding 24 miles in length, may be computed by an approximate proportion, which combines the advantages of convenience with an accuracy sufficient for the ordinary wants of the land surveyor; the proportion is this:

The cosines of the latitudes are to each other as the lengths of the intercepted parallels.

The following example illustrates the use of this rule:

The distance between the Principal Meridian and first range line west, in latitude $42^\circ 39' 07''$, is 6 miles; what is the convergency of the two range lines at the Base Line, the meridional distance being 24 miles?

$\cos 42^\circ 39' 07'' : \cos 43^\circ :: 480.00 \text{ chs} : 477.31 \text{ chs.}$, which proportion may be worked with natural cosines, or more expeditiously by logarithms, as follows:

| | | |
|---------------|---------------------|----------|
| a. c. log cos | $42^\circ 39' 07''$ | 0.133427 |
| log cos | 43° | 9.864127 |
| log | 480.00 | 2.681241 |
| | | <hr/> |
| log | 477.30 | 2.678795 |

The difference 2.70 chs. is the convergency required.

The convergency division of Table XI having been sufficiently explained, application of the remaining columns may be inferred from their titles.

OFFSETS AND TRIANGULATIONS.

356. Offsets from and to standard parallels, guide meridians, township or section lines, will always be run north, south, east, or west, as the case may be, while the offset line will be run parallel to the random or true line, as prevailing conditions may require. Examples may be found in Specimen Field Notes No. 5, pages 166, 179, and 180, and on Plate III.

357. In obtaining distances by triangulation, right-angled triangles are to be used when practicable, and they should have the angle opposite the required side not greater than 45° , using a base longer than the required distance. If circumstances compel the use of a triangle having

a vertex or angle opposite to the base less than 30°, the field notes must fully explain the reason, and all readings of the angles should be repeated. In no case must the angle opposite the base be less than 15°.

A small marginal diagram should be drawn in the original field notes and in the tablets written in the field, showing the approximate direction of lines, and the essentials of the process, with the location of the obstacle to direct measurement. This has been the practice of many of the early surveyors.

358. The angles of oblique-angled triangles should in no case be greater than 120° or less than 30°. All the angles of a triangle will be measured when the angular points are accessible. It will avoid several sources of possible error to take the readings of the courses to the two ends of the base from the opposite angle, both at a single setting of the instrument. This may readily be done by leaving the base properly flagged for observation; or by having the base laid off on the objective side of the obstacle, and angles taken both before and after crossing.

Computation of particular cases in the field notes, inserted here, as examples. See page 163.

| | |
|-----------------------|--------|
| log tan 40° 55' | 9.9379 |
| log 20.00 | 0.3010 |
| log 17.34 | 0.2389 |
| a. c. log sin 48° 15' | 0.1272 |
| log sin 64° 47' | 9.9565 |
| log 15.00 | 1.1761 |
| log 18.19 | 1.2598 |

359. By traverse table. (See page 179.) From the south end of the base, let fall a perpendicular to the required distance, dividing it into two parts, thus forming two right-angled triangles; call the perpendicular a meridian; and, from the base as a course (N. 30° 30' E., 36.00 chs.), determine the corresponding diff. lat. and departure, the latter being the length of the east part of the required distance; then, with the latitude just determined and bearing to flag, find the corresponding departure or west part of the required distance. The work may be arranged as follows:

| Designation. | Bearing. | Distance. | Difference of latitude. | Departure. |
|----------------------------------|----------------|-----------|-------------------------|----------------------------|
| Base | N. 30° 30' E.. | 36.00 | 31.02 | 18.27 (E. part). |
| Perpendicular | North | 31.02 | ..... |  |
| From S. end of base to flag..... | N. 37° 30' W. | (?)* | { 30.94 0.08 | 23.74 0.06 } (W. part). |
| | | (?)* | 31.02 | 23.80 (W. part). |

* These distances are not required. The departures will be found with the arguments "bearing" and "diff. lat."

Then, 18.27 + 23.80 = 42.07 chs., the required distance.
Same example by logarithms:

| | |
|-----------------------|--------|
| a. c. log sin 52° 31' | 0.1005 |
| log sin 68° | 9.9672 |
| log 36.00 | 1.5563 |
| log 42.07 | 1.6240 |

Four-place logarithms are quite sufficient if the tables are correct.

TRANSIT OBSERVATION OF THE SUN FOR MERIDIAN.

360. A practice has been used, and highly recommended by some, of determining the meridian by a single observation of the sun some hours before or after noon, with a plain transit provided with a vertical circle. This has been erroneously thought a substitute for Polaris observations, of sufficient accuracy for the requirements of public-land surveys. But while theoretically a good method, it is found somewhat unreliable in practice, owing to the imperfect graduations or erroneous readings of altitude, the length and intricacy of the process, and the numerous chances for error. Hence no examples of its use are inserted in the specimen field notes, and neither deputies nor examiners are permitted to omit the direct observation of Polaris as a final test of accuracy of courses.

REMARKS ON USE OF SOLAR EPHEMERIS.

361. In preparing for each day's work with a solar compass or solar transit, the deputy should construct in advance a table of declinations for the successive hours of work; and for convenience of subsequent review or evidence, it should form a part of his book of tablets, or penciled field notes.

The approximate longitude must be used in finding what morning hour is nearly simultaneous with Greenwich noon. This should be determined to the nearest hour, or to the half hour in cases when a low sun is to be used.

The declination for successive periods through the day is computed from the hourly difference. At the end, as at 5 p. m., the accuracy of the whole table should be checked by a single computation, thus: From $6\frac{1}{2}$ a. m., Greenwich noon, to 5 p. m. = $10\frac{1}{2}$ hrs. \times $42''$ (the hourly difference) = $441'' = 7' 21''$ the total decrease already found by separate subtractions.

362. After thus recording and proving a table for the day, the results for the following day can be set down in an adjacent column of the table, by adding to, or subtracting from, each previous declination, the proper number of minutes of arc for the 24 hours. For example, the declinations at Greenwich noon on Nov. 1 and 2, 1898, having a difference of $19' 03''.2$, the table for Nov. 2 is rapidly and correctly produced from that of Nov. 1 by adding $19'$ to each hourly item of south declination. For a very few days this method will suffice.

363. In a latitude observation, to determine the correct local mean time of the sun's transit across the meridian:

When the "equation of time" given in the ephemeris is to be added to apparent time, the observation comes so many minutes after local mean or watch time of noon, (not standard or railroad time); when it is subtractive, the sun's transit is before local mean noon, by the given interval of minutes.

TO SET A WATCH BY CORRECT LOCAL MEAN TIME.

364. Having made an observation of the passage of the sun across the meridian, (the watch not being correct for solar and hour-angle uses), and desiring to set it to local mean time:

If the ephemeris for the day shows "equation of time to be added to apparent time" (called "sun slow" in almanacs), then at the mo-

ment of the sun's transit set the minute hand as many minutes after 12 as the table shows to be added, and the watch will be properly adjusted to local mean time.

If the equation figures are subtractive ("sun fast"), set the minute hand so much before the 12.

LOCAL VERSUS STANDARD TIME.

365. If the deputy keeps his time-piece adjusted to standard time, he must use great care lest it lead him into error, by erroneous ideas of his longitude east or west of the meridian that is central to that standard-time division of the country. All the uncertainties of calculating, and of adding or subtracting minutes to determine probable local time, are obviated by resetting the watch as above shown, or by keeping another watch thus adjusted, which would be of value in case of accident to the former in a remote region.

TABLE XIII.—LENGTHS OF DEGREES OF LATITUDE.

366. This table enables the surveyor to ascertain the difference of latitude corresponding to any distance of northing or southing expressed in chains, and also to perform the reverse operation. The following rules and examples will illustrate their use:

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

RULE.—Find from Table XIII 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, $45^{\circ} 26' 4''.08$; 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 XIII 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.

367. Table XIV, showing precise length of a degree of longitude for every degree and minute between 28° and 49° of latitude, given in chains and links, will often be found useful in connection with the public-land surveys and other geographical computations.

TABLE XIII.—Length of a Degree of Latitude Computed to Minutes.

| Lat. | 29° | 30° | 31° | 32° | 33° | 34° | 35° | 36° | 37° | 38° | Lat. |
|------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------|
| 0 | Chains. 5509.15 | Chains. 5509.97 | Chains. 5510.82 | Chains. 5511.67 | Chains. 5512.55 | Chains. 5513.44 | Chains. 5514.34 | Chains. 5515.25 | Chains. 5516.18 | Chains. 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 | 13.51 | 14.42 | 15.33 | 16.25 | 17.19 | 5 |
| 6 | 09.23 | 10.06 | 10.90 | 11.76 | 12.64 | 13.53 | 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 | 13.57 | 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 | 15.56 | 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 | 15.68 | 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 | 15.90 | 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 | 15.07 | 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 | 15.24 | 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 XIII.—Length of a Degree of Latitude—Concluded.

| Lat. | 39° | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 47° | 48° | Lat. |
|------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|------|
| 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 | 23.86 | 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 | 24.51 | 25.48 | 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 | 25.51 | 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 | 18.84 | 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 | 27.53 | 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 XIV.—Length of a Degree of Longitude.

| Lat. | 29° | 30° | 31° | 32° | 33° | 34° | 35° | 36° | 37° | 38° | Lat. |
|------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|------|
| 0 | 4943.37 | 4795.82 | 4747.01 | 4696.75 | 4645.06 | 4591.96 | 4537.45 | 4481.56 | 4424.29 | 4365.68 | 0 |
| 1 | 42.40 | 95.02 | 46.19 | 95.90 | 44.19 | 91.06 | 36.53 | 80.61 | 23.33 | 64.69 | 1 |
| 2 | 41.62 | 94.22 | 45.36 | 95.05 | 43.32 | 90.16 | 35.61 | 79.67 | 22.36 | 63.70 | 2 |
| 3 | 40.84 | 93.42 | 44.53 | 94.20 | 42.44 | 89.26 | 34.69 | 78.73 | 21.40 | 62.72 | 3 |
| 4 | 40.06 | 92.61 | 43.71 | 93.35 | 41.57 | 88.37 | 33.77 | 77.78 | 20.43 | 61.78 | 4 |
| 5 | 39.28 | 91.81 | 42.88 | 92.50 | 40.69 | 87.47 | 32.84 | 76.84 | 19.46 | 60.74 | 5 |
| 6 | 38.50 | 91.01 | 42.05 | 91.65 | 39.82 | 86.57 | 31.92 | 75.89 | 18.49 | 59.75 | 6 |
| 7 | 37.72 | 90.20 | 41.22 | 90.80 | 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 | 16.56 | 57.77 | 8 |
| 9 | 36.16 | 88.59 | 39.56 | 89.09 | 37.19 | 83.87 | 29.15 | 73.05 | 15.59 | 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 | 12.68 | 53.80 | 12 |
| 13 | 33.04 | 85.37 | 36.24 | 85.67 | 33.68 | 80.26 | 25.46 | 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 | 21.75 | 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 | 27.55 | 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 | 18.04 | 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 | 76.25 | 23.99 | 70.32 | 15.26 | 58.81 | 01.01 | 41.86 | 24 |
| 25 | 23.62 | 75.66 | 26.25 | 75.39 | 23.11 | 69.41 | 14.33 | 57.86 | 4400.04 | 40.86 | 25 |
| 26 | 22.83 | 74.85 | 25.41 | 74.53 | 22.22 | 68.51 | 13.40 | 56.91 | 4399.06 | 39.87 | 26 |
| 27 | 22.05 | 74.04 | 24.57 | 73.67 | 21.34 | 67.60 | 12.47 | 55.96 | 96.08 | 38.87 | 27 |
| 28 | 21.26 | 73.22 | 23.74 | 72.81 | 20.45 | 66.69 | 11.54 | 55.00 | 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 | 53.09 | 95.16 | 35.87 | 30 |
| 31 | 18.89 | 70.78 | 21.22 | 70.22 | 17.80 | 63.97 | 08.74 | 52.14 | 94.18 | 34.87 | 31 |
| 32 | 18.10 | 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 | 06.88 | 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 | 65.89 | 16.19 | 65.05 | 12.48 | 58.51 | 03.14 | 46.41 | 88.31 | 28.87 | 37 |
| 38 | 13.35 | 65.08 | 15.35 | 64.18 | 11.59 | 57.60 | 02.21 | 45.45 | 87.33 | 27.87 | 38 |
| 39 | 12.56 | 64.26 | 14.51 | 63.32 | 10.70 | 56.68 | 01.28 | 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 | 62.62 | 12.82 | 61.59 | 08.93 | 54.86 | 4499.40 | 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 | 51.21 | 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 | 56.89 | 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 | 47.55 | 91.91 | 34.89 | 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 | 53.60 | 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 | 88.15 | 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 | 4537.45 | 4481.56 | 4424.29 | 4365.68 | 4305.78 | 60 |

TABLE XIV.—Length of a Degree of Longitude—Concluded.

| Lat. | 89° | 40° | 41° | 42° | 48° | 44° | 45° | 46° | 47° | 48° | Lat. |
|------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------|
| 0 | Chains. 4305.73 | Chains. 4244.47 | Chains. 4181.91 | Chains. 4118.06 | Chains. 4052.96 | Chains. 3986.62 | Chains. 3919.05 | Chains. 3850.28 | Chains. 3780.33 | Chains. 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 | 50.77 | 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 | 56.76 | 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 | 53.21 | 81.66 | 23 |
| 24 | 81.39 | 19.60 | 56.52 | 92.17 | 26.57 | 59.73 | 91.68 | 22.44 | 52.02 | 80.46 | 24 |
| 25 | 80.37 | 18.56 | 55.46 | 91.09 | 25.47 | 58.61 | 90.54 | 21.28 | 50.84 | 79.25 | 25 |
| 26 | 79.35 | 17.52 | 54.40 | 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 | 96.66 | 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 |

FIELD EXAMINATION OF SURVEYS.

368. To insure the faithful and accurate execution of surveys of Government lands, the Department has found it necessary to adopt a uniform rule requiring all work to be inspected in the field, before its acceptance will be considered. The details of this process are governed by instructions issued by the General Land Office to those serving as examiners of surveys. The rules are subject to such modifications as the good of the service may demand.

369. For several years past, it has been required that 10 per cent of all lines run by a deputy in each township, must be carefully retraced. A full report of all courses, distances, topography, and descriptions of corner monuments and accessories, upon lines examined, must be returned under oath to the Commissioner, for comparison with the returns of the deputy. The examiner's returns must show all distances across lands that are mountainous, heavily timbered, or covered with dense undergrowth.

370. If the examiner finds erroneous or negligent work which in his opinion deserves correction or rejection, he has been instructed to continue his work by extending the retracement to 20 or 30 per cent of the lines, in order to make his evidence conclusive.

371. Examiners are required to observe the rules of the Manual in the technical and professional details, to use instruments of the best construction and adaptation, and to exercise special care that their courses and measurements are precise and free from all error, that no injustice may be done to a deputy. In case a serious error is found, they may repeat the chaining or observation, to guard against possible mistake on their part. They are required, whenever practicable, to make a closed survey around one or several sections, which should close by traverse within limits; also to extend the examination into remote and difficult parts, as well as those easily accessible. Whatever future regulations may be adopted will seek the same purpose of preventing error, negligence or fraud.

SPECIMEN FIELD NOTES.

No. 1.

TITLE PAGE.

[See Plate I.]

FIELD NOTES

OF THE SURVEY OF THE

THIRD STANDARD PARALLEL NORTH

THROUGH

Ranges Nos. 21, 22, 23, and 24 East

OF THE

PRINCIPAL BASE AND MERIDIAN

IN THE

STATE OF MONTANA,

AS SURVEYED BY

RICHARD ROODS,

U. S. DEPUTY SURVEYOR,

UNDER HIS CONTRACT No. 97,

DATED JULY 10, 1890.

Survey commenced August 22, 1890.

Survey completed August 29, 1890.

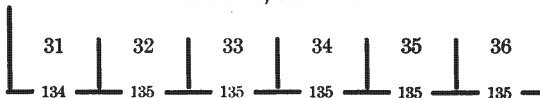
[Second page.]

NAMES AND DUTIES OF ASSISTANTS.

PETER LONGChainman.
JOHN SHORTChainman.
ELI MARKERChainman.
WILLIAM TALLYChainman.
LEWIS LINKChainman.
HENRY CLAYMoundman.
WILLIAM STONEMoundman.
GEORGE SHARPAxman.
ADAM DULLAxman.
JAMES BANNERFlagman.

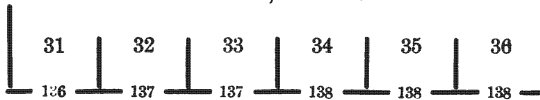
INDEX.

T. 13 N., R. 21 E.



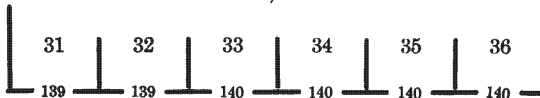
3rd Standard Parallel N.

T. 13 N., R. 22 E.



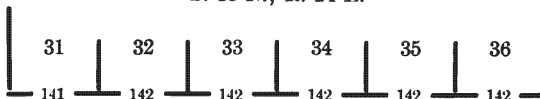
3rd Standard Parallel N.

T. 13 N., R. 23 E.



3rd Standard Parallel N.

T. 13 N., R. 24 E.



3rd Standard Parallel N.

[Third Page.]

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 chainmen; 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 distances 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 Ranges Nos. 21, 22, 23, and 24 East, of the Principal Base and Meridian, in the State of Montana.

PETER LONG, *Chainman.*
 JOHN SHORT, *Chainman.*
 ELI MARKER, *Chainman.*
 WILLIAM TALLY, *Chainman.*

Subscribed and sworn to before me this second day of August, 1890.

[SEAL.]

WILLIAM MARTIN,
Notary Public.

We, Henry Clay and William Stone, do solemnly swear that we will well and truly perform the duties of moundmen, in the establishment of corners, according to the instructions given us, to the best of our skill and ability, in the survey of the Third Standard Parallel North, through Ranges Nos. 21, 22, 23, and 24 East, of the Principal Base and Meridian, in the State of Montana.

HENRY CLAY, *Moundman.*
 WILLIAM STONE, *Moundman.*

Subscribed and sworn to before me this second day of August, 1890.

[SEAL.]

WILLIAM MARTIN,
Notary Public.

We, George Sharp and Adam Dull, do solemnly swear that we will well and truly perform the duties of axmen, 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 Ranges Nos. 21, 22, 23, and 24 East, of the Principal Base and Meridian, in the State of Montana.

GEORGE SHARP, *Axman.*
 ADAM DULL, *Axman.*

Subscribed and sworn to before me this second day of August, 1890.

[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 Ranges Nos. 21, 22, 23, and 24 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, 1890.

[SEAL.]

WILLIAM MARTIN,
Notary Public.

I, Lewis Link, do solemnly swear that I will well and faithfully execute the duties of chainman; that I will level the chain upon even and uneven ground, and plumb the tally pins, either by sticking or dropping the same; that I will report the true distances to all notable objects, and the true length of all lines that I assist in measuring, to the best of my skill and ability, and in accordance with instructions given me, in the survey of the Third Standard Parallel North, through Ranges Nos. 23 and 24 East, of the Principal Base and Meridian, in the State of Montana.

LEWIS LINK, *Chainman.*

Subscribed and sworn to before me this twenty-seventh day of August, 1890.

[SEAL.]

RICHARD ROODS,
U. S. Deputy Surveyor.

Third Standard Parallel North, through Range 21 East.

| | |
|---------|--|
| | <p>NOTE.—To avoid needless repetition of routine topography and descriptions of corners it is deemed expedient in this edition to abridge the specimen field notes by omitting much of the matter previously given. Hence many portions are condensed to a mere outline, asterisks and the phrase "etc." being used to represent missing data. But deputies and surveyors general will not consider that this allows similar omissions or the use of "etc." in any field notes of surveys prepared for official use.</p> |
| Chains. | <p>Survey commenced August 22, 1890, and executed with a W. & L. E. Gurley light mountain transit, No. —; the horizontal limb having two double verniers placed opposite to each other and reading to 30" of arc. The instrument was examined, tested on the true meridian at Helena, found correct, and was approved by the surveyor general for Montana, August 1, 1890.</p> <p>I begin at the standard corner of townships 13 north, ranges 20 and 21 east, which is a sandstone, 8×7×5 ins. above ground, firmly set, and marked and witnessed as described by the surveyor general.</p> <p>At a point 3.39 ft. ^a south of said standard corner, in latitude 45° 34'.5 N., longitude 107° 54' W., ^b at 9^h 19.7^m p. m., by my watch, which is 2 minutes fast of local mean time, I observe Polaris at eastern elongation, in accordance with instructions^c in the Manual, and mark the line thus determined, by a tack driven in a wooden peg set in the ground, five chains north of my station.</p> <p style="text-align: right;">August 22, 1890.</p> <p>August 23, 1890: At 6 a. m., I lay off the azimuth of Polaris, 1° 49'.6, to the west, and mark the true meridian thus determined, by cutting a mark on a stone firmly set in the ground, west of the point established last night; the magnetic bearing of said true meridian is N. 18° 13' W., which gives the magnetic declination, 18° 13' east.</p> <p>At this station (i. e., the point 3.39 ft. S. of the standard cor.), I turn off from the meridian, an angle^d of 89° 57' 20".9 toward the east, and run N. 89° 57' E. on the secant, S. of sec. 31.</p> |
| 28. 10 | <p>Over gently rolling prairie.</p> <p>Indian trail, bears N. 28° E. and S. 28° W.</p> <p>Difference between measurements of 40.00 chs., by two sets of chainmen, is 4 lks.; position of middle point</p> <p style="padding-left: 2em;">By 1st set, 40.02 chs.</p> <p style="padding-left: 2em;">By 2nd set, 39.98 chs.; the mean of which is</p> |
| 40. 00 | <p>N. 1.53 ft. from the secant,</p> <p>Set a limestone, 20×8×5 ins., 15 ins. in the ground, for standard $\frac{1}{4}$ sec. cor., marked S C $\frac{1}{4}$ on N. face; dig pits 18×18×12 ins., E. and W. of stone, 3 ft. dist.; and raise a mound of earth, 3$\frac{1}{2}$ ft. base, 1$\frac{1}{2}$ ft. high, N. of cor. Samuel Somer's house bears N. 65° E.</p> |
| 54. 10 | <p>Leave prairie, enter Somer's field, bears N. and S.</p> |
| 71. 55 | <p>Leave field, enter prairie, bears N. and S.; field extends N. to Somer's house, and S. about 15 chs.</p> <p>Difference between measurements^e of 80.00 chs. by two sets of chainmen, is 6 lks.; position of middle point</p> <p style="padding-left: 2em;">By 1st set, 79.97 chs.</p> <p style="padding-left: 2em;">By 2nd set, 80.03 chs.; the mean of which is</p> |
| 80. 00 | <p>Set a limestone, 24×9×6 ins., 18 ins. in the ground, for standard cor. of secs. 31 and 32, ^f marked S C on N., with 5 grooves on E. and 1 groove on W. face; dig pits 24×18×12 ins., crosswise on each line, E. and W., 3 ft., and N. of stone, 7 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, N. of cor. Samuel Somer's house bears N. 38° W.</p> <p>Land, gently rolling prairie.</p> <p>Soil, sandy loam; 1st rate.</p> <p>No timber.</p> |

^a Interpolated by simple proportion, for the given latitude, from the second column of Table VIII.

^b The latitude and longitude will be given by the surveyor general, in his special written instructions.

^c See directions for making the observation, page —.

^d This angle is interpolated by simple proportion, for the given latitude, from the column headed "3 miles" in Table IX. But hereafter the exact angle required will be changed to the nearest angle that can be set off or read on the instrument used.

^e The measurements are counted from the beginning of the mile; 40.00 chs. are measured from the last $\frac{1}{4}$ sec. cor.; see "Base Line," sec. 121.

^f At this point, the secant intersects the standard parallel. See Plate I, figs. 1 and 2.

Third Standard Parallel North, through Range 21 East.

| | |
|---------|---|
| Chains. | N. 89° 58' E. on the secant, through sec. 32. |
| 40. 00 | S. 1.19 ft. from the secant, Set a granite stone, etc. |
| 80. 00 | S. 2.04 ft. from the secant, Set a granite stone, 20×8×4 ins., 15 ins. in the ground, for standard cor. of secs. 32 and 33, marked S C on N., with 4 grooves on E. and 2 grooves on W. face; and raise a mound of stone, 2 ft. base, 1½ ft. high, N. of cor. Pits impracticable. |
| | NOTE.—I erect a signal at this corner for a test sight from one of the high points visible to the east. |
| | August 22, 1890. |
| | NOTE.—The sky was overcast during the entire night. Polaris not visible. |
| | August 23, 1890. |
| 40. 00 | N. 89° 59' E. on the secant, through sec. 33. S. 2.55 ft. from secant, Set a granite stone, etc. |
| 80. 00 | S. 2.72 ft. from the secant, Set a granite stone, etc. |
| | East, on the secant, through sec. 34. |
| 20. 68 | To right bank of Black River, course S. 28° W. S. 2.64 ft. ^a from the secant, Set a granite stone, for meander cor., etc. |
| | To find the distance across the river, I set a flag on the secant line, on east bank; then measure a base, N. 6.20 chs., to a point from which the flag bears S. 43° 10' E.; which gives for the distance, $\tan. 43^\circ 10' \times \text{base}$, or $0.938 \times 6.20 \text{ chs.} = 5.82 \text{ chs.}$ |
| 26. 50 | To left bank of Black River, course SW. Banks, 12 ft. high; rapid cur- rent over stony bottom; clear water, about 5 ft. deep: S. 2.64 ft. ^b from the secant, Set a granite stone, 17×9×7 ins., 12 ins. in the ground, for meander cor. on S. bdy. sec 34, marked, etc. |
| 40. 00 | S. 2.55 ft. from the secant set standard ¼ sec. cor., etc. |
| 80. 00 | S. 2.04 ft. from the secant, Set a granite stone, 21×8×5 ins., 16 ins. in the ground, for standard cor. of secs. 34 and 35, marked, etc. |
| | August 23, 1890. |
| | NOTE.—Continuous rain since afternoon of August 23; observations on Polaris not possible. |
| | August 25, 1890, 7 a. m. |
| 40. 00 | S. 89° 59' E. on the secant, through sec. 35. S. 1.19 ft. from the secant, Set a granite stone, 15×8×5 ins., 10 ins. in the ground, etc. |
| 80. 00 | *Set a limestone, 20×8×6 ins., 15 ins. in the ground, for standard cor. of, etc. |
| | S. 89° 58' E. on the secant, S. of sec. 36. |
| 40. 00 | N. 1.53 ft. from the secant, Set a limestone, 16×7×5 ins., 11 ins. in the ground, for standard ¼ sec. cor., etc. |
| 80. 00 | N. 3.39 ft. from the secant, Set a granite stone, 20×7×6 ins., 15 ins. in the ground, for standard cor., etc. |
| | August 25, 1890. |

^a These distances may be found by taking the mean of the offsets at the preceding sec., and follow-
ing ¼ sec. cor.

^b The secant intersects the standard parallel 1 mile from end of secant, and at the point for the cor-
ner of secs. 35 and 36. See Plate 1, figs. 1 and 2.

Third Standard Parallel North, through Range 22 East.

| | | | | | | | | | | | | | |
|---|--|---|-------------|----------------------------------|-----------------------|-----------------------|------------|--|--------|--|------------------------------|--------|--------|
| Chains. | At the last point determined on the secant, which is 6 miles from the starting point and 3.39 ft. south of the corner of Tps. 13 N., Rs. 21 and 22 E., I deflect an angle ^a of 5' to the north and run N. 89° 57' E., on the secant, S. of sec. 31. | | | | | | | | | | | | |
| 36. 10 | Up steep ascent, over stony ground sloping west. To edge of mesa, 60 ft. above Tp. cor., bears N. and S. Difference between measurements of 40.00 chs., by two sets of chainmen, is 14 lks.; position of middle point By 1st set, 40.07 chs. | | | | | | | | | | | | |
| 40. 00 | By 2nd set, 39.93 chs.; the mean of which is N. 1.53 ft. from the secant; the point for standard $\frac{1}{4}$ sec. cor. falls on rock in place, 6 × 3 × 2 ft. above ground, on which Cut a cross (×) at the corner point, for standard $\frac{1}{4}$ sec. cor., marked S C $\frac{1}{4}$, on N. side of cross; and raise a mound of stone, 2 ft. base, 1½ ft. high, N. of cor. Pits impracticable. August 26, 1890: At this standard $\frac{1}{4}$ sec. cor., I observe Polaris at 5 ^h 9 ^m a. m., by my watch, which is 2 ^m 47 ^s fast of local mean time, and mark the direction thus determined by a tack driven in a picket firmly set, 5 chains north of the cor. | | | | | | | | | | | | |
| | <table border="0"> <tr> <td style="padding-right: 20px;">Astron. time by watch, Aug. 25</td> <td style="text-align: right;">h. m.</td> </tr> <tr> <td style="padding-right: 20px;">Watch fast</td> <td style="text-align: right;">17 9.0</td> </tr> <tr> <td></td> <td style="text-align: right; border-top: 1px solid black;">2.8</td> </tr> <tr> <td style="padding-right: 20px;">Astron. l. m. t. of obs. Aug. 25</td> <td style="text-align: right;">17 6.2</td> </tr> </table> | Astron. time by watch, Aug. 25 | h. m. | Watch fast | 17 9.0 | | 2.8 | Astron. l. m. t. of obs. Aug. 25 | 17 6.2 | | | | |
| Astron. time by watch, Aug. 25 | h. m. | | | | | | | | | | | | |
| Watch fast | 17 9.0 | | | | | | | | | | | | |
| | 2.8 | | | | | | | | | | | | |
| Astron. l. m. t. of obs. Aug. 25 | 17 6.2 | | | | | | | | | | | | |
| | <table border="0"> <tr> <td style="padding-right: 20px;">U. C. Polaris, August 15</td> <td style="text-align: right;">h. m.</td> <td></td> </tr> <tr> <td style="padding-right: 20px;">Red. to Aug. 25</td> <td style="text-align: right;">15 40.1</td> <td></td> </tr> <tr> <td></td> <td style="text-align: right; border-top: 1px solid black;">39.2</td> <td></td> </tr> <tr> <td style="padding-right: 20px;">U. C. Polaris, Aug. 25</td> <td style="text-align: right;">15 0.9</td> <td style="text-align: right;">15 0.9</td> </tr> </table> | U. C. Polaris, August 15 | h. m. | | Red. to Aug. 25 | 15 40.1 | | | 39.2 | | U. C. Polaris, Aug. 25 | 15 0.9 | 15 0.9 |
| U. C. Polaris, August 15 | h. m. | | | | | | | | | | | | |
| Red. to Aug. 25 | 15 40.1 | | | | | | | | | | | | |
| | 39.2 | | | | | | | | | | | | |
| U. C. Polaris, Aug. 25 | 15 0.9 | 15 0.9 | | | | | | | | | | | |
| | <table border="0"> <tr> <td style="padding-right: 20px;">Hour angle of Polaris and time argument</td> <td style="text-align: right;">2 5.3</td> </tr> <tr> <td style="padding-right: 20px;">Azimuth of Polaris, at obs</td> <td style="text-align: right; border-top: 1px solid black; border-bottom: 3px double black;">0° 57'.5 W.</td> </tr> </table> | Hour angle of Polaris and time argument | 2 5.3 | Azimuth of Polaris, at obs | 0° 57'.5 W. | | | | | | | | |
| Hour angle of Polaris and time argument | 2 5.3 | | | | | | | | | | | | |
| Azimuth of Polaris, at obs | 0° 57'.5 W. | | | | | | | | | | | | |
| | (NOTE.—The meridian could be defined by laying off the azimuth to the east, but this is unnecessary; the bearing of the signal will be found as follows:) | | | | | | | | | | | | |
| | I measure the angle between the direction thus determined, and the signal established at the standard cor. of secs. 32 and 33, as follows: | | | | | | | | | | | | |
| | <table border="0"> <tr> <td style="padding-right: 20px;">1. 88 59 45</td> </tr> <tr> <td style="padding-right: 20px;">2. 89 00 30</td> </tr> <tr> <td style="padding-right: 20px;">3. 89 00 30</td> </tr> <tr> <td style="text-align: center; border-top: 1px solid black;">Mean, 89 00 15</td> </tr> <tr> <td style="padding-right: 20px;">Add the azimuth</td> <td style="text-align: right;">0 57 30 W.</td> </tr> </table> | 1. 88 59 45 | 2. 89 00 30 | 3. 89 00 30 | Mean, 89 00 15 | Add the azimuth | 0 57 30 W. | | | | | | |
| 1. 88 59 45 | | | | | | | | | | | | | |
| 2. 89 00 30 | | | | | | | | | | | | | |
| 3. 89 00 30 | | | | | | | | | | | | | |
| Mean, 89 00 15 | | | | | | | | | | | | | |
| Add the azimuth | 0 57 30 W. | | | | | | | | | | | | |
| | The observed bearing is N. 89 57 45.0 W. The true bearing ^b isN. 89 58 00.7 W. | | | | | | | | | | | | |
| | The difference..... 0 00 15.7, is the deviation of the standard, south of the true latitude curve. As the difference is probably less than the errors of observation, I continue the secant as marked on the ground. | | | | | | | | | | | | |
| | Over level mesa. | | | | | | | | | | | | |
| 80. 00 | ^c Set a sandstone, 15×7×6 ins., 10 ins. in the ground, for standard cor., etc. | | | | | | | | | | | | |

^a Interpolated by simple proportion from right-hand column of Table VIII, page 111 See directions following the table.

^b Interpolated by simple proportion from Table IX, for the given latitude, and for 2½ miles (1. e.) or one-half of the distance to signal.

^c At this point, the secant intersects the standard, see Plate I, figs. 1 and 2.

Third Standard Parallel North, through Range 22 East.

| | | | | | | | |
|---|--|----|----------|----|----------|----|----------|
| Claims. | N. 89° 58' E. on the secant, through sec. 32. | | | | | | |
| 40.00 | S. 1.19 ft. from the secant, falls on a boulder, 8×6×3 ft. above ground, on which I cut a cross (×) at the exact corner point, for standard $\frac{1}{4}$ sec. cor., marked S C $\frac{1}{4}$ on N. side of cross; and raise a mound of stone, 2 ft. base, 1 $\frac{1}{2}$ ft. high, N. of cor. Pits impracticable. | | | | | | |
| 80.00 | S. 2.04 ft. from the secant, Set a granite stone, 15×8×6 ins., 10 ins. in the ground, for standard cor., etc. August 26, 1890. | | | | | | |
| <p>At the corner last described (i. e.) the standard cor. of secs. 32 and 33, I observe Polaris at eastern elongation, August 26, at 9^h 5^m p. m. by my watch, which is 3 minutes fast of local mean time; and mark the direction thus determined by a tack driven in a wooden peg set firmly in the ground, five chains north of my station.</p> <p>August 27, 1890: At 6 a. m., I lay off the azimuth of Polaris, 1° 50' to the west; and mark the meridian thus determined by a cross on a stone firmly set in the ground, west of the point marked last night. I measure the angle between the true meridian and the signal erected at the standard cor. of secs. 32 and 33, Tp. 13 N., R. 21 E., as follows:</p> <table style="margin-left: auto; margin-right: auto;"> <tbody> <tr> <td>1.</td> <td>89 57 00</td> </tr> <tr> <td>2.</td> <td>89 56 30</td> </tr> <tr> <td>3.</td> <td>89 57 00</td> </tr> </tbody> </table> <p style="text-align: center;">Mean, 89 56 50 therefore</p> <p>The observed bearing is N. 89 56 50 W. The true bearing is N. 89 57 20.9 W.; and the difference, 0' 31" is the deviation of the standard parallel south of the true latitude curve; therefore, this corner is 4.80 ft. south of its true place on the parallel of latitude passing through the signal.</p> <p>I will correct the line east of this corner and return to the true latitude curve, at the corner of Tps. 13 N., Rs. 22 and 23 E. The nat. tan. of the angle subtended by 4.80 feet at a distance of 4 miles, will be 4.80 ft. divided by 4 miles (expressed in feet) and the angle itself will be 0' 47"; which added to the deviation of the secant, 0' 31", determined by observation, gives 1' 18" for the total deflection of the secant to make the curve of the parallel attain the Tp. cor.*</p> <p>The new reference line thus determined, will be called the correction secant. The bearings of said "correction secant" at successive mile points, will be those of Table VIII, corrected by the total deflection (1' 18"); while the offsets will remain unchanged. The corrected bearings will be as follows:</p> <p>At corner of secs. 32 & 33; secs. 33 & 34; secs. 34 & 35; secs. 35 & 36. Corrected bearings: N. 89° 58' E.; N. 89° 59' E.; East; S. 89° 59' E.</p> | | 1. | 89 57 00 | 2. | 89 56 30 | 3. | 89 57 00 |
| 1. | 89 57 00 | | | | | | |
| 2. | 89 56 30 | | | | | | |
| 3. | 89 57 00 | | | | | | |
| 40.00 | N. 89° 58' E. on the secant, through sec. 33. S. 2.55 ft. from the secant, Set a granite stone, 15×8×8 ins., 10 ins. in the ground, for standard $\frac{1}{4}$ sec. cor., marked, etc. | | | | | | |
| 80.00 | S. 2.72 ft. from the secant, Set a granite stone, 21×8×4 ins., 16 ins., in the ground, for standard cor. of secs. 33 and 34, marked etc. | | | | | | |

*This method for correcting a standard parallel may be employed when the deviation does not exceed one minute of arc. but, if greater error is discovered, the corners already set will be corrected as far back on the line as the stated limit of deviation (1'), is exceeded.

Third Standard Parallel North, through Range 22 East.

| | |
|--|--|
| Chains. | N. 89° 59' E., on the secant, through sec. 34. |
| 40.00 | S. 2.55 ft. from the secant, Set a sandstone, 19×7×5 ins., 15 ins. in the ground, for standard $\frac{1}{4}$ sec. cor., marked etc. |
| 80.00 | S. 2.04 ft. from the secant, Set a sandstone, 24×7×5 ins., 18 ins. in the ground, for standard cor., etc. |
| <hr/> | |
| | East on the secant, through sec. 35. |
| 40.00 | S. 1.19 ft. from the secant, Set a sandstone, 15×8×5 ins., 10 ins. in the ground, for standard $\frac{1}{4}$ sec. cor., etc. |
| 80.00 | Set a sandstone, 16×8×6 ins., 11 ins. in the ground, for standard cor., etc. |
| <hr/> | |
| | S. 89° 59' E. on the secant, S. of sec. 36. |
| 40.00 | N. 1.53 ft. from the secant, Set a sandstone, 17×8×4 ins., 11 ins. in the ground, for standard $\frac{1}{4}$, etc. |
| 80.00 | N. 3.39 ft. from the secant, Set a sandstone, 20×8×5 ins., 15 ins. in the ground, for standard cor. of Tps. 13 N., Rs. 22 and 23 E., marked, etc. |
| <p>RICHARD ROODS, U. S. Deputy Surveyor.</p> <p>August 27, 1890.</p> | |

[These specimen field notes of the survey of the third standard parallel north will be continued through range 23 east, to illustrate the method by offsets from a tangent to the latitude curve at a township corner; see "Tangent Method," page 115, and Plate I, fig. 3.]

Third Standard Parallel North, through Range 23 East.

| | |
|---------|--|
| Chains. | <p>Survey commenced August 27, 1890, and executed with a Young & Sons light mountain transit, No. —, the horizontal limb being provided with two opposite verniers reading to 30" of arc.</p> <p>At the standard corner of townships 13 north, ranges 22 and 23 east, in latitude 45° 34'.5 N., longitude 107° 39' W., at 9^h 00^m p. m. by my watch, which is 2^m fast of local mean time, I observe Polaris at eastern elongation, in accordance with instructions in the Manual, and mark the line thus determined, by a tack driven in a wooden peg set in the ground five chains north of my station.</p> <p>August 28, 1890: At 6 a. m., I turn off the azimuth of Polaris, 1° 50' to the west, and mark the meridian thus determined by cutting a mark on a stone firmly set in the ground, west of the mark established last night; the magnetic bearing of said true meridian is N. 18° 08' W., which gives the magnetic declination 18° 08' east.</p> <p>I lay off from the meridian, an angle of 90°, from north to east, and run East on the tangent, S. * of sec. 31.</p> <p>Over level prairie.</p> <p>Difference between measurements of 40.00 chs., by two sets of chainmen, is 4 lks.; position of middle point</p> <p>By 1st set, 40.02 chs.</p> <p>By 2nd set, 39.98 chs.; the mean of which is</p> |
| 40.00 | <p>^bN. $\frac{1}{4}$ link from the tangent,</p> <p>Set a sandstone, 15×9×6 ins., 10 ins. in the ground, for standard $\frac{1}{4}$ sec. cor., marked S C $\frac{1}{4}$ on N. face; dig pits, 18×18×12 ins., E. and W. of stone, 3 ft. dist.; and raise a mound of earth, 3$\frac{1}{2}$ ft. base, 1$\frac{1}{2}$ ft. high, N. of cor.</p> <p>Difference between measurements of 80 chs., by two sets of chainmen, is 8 lks.; position of middle point</p> <p>By 1st set, 79.96 chs.</p> <p>By 2nd set, 80.04 chs.; the mean of which is</p> |
| 80.00 | <p>N. 1 lk. from the tangent,</p> <p>An oak, 32 ins. diam., for standard cor. of secs. 31 and 32, I mark S C T 13 N R 23 E on N., S 32 on E., and S 31 on W. side; with 5 notches on E. and 1 notch on W. side; from which</p> <p>An oak, 28 ins. diam., bears N. 31$\frac{1}{2}$° E., 18 lks. dist., marked T 13 N R 23 E S 32 B T.</p> <p>An oak, 13 ins. diam., bears N. 74$\frac{1}{4}$° W., 24 lks. dist., marked T 13 N R 23 E S 31 B T.</p> <p>Land, level.</p> <p>Soil, gravelly loam; 3rd rate.</p> <p>Timber, oak, with some beech and white ash.</p> <p>Heavily timbered land, 30.00 chs.</p> |
| 40.00 | <p>S. 89° 59' E. on the tangent, S. of sec. 32.</p> <p>Over level ground, through heavy oak timber.</p> <p>N. 2.3 lks.° from the tangent,</p> <p>Set an oak post, 3 ft. long, 3 in. sq., 24 ins. in the ground, for standard $\frac{1}{4}$ sec. cor., marked, etc.</p> |
| 64.00 | Leave heavy oak timber, enter prairie land, bears NW. and SE. |
| 74.50 | Spring of pure water, 3 ft. deep, bears N. 7 chs. dist. |
| 80.00 | <p>N. 4.1 lks. from the tangent,</p> <p>Set a sandstone, 19×6×5 ins., 15 ins. in the ground, for standard cor., etc.</p> <p>Heavily timbered land, 56.00 chs.</p> |

* The tangent leaves the parallel as soon as started, and will always lie south of the sec. bdy., not on it. See Plate I. Fig. 3.

^b The form given above will always be employed for stating the dist. between the tan. and the cor.; the word "offset" will not be used for such purpose.

* For half-mile offset, see page 115.

Third Standard Parallel North, through Range 23 East.

| | |
|---------|--|
| Chains. | S. 89° 58' E. on the tangent, S. of sec. 33. |
| 40.00 | N. 6.4 lks. from the tangent, Set a sandstone, 17×7×5 ins., 12 ins. in the ground, for, etc. |
| 80.00 | N. 9.3 lks. from the tangent, Set a granite stone, 20×6×6 ins., 15 ins. in the ground, for standard cor. etc. |
| <hr/> | |
| | S. 89° 57' E. on the tangent, S. of sec. 34. |
| 40.00 | N. 12.5 lks. from the tangent, Set a sandstone, 15×8×6 ins., 10 ins. in the ground, for standard $\frac{1}{4}$, etc. |
| 80.00 | N. 16.3 lks. from the tangent, A cottonwood, 18 ins. diam., for st. cor. of secs. 34 and 35, I mark, etc. |
| <hr/> | |
| | S. 89° 56' E. on the tangent, S. of sec. 35. Through cottonwood timber. |
| 11.21 | At 11.40 chs. * intersect right bank of Turtle River, course SE. At this point, the distance between the tangent and standard, is 11.65 feet, or 18 lks. nearly; the bank of the stream bears about N. 47½° W.; therefore, N. 47½° W., 26 lks., determines the point for the meander cor. at On the standard parallel, where I Set a cedar post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for meander cor. on S. bdy. sec. 35, marked, etc. Turtle River is a turbid stream, with muddy banks 3 to 5 ft. high; water 4 to 10 ft. deep; sluggish current over mud bottom. To determine the distance across the river, I set a flag on line, ^b on the left bank; then measure a base line, S. 0° 04' W., 6.00 chs., to a point, from which the flag bears N. 37° 34' E. Therefore, tan. 37° 30' × base, or 0.767 × 6.00 = 4.60 chs., the distance across; which, added to 11.40 chs., makes 16.00 chs., measured on the tangent, to left bank of river. At the point thus determined, the distance between the tangent and standard, is 11.97 ft. or 18 lks. nearly; the bank bears about N. 52° W.; therefore, N. 52° W., 29 lks., determines the point for the meander cor. at |
| 15.77 | On the standard parallel, where I |
| 40.00 | Set a cedar post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for M. C. etc. |
| 80.00 | N. 20.8 lks. from the tangent, Set a cedar post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for etc. N. 25.6 lks. from the tangent, Set a cedar post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for standard cor. of secs. 35 and 36, marked etc. |
| <hr/> | |
| 40.00 | S. 89° 56' E. on the tangent, S. of sec. 36. N. 31.1 lks. from the tangent, Set a sandstone, 19 × 7 × 5 ins., 15 ins. in the ground, for etc. |
| <hr/> | |
| 80.00 | N. 37 lks. from the tangent, Set a granite stone, 22×7×5 ins., 17 ins. in the ground, for standard cor. of Tps. 13 N., Rs. 23 and 24 E., marked S. C., on N.; with 6 grooves on N., E., and W. faces; and raise a mound of stone, 2 ft. base, 1½ ft. high, N. of cor. Pits impracticable. |

August 28, 1890.

*See Plate I, fig. 4. In actual practice the diagram will be placed in the field notes; for these specimen notes it is more convenient to place the diagram on a plate. See section 357.

^b On the tangent line, as a matter of course.

For the purpose of illustration, these specimen field notes of the survey of the third standard parallel north, will be continued through range 24 east; assuming that the survey has been executed with a solar compass or a transit with solar attachment.

Third Standard Parallel North, through Range 24 East.

| | |
|---------|---|
| Chains. | <p>Survey commenced August 28, 1890, and executed with a light mountain transit with solar attachment, No. —, made by Young & Sons. The horizontal limb is provided with two opposite verniers, reading to 30" of arc, which is also the least count of the verniers of the latitude and declination arcs.</p> <p>I begin at the standard corner of townships 13 north, ranges 23 and 24 east, which I established August 28, 1890. * Latitude 45° 34'.5 N., longitude 107° 31' W.</p> <p>In order to test the solar apparatus, by comparing the results of observations on the sun, made during a. m. and p. m. hours, with a true meridian determined by observations on Polaris, I proceed as follows:</p> <p>At 4^h 2^m p. m., local mean time, I set off 45° 34'.5 on the latitude arc; 9° 30'.5 N., on the declination arc; and mark the meridian thus determined with the solar, by a cross on a stone firmly set in the ground, 5 chs. N. of the instrument.</p> <p>At 8^h 56^m 1 p. m., by my watch, which is 2^m fast of local mean time, I observe Polaris at eastern elongation, in accordance with instructions in the Manual, and mark the line thus determined by a tack driven in a wooden peg set in the ground, 5 chains north of my station.</p> <p style="text-align: right;">August 28, 1890.</p> |
| | <p>August 29: At 6 a. m., I lay off the azimuth of Polaris, 1° 49'.5, to the west and mark the meridian thus determined, by cutting a small groove in the stone set last evening, on which the meridian falls 0.2 ins. west of the mark determined by the solar.</p> <p>At 8^h a. m., I set off 45° 34'.5, on the lat. arc; 9° 16' N., on the decl. arc, and mark the true meridian determined with the solar, by a cross on the stone already set 5 chs. N. of my station; this mark falls 0.3 ins. west of the meridian established by the Polaris observation.</p> <p>The solar apparatus, by p. m. and a. m. observations, defines positions for meridians, about 0' 11"^b east, and 0' 16"^b west of the meridian established by the Polaris observation; therefore, I conclude that the adjustments of the instrument are satisfactory.</p> <p>The magnetic bearing of the meridian, at 8^h a. m., is N. 18° 10' W.; the angle thus determined gives the mag. decl. 18° 10' east.</p> <p>From the standard cor. above described, I run East, on S. bdy. sec. 31.</p> <p>Difference between measurements of 40.00 chs., by two sets of chainmen, is 20 lks.; position of middle point By 1st set, 39.90 chs. By 2nd set, 40.10 chs.; the mean of which is</p> <p>40.00 Set a granite stone, 20×7×5 ins., 15 ins. in the ground, for standard, etc. Difference between measurements of 80.00 chs., by two sets of chainmen, is 18 lks.; position of middle point By 1st set, 80.09 chs. By 2nd set, 79.91 chs.; the mean of which is</p> <p>80.00 Set a granite stone, 22×8×6 ins., 17 ins. in the ground, for standard, etc.</p> |

*When the corner at which the survey begins shall have been established under a prior contract, the words "which I established August 28, 1890," will be omitted; and in describing the corner, the deputy will write (e. g.), "which is a sandstone, 5×7×5 ins. above ground, firmly set, and marked and witnessed as described by the surveyor general," in all cases making the description agree with the facts. The latitude and longitude, to the nearest whole minute, will be supplied by the surveyor general in his special written instructions and will be marked on the accompanying diagram, at the point where the survey will begin.

^bThese angles are too small to measure with ordinary field instruments; but, when the mark is 5 chs. dist., as in this case, the angles may be obtained, in seconds of arc, by dividing the fallings, 0.2 and 0.3 ins., by 0.019.

Third Standard Parallel North, through Range 24 East.

| | |
|---------|---|
| Chains. | East, on S. bdy. sec. 32. |
| 40.00 | A pine, 19 ins. diam., for standard $\frac{1}{4}$ sec. cor., I mark, etc. |
| 80.00 | Set a granite stone, $24 \times 8 \times 4$ ins., 18 ins. in the ground, for standard cor. of secs. 32 and 33, marked S C on N., with 4 grooves on E. and 2 grooves on W. face; from which A pine, 18 in. diam., bears N. $62\frac{1}{2}^\circ$ E., 26 lks. dist., marked T 13 N R 24 E S 33 B T. A pine, 28 ins. diam., bears N. $26\frac{1}{4}^\circ$ W., 31 lks. dist., marked T 13 N R 24 E S 32 B T. |
| | Land, level and mountainous. Soil, loam and rock; 1st and 4th rate. Timber, pine. Mountainous or heavily timbered land, 80.00 chs. |
| | East on S. bdy. sec. 33. |
| 40.00 | Set a granite stone, $15 \times 8 \times 6$ ins., 10 ins. in the ground, for standard $\frac{1}{4}$ sec. cor., marked S C $\frac{1}{4}$ on N. face, etc. |
| 80.00 | An oak, 20 ins. diam., for standard cor. of secs. 33 and 34, I mark, etc. |
| | August 29, 1890: I set off $9^\circ 12'.5$ on the decl. arc; and, at $12^h 00^m 44^s$ by my watch, which is 3^m fast of local mean time, observe the sun on the meridian, and obtain on the lat. arc. the reading $45^\circ 35'$, which agrees with other data. |
| | East on S. bdy. sec. 34. |
| 38.40 | Right bank of shallow stream. Difference between measurements of 40.00 chs., by two sets of chainmen, is 14 lks.; position of middle point By 1st set, 39.93 chs. By 2nd set, 40.07 chs.; the mean of which, 40.00 chs., falls in stream with quicksand bottom; therefore I perpetuate the corner on solid ground, as follows: |
| 37.00 | Set a granite stone, $15 \times 9 \times 6$ ins., 10 ins. in the ground, for witness cor. to standard $\frac{1}{4}$ sec. cor., marked W C S C $\frac{1}{4}$ on N. face; from which An aspen, 4 ins. diam., bears N. $88\frac{1}{4}^\circ$ W., 102 lks. dist., marked W C S C $\frac{1}{4}$ S 34 B T. An aspen, 3 ins. diam., bears N. 55° W., 110 lks. dist., marked W C S C $\frac{1}{4}$ S 34 B T. |
| 38.40 | Right bank of shallow stream; bank 1 ft. high; clear water, 2 to 6 ins. deep; gentle current, over quicksand bottom; course S. 17° W. |
| 40.00 | Point for $\frac{1}{4}$ sec. cor. falls in stream. |
| 42.20 | Leave shallow stream; bank, 2 ft. high, bears S. 17° W. |
| 80.00 | Set a granite stone, $16 \times 8 \times 6$ ins., 11 ins. in the ground, for standard cor., etc. At this cor. I erect a signal for a test sight from some point to the east. |
| | East, on S. bdy. sec. 35. |
| 40.00 | Falls on a boulder, $7 \times 6 \times 4$ ft. above ground: |
| 80.00 | I cut a cross (X) at the exact cor. point for standard $\frac{1}{4}$ sec. cor., etc. Set a granite stone, $15 \times 7 \times 6$ ins., 10 ins. in the ground, for st. cor., etc. |
| | East, on S. bdy. sec. 36. |
| 40.00 | Deposit a marked stone, 12 ins. in the ground, for standard $\frac{1}{4}$ sec. cor., etc. |
| 80.00 | Set a granite stone, $20 \times 6 \times 5$ ins., 15 ins. in the ground, for standard cor. of Tps. 13 N., Rs. 24 and 25 E., marked S C on N., etc. |

Third Standard Parallel North, through Range 24 East.

August 29, 1890: I set up the instrument at the last described Tp. cor. and immediately after sunset, at 6^h 39^m p. m., l. m. t., direct the telescope to the signal established at the cor. of secs. 34 and 35, and note the readings of the horizontal limb, as follows:

| | | | | |
|------------|---|----|----|--|
| | ° | / | " | |
| Vernier A, | 3 | 47 | 30 | |
| Vernier B, | 3 | 47 | 00 | |
| Mean, | 3 | 47 | 15 | |

At 7^h 13^m p. m., I unclamp the vernier plate, observe Polaris in accordance with instructions in the manual, and mark the direction thus determined by a tack driven in a wooden peg firmly set in the ground, 5 chs. north of the corner. The readings of the horizontal limb at the instant of observation are as follows:

| | | | | |
|------------|----|----|----|--|
| | ° | / | " | |
| Vernier A, | 92 | 07 | 40 | |
| Vernier B, | 92 | 07 | 30 | |
| Mean, | 92 | 07 | 35 | |
| 1st mean, | 3 | 47 | 15 | |

Angle, 88 20 20

| | | | | |
|---|-----------|-----------|-----------|------|
| Astron. l. m. t. of obs., Aug. 29 | | <i>h.</i> | <i>m.</i> | |
| | | 7 | | 13.0 |
| U. C. Polaris, Aug. 15..... | <i>h.</i> | <i>m.</i> | | |
| | 15 | 40.1 | | |
| Red. to Aug. 28 | | 51.0 | | |
| U. C. Polaris, Aug. 28..... | 14 | 49.1 | 14 | 49.1 |
| Hour angle of Polaris at obs | | | 16 | 23.9 |
| Subtract from..... | | | 23 | 56.1 |
| Time argument for Table VII | | | 7 | 32.2 |
| Azimuth of Polaris at obs | 1° | 39' | 00" E. | |
| Add above angle | 88 | 20 | 20 | |
| The observed bearing of signal is..... | N. 89 | 59 | 20 W. | |
| The true bearing is | N. 89 | 59 | 07 W. | |

The difference 0 00 13 is the deviation of the last two miles of the standard parallel, north of east; which being less than the probable errors of observation, I deem the standard parallel satisfactorily established.

August 29, 1890.

GENERAL DESCRIPTION.

Through ranges 21 and 22 this line runs across low mountain ridges and streams having a northeasterly trend, while low level prairies are traversed through ranges 22 and 23, and low timbered ridges with a northerly trend in range 24.

The land south of the line is of a mountainous and broken character, well watered and containing large groves of pine, oak, and fir timber of a fair quality, while that to the north consists of rolling prairie and meadow land, which should be subdivided.

RICHARD ROODS,
U. S. Deputy Surveyor.

FINAL OATHS OF DEPUTY SURVEYOR AND ASSISTANTS.

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 Ranges Nos. 21, 22, 23, and 24 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. |
| ELI MARKER | Chainman. |
| WILLIAM TALLY | Chainman. |
| LEWIS LINK | Chainman. |
| HENRY CLAY | Moundman. |
| WILLIAM STONE | Moundman. |
| GEORGE SHARP | Axman. |
| ADAM DULL | Axman. |
| JAMES BANNER | Flagman. |

FINAL OATHS OF ASSISTANTS.

I hereby certify that I assisted Richard Roods, United States deputy surveyor, in surveying all those parts or portions of the Third Standard Parallel North, through Ranges Nos. 21 and 22 East of the Principal Base and Meridian in the State of Montana, which 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.

JOHN SHORT, *Chainman.*

Subscribed and sworn to before me this 27th day of August, 1890.

RICHARD ROODS,
U. S. Deputy Surveyor.

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 Ranges Nos. 21, 22, 23, and 24 East of the Principal Base and Meridian in the State of Montana, which 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.*
 ELI MARKER, *Chainman.*
 WILLIAM TALLY, *Chainman.*
 HENRY CLAY, *Moundman.*
 WILLIAM STONE, *Moundman.*
 GEORGE SHARP, *Axman.*
 ADAM DULL, *Axman.*
 JAMES BANNER, *Flagman.*

Subscribed and sworn to before me this first day of September, 1890.

[SEAL.]

WILLIAM MARTIN, *Notary Public.*

I hereby certify that I assisted Richard Roods, United States deputy surveyor, in surveying all those parts or portions of the Third Standard Parallel North, through Ranges Nos. 23 and 24 East of the Principal Base and Meridian in the State of Montana, which 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.

LEWIS LINK, *Chainman.*

Subscribed and sworn to before me, this first day of September, 1890.

[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 (or special written instructions in lieu of contract, as the case may be) 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 Ranges Nos. 21, 22, 23 and 24 East of the Principal Base and Meridian in the State of Montana, which 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 Surveying Instructions and 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 original field notes of such survey.

RICHARD ROODS,
U. S. Deputy Surveyor.

Subscribed by said Richard Roods and sworn to before me this first day of September, 1890.

[SEAL.]

A— B—,
U. S. Surveyor General for Montana.

18791—02—10

SPECIMEN FIELD NOTES.

No. 2.

TITLE PAGE.

(See Plate II.)

FIELD NOTES

OF THE SURVEY OF THE

SIXTH GUIDE MERIDIAN EAST

THROUGH

Townships No. 13 North
Between Ranges Nos. 24 and 25 East

OF THE

PRINCIPAL BASE AND MERIDIAN

IN THE

STATE OF MONTANA,

AS SURVEYED BY

RICHARD ROODS,

U. S. DEPUTY SURVEYOR,

UNDER HIS CONTRACT No. 97,

DATED JULY 10, 1890.

Survey commenced August 29, 1890.

Survey completed August 30, 1890.

[Second Page.]

NAMES AND DUTIES OF ASSISTANTS.

* * * * *

INDEX.

1 150 6

12 150 7

13 150 18

T. 13 N.
R. 24 E.

24 149 19

25 149 30

36 149 31

6th Guide Meridian E.

T. 13 N.
R. 25 E.

3rd Standard Parallel N.

NOTE.—Preliminary oaths will be similar to the typical matter before specimen notes of third standard parallel.

6th Guide Meridian East, through Tps. 13 N., between Rs. 24 and 25 E.

| | |
|---------|--|
| Chains. | <p>Note: See note on page 134 on omitted data.</p> <p>Survey commenced August 29, 1890, and executed with a W. & L. E. Gurley light mountain transit, No. —, the horizontal limb being provided with two opposite verniers reading to 30" of arc.</p> <p>I begin at the Standard Corner of Township 13 North, Ranges 24 and 25 East, which I established August 29, 1890. Latitude 45° 34'.5 N., longitude 107° 24' W.</p> <p>At this corner, at 8^h 54^m p. m., by my watch, which is 3^m 49^s fast of local mean time, I observe Polaris at eastern elongation in accordance with instructions in the manual, and mark the point in the line thus determined by a tack driven in a wooden peg set in the ground, 5.00 chs. north of my station.</p> <p style="text-align: right;">August 29, 1890.</p> |
| 40.00 | <p>August 30: At 6^h 30^m a. m., I lay off the azimuth of Polaris, 1° 49'.5 to the west, and mark the Meridian thus determined by a cross on a stone firmly set in the ground, west of the point established last night.</p> <p>The magnetic bearing of the true meridian is N. 18° 05' W., which gives the magnetic declination 18° 05' E.</p> <p>From the standard cor. I run North, bet. Secs. 31 and 36.</p> <p>Difference between measurements of 40.00 chs., by two sets of chainmen, is 18 lks.; position of middle point</p> <p style="padding-left: 2em;">By 1st set, 40.09 chs.</p> <p style="padding-left: 2em;">By 2nd set, 39.91 chs.; the mean of which is</p> <p>Set a limestone, 16 × 7 × 5 ins., 11 ins. in the ground, for ¼ sec. cor., etc.</p> <p>Difference bet. measurements of 80.00 chs., by two chainmen, is 22 lks.; position of middle point</p> <p style="padding-left: 2em;">By 1st set, 79.89 chs.</p> <p style="padding-left: 2em;">By 2nd set, 80.11 chs.; the mean of which is</p> <p>80.00 The point for sec. cor., 150 ft. below top of ridge, falls on a flat rock in place, 10 ft. E. and W. by 6 ft. N. and S., on which I Cut a cross (×) at the cor. point, for cor. of secs. 25, 30, 31, and 36, etc.</p> |
| 2.00 | <p>North, bet. secs. 25 and 30.</p> <p>Precipitous descent of 60 ft., down which I can not chain; set a flag on line at foot of precipice; measure a base east 4 chs. to a point, from which the flag bears N. 68° W.; which gives for the distance (by traverse table) 1.50 chs., which, added to 2.00 chs., makes</p> |
| 3.50 | <p>To foot of precipice, bears E. and W.; thence, descend.</p> |
| 40.00 | <p>Set a cedar post, 3 ft. long, 3 ins. sq., with marked stone, 24 ins. in the ground, for ¼ sec. cor., marked ¼ S 25, on W. and 30 on E. face; dig pits, etc.</p> |
| 80.00 | <p>Set a cedar post, 3 ft. long, 4 ins. sq., with marked stone, 24 ins. in the ground, for cor. of secs. 19, 24, 25, and 30, marked, etc.</p> |
| 40.00 | <p>North, bet. secs. 19 and 24.</p> <p>Set a cedar post, 3 ft. long, 3 ins. sq., with marked stone, etc.</p> |
| 80.00 | <p>Deposit a quart of charcoal, 12 ins. in the ground, for cor. of secs. 13, 18, 19, and 24; dig pits, 18 × 18 × 12 ins., in each sec., 4 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, over deposit.</p> <p style="padding-left: 2em;">In SE. pit drive a stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked</p> <p style="padding-left: 2em;">T 13 N S 18 on N E.,</p> <p style="padding-left: 2em;">R 25 E S 19 on S E.,</p> <p style="padding-left: 2em;">S 24 on S W., and</p> <p style="padding-left: 2em;">R 24 E S 13 on N W. face; with 3 notches on N. and S. edges.</p> |

6th Guide Meridian East, through Tps. 13 N., between Rs. 24 and 25 E.

| | |
|---------|--|
| Chains. | North, bet. secs. 13 and 18. |
| 40.00 | Set a granite stone, 15 × 8 × 5 ins., 10 ins. in the ground, for $\frac{1}{4}$ sec. cor., etc. |
| 80.00 | Set a granite stone, 15 × 8 × 6 ins., 10 ins. in the ground, for cor. of, etc. |
| <hr/> | |
| | North, bet. secs. 7 and 12. |
| 40.00 | Set a cedar post, 3 ft. long, 3 ins. sq., with marked stone, 24 ins. in, etc. |
| 80.00 | Set a cedar post, 3 ft. long, 4 ins. sq., with marked stone, 24 ins. in, etc. |
| <hr/> | |
| | North, bet. secs. 1 and 6. |
| 40.00 | Deposit a marked stone, 12 ins. in the ground, for $\frac{1}{4}$ sec. cor., dig pits, 18 × 18 × 12 ins., N. and S. of cor., 4 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, over deposit. |
| | In S. pit drive a cedar stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked |
| | $\frac{1}{4}$ S. 1 on W. and 6 on E. face. |
| 80.00 | Set a cedar post, 3 ft. long, 4 ins. sq., with quart of charcoal, 24 ins. in the ground, for cor. of Tps. 13 and 14 N., Rs. 24 and 25 E., marked, etc. |
| | August 30, 1890. |

GENERAL DESCRIPTION.

Townships 13 N., Ranges 24 and 25 East, are generally rolling table-lands, producing an abundant growth of grass, and there is some good land along Ford's Creek and its tributaries. About two miles east of the corner of Tps. 13 and 14 N., Rs. 24 and 25 E., is a lake some two and a half miles long by two miles wide, lying in Tps. 13 and 14 N., R. 25 E.

RICHARD ROODS,
U. S. Deputy Surveyor.

AUGUST 30, 1890.

NOTE.—Final oaths of deputy surveyor and assistants are to be similar to typical matter following specimen field notes of third standard parallel.

SPECIMEN FIELD NOTES.

No. 3.

TITLE PAGE.

[See Plate II.]

FIELD NOTES

OF THE SURVEY OF THE

EAST AND NORTH BOUNDARIES

OF

TOWNSHIP No. 13 NORTH, RANGE No. 21 EAST

OF THE

PRINCIPAL BASE AND MERIDIAN

IN THE

STATE OF MONTANA,

AS SURVEYED BY

RICHARD ROODS,

U. S. DEPUTY SURVEYOR,

UNDER HIS CONTRACT No. 97,

DATED JULY 10, 1890.

Survey commenced September 8, 1890.

Survey completed September 13, 1890.

[Second Page.]

NOTE.—Names and duties of assistants, also preliminary oaths, are to follow forms already given.

I N D E X .

| | | | | | | | | | | | | | |
|--|-----|---|-----|---|-----|---|-----|---|-----|---|-----------------------|-----|----|
| | 31 | | 32 | | 33 | | 34 | | 35 | | 36 | | |
| | 154 | + | 154 | + | 154 | + | 154 | + | 154 | + | 154 | — | |
| | 6 | | 5 | | 4 | | 3 | | 2 | | 1 | | |
| | | | | | | | | | | | 153 | 6 | |
| | | | | | | | | | | | + | | |
| | | | | | | | | | | | 12 | 153 | 7 |
| | | | | | | | | | | | + | | |
| | | | | | | | | | | | 13 | 153 | 18 |
| | | | | | | | | | | | + | | |
| | | | | | | | | | | | 24 | 153 | 19 |
| | | | | | | | | | | | + | | |
| | | | | | | | | | | | 25 | 153 | 30 |
| | | | | | | | | | | | + | | |
| | | | | | | | | | | | 36 | 153 | 31 |
| | | | | | | | | | | | + | | |
| | | | | | | | | | | | 3rd Standard Par'l N. | — | |

5th G. M. E.

T. 13 N., R. 21 E.

East boundary of T. 13 N., R. 21 E.

| | |
|---------|---|
| Chains. | <p>Survey commenced September 8, 1890, and executed with a Young & Sons light mountain transit, No. —, with solar attachment.</p> <p>NOTE.—Description of instrument and tests of its condition to be noted in manner similar to notes previously given, or with equal care and precision.</p> <p>NOTE.—See note on page 134, on omitted data.</p> <p>September 9: I begin at the standard corner of Tps. 13 N., Rs. 21 and 22 E., which I established August 25, 1890.</p> <p>Thence I run</p> <p>North, bet. secs. 31 and 36.</p> |
| 40.00 | Set a sandstone, 15×8×6 ins., 10 ins. in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ on W. face; dig pits, 18×18×12 ins., N. and S. of stone, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, W. of cor. |
| 80.00 | A cedar, 8 ins. diam., for cor. of secs. 25, 30, 31, and 36, I mark, etc. |
| 40.00 | <p>North, bet. secs. 25 and 30.</p> <p>Set a cedar post, 3 ft. long, 3 ins. sq., with charred stake, 24 ins. in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ S. 25 on W. and 30 on E. face; dig pits 18×18×12 ins., N. and S. of post, 3 ft. dist.; and raise a mound of earth, 3$\frac{1}{2}$ ft. base, 1$\frac{1}{2}$ ft. high, W. of cor.</p> <p>September 9: At this $\frac{1}{4}$ sec. cor. I set off 5° 9' N., on the decl. arc; and at 11^h 57^m.1 l. m. t., observe the sun on the meridian; the resulting lat. is 45° 36.0' which is about 0.2' greater than the proper lat.</p> |
| 80.00 | Set a cedar post, 3 ft. long, 4 ins. sq., with quart of charcoal, 24 ins. in the ground, for cor. of secs. 19, 24, 25, and 30, marked, etc. |
| 40.00 | <p>North, bet. secs. 19 and 24.</p> <p>Set a sandstone, 15×8×6 ins., 10 ins. in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ on W. face; dig pits, etc.</p> |
| 80.00 | Set a cedar post, 3 ft. long, 4 ins. sq., with charred stake, 24 ins., etc. September 9, 1890. |
| 40.00 | <p>September 10: At 7^h 56.8^m a. m., I set off 45° 37' on the lat. arc; 4° 47' N., on the decl. arc; and determine a true meridian with the solar, at the cor. of secs. 13, 18, 19, and 24.</p> <p>Thence I run</p> <p>North, bet. secs. 13 and 18.</p> |
| 80.00 | Set a cedar post, 3 ft. long, 3 ins. sq., with marked stone, 24 ins., etc. |
| 80.00 | Set a limestone, 20×8×4 ins., 15 ins. in the ground, for cor. of secs., etc. |
| 40.00 | <p>North, bet. secs. 7 and 12.</p> <p>Set a cedar post, 3 ft. long, 3 ins. sq., with quart of charcoal, 24 ins., etc.</p> |
| 80.00 | Set a limestone, 19×8×6 ins., 15 ins. in the ground, for cor. of secs. 1, 6, 7, and 12, etc. |
| 40.00 | <p>North, bet. secs. 1 and 6.</p> <p>Set a locust post, 3 ft. long, 3 ins. sq., with quart of charcoal, 24 ins., etc.</p> |
| 80.00 | Set a limestone, 15×8×7 ins., 10 ins. in the ground, for cor. of Tps. 13 and 14 N., etc. September 10, 1890. |

North boundary of T. 13 N., R. 21 E.

| | |
|---------|--|
| Chains. | <p>September 11: At 7^h 56.4^m a. m., l. m. t., I set off 45° 40' on the lat. arc; 4° 25' N., on the decl. arc; and determine a true meridian with the solar, at the cor. of Tps. 13 and 14 N., Rs. 21 and 22 E.</p> <p>Thence I run</p> <p>West on a random line, along the N. bdy. of Tp. 13 N., R. 21 E., setting temp. $\frac{1}{4}$ sec. and sec. cors. at intervals of 40.00 chs.; and, at 479.25 chs., intersect the 5th Guide Meridian, 42 lks. N. of the cor. of Tps. 13 and 14 N., Rs. 20 and 21 E., which is a limestone, 5×8×6 ins. above ground, marked and witnessed as described by the surveyor general. The falling answers to a correction of 0° 03', or 7 lks. S. per mile, counting from the NE. cor. of the Tp.; therefore I run</p> <p>N. 89° 57' E., bet. secs. 6 and 31, marking and blazing true line.</p> <p>39.25 Set a cedar post, 3 ft. long, 3 ins. sq., with marked stone, etc.</p> <p>79.25 Set a limestone, 20×8×4 ins., 15 ins. in the ground, for cor. of secs. 5, 6, 31, and 32, etc.</p> <p style="text-align: right;">September 11, 1890.</p> |
| | <p>September 12: At —^h —^m a. m., l. m. t., I set off 45° 40' on the lat. arc; 4° 02' N., on the decl. arc; and determine a true meridian with the solar, at the cor. of secs. 5, 6, 31, and 32.</p> <p>Thence I run</p> <p>N. 89° 57' E., bet. secs 5 and 32.</p> <p>40.00 Set a juniper post, 3 ft. long, 3 ins. sq., with quart of charcoal, 24 ins. in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ S. 32, on N. and 5 on S. face, etc.</p> <p>80.00 Deposit a quart of charcoal, 12 ins. in the ground, for cor. of secs. 4, 5, 32, and 33; dig pits, 18×18×12 ins., in each sec., 4 ft. dist., etc.</p> <p>September 12: At this cor., I set off 3° 53' N., on the decl. arc; and, at 11^h 56.1^m l. m. t., observe the sun on the meridian; the resulting lat. is 45° 40', which is within 1' of the proper lat.</p> <p style="text-align: right;">September 12, 1890.</p> |
| | <p>N. 89° 57' E., bet. secs. 4 and 33.</p> <p>40.00 Set a limestone, 15×8×5 ins., 10 ins. in ground, for $\frac{1}{4}$ sec. cor., etc.</p> <p>80.00 An oak, 14 ins. diam., for cor. of secs. 3, 4, 33, and 34, I mark, etc.</p> |
| | <p>September 13: At —^h —^m, l. m. t., I set off 45° 40' on the lat. arc; —° —' N., on the decl. arc; and determine a true meridian with the solar at the cor. of secs. 3, 4, 33, and 34.</p> <p>Thence I run</p> <p>N. 89° 57' E., bet. secs. 3 and 34.</p> <p>40.00 An oak, 18 ins. diam., for $\frac{1}{4}$ sec. cor., I mark $\frac{1}{4}$ S. 34, on N. and 3 on S. side, etc.</p> <p>80.00 Set a limestone, 22×8×7 ins., 17 ins. in the ground, for cor., etc.</p> |
| | <p>N. 89° 57' E., bet. secs. 2 and 35.</p> <p>40.00 Set a locust post, 3 ft. long, 3 in. sq., with marked stone, 24 ins., etc.</p> <p>80.00 Set a limestone, 15×8×6 ins., 10 ins. in the ground, for cor. of secs., etc.</p> <p>September 13: At this cor., I set off —° —' N., on the decl. arc; and at —^h —^m l. m. t., observe the sun on the meridian; the resulting lat. is 45° 39', which is within 1' of the proper lat.</p> |
| | <p>N. 89° 57' E., bet. secs. 1 and 36.</p> <p>40.00 Set a limestone, 18×18×12 ins., 12 ins. in the ground, for $\frac{1}{4}$ sec. cor., etc.</p> <p>80.00 Intersect the cor. of Tps. 13 and 14 N., Rs. 21 and 22 E.</p> <p>Land, level.</p> <p>Soil, sandy loam; 1st rate.</p> <p>No timber.</p> <p style="text-align: right;">September 13, 1890.</p> |

Boundaries of T. 13 N., R. 21 E.

Latitudes, departures, and closing errors.

| Line designated. | True bearing. | Distance. | Latitudes. | | Departures. | |
|---------------------------------|--------------------|-----------------------|-------------|--------------------|-------------|-----------------------|
| | | | N. | S. | E. | W. |
| 3rd Standard Parallel N | West | <i>Chs.</i> 480.00 | <i>Chs.</i> | <i>Chs.</i> | <i>Chs.</i> | <i>Chs.</i> 480.00 |
| 5th G. Meridian E | North | 480.00 | 480.00 | ..... | ..... | ..... |
| N. bdy. T. 13 N., R. 21 E. | N. 89° 57' E. | 479.25 | 0.42 | ..... | 479.25 | ..... |
| E. bdy. T. 13 N., R. 21 E. | South | 480.00 | ..... | 480.00 | ..... | ..... |
| Convergency ..... | ..... | ..... | ..... | ..... | 0.74 | ..... |
| Totals ..... | ..... | ..... | 480.42 | 480.00 | 479.99 | 480.00 |
| ..... | ..... | ..... | 480.00 | ..... | ..... | 479.99 |
| Error in lat ..... | ..... | ..... | 0.42 | Error in dep ..... | ..... | 0.01 |

NOTE: The convergency will always be entered in the column containing the departure of the north boundary.

General Description.

This township is rough and mountainous in the southern part, rolling in the interior, and nearly level in the north and east, while prairie land is found in the vicinity of the southwest corner. The township is well watered, and well timbered in the interior; and the soil along the south fork of Spring Creek and its tributaries is very fertile. The township should be subdivided.

RICHARD ROODS,
U. S. Deputy Surveyor.

September 13, 1890.

FINAL OATHS OF DEPUTY SURVEYOR AND ASSISTANTS.

(Similar to oaths in foregoing typical field notes.)

SPECIMEN FIELD NOTES.—No. 4.

Resurvey of the E. bdy. of T. 25 N., R. 2 W., Willamette Meridian.

| | |
|---------|--|
| Chains. | <p>(NOTE.—Field notes of retracements and resurveys will be incorporated with the field notes of the subdivisions to which they are directly related, and will be covered by the preliminary and final oaths of said subdivisional field notes. See page 69. The notes will also be indexed. In case the deputy does not know from recent observations that his instrument is in adjustment, he will make the observations prescribed at the beginning of specimen field notes No. 2, or No. 5, as the character of the instrument employed may require. A transit with solar attachment is the instrument employed for this resurvey.) See note on page 134 on omitted data.</p> |
| | <p>Preliminary to commencing the subdivision of this township, I run north on a blank line, on the east boundary of sec. 36; at 40.00 chs. I find the $\frac{1}{4}$ sec. cor., N. 80° E., 30 lks. dist., and at 80.00 chs., the cor. of secs. 25, 30, 31 and 36, east, 58 lks. dist.; therefore I continue my line north, find no part of the E. bdy. in alinement, and that many of the corners are nearly obliterated. At 5 miles 79.83 chs., intersect E. and W. line, 42 lks. E. of the cor. of Tps. 25 and 26 N., Rs. 1 and 2 W., and as these townships have not been subdivided, I resurvey the range line between them, as follows: The old standard cor. of Tps. 25 N., Rs. 1 and 2 W., is a post greatly decayed, and the marks are nearly obliterated. I destroy all traces of the old corner and reestablish it at the same point, as follows: Set a sandstone, 18×8×5 ins., 12 ins. in the ground, for standard cor., etc. Thence I run N. 0° 3' W., bet. secs. 31 and 36.</p> |
| 40.00 | <p>Set a sandstone, 20×8×4 ins. 15 ins. in the ground, for $\frac{1}{4}$ sec. cor., etc. From this point, the old $\frac{1}{4}$ sec. cor., which is a decayed stake, with marks almost obliterated, bears N. 80° E., 33 lks. dist. I destroy this stake and the marks on the stump of a beech tree, described as a bearing tree in the field notes of the original survey. No trace can be found of a poplar, described as a bearing tree.</p> |
| 80.00 | <p>Set a cedar post, 3 ft. long, 4 ins. sq., with marked stone, 24 ins., etc. From this cor. the old cor., a decayed post, bears E. 65 lks. I destroy all traces of the old cor.</p> |
| 40.00 | <p>N. 0° 3' W., bet. secs. 25 and 30. Set a locust post, 3 ft. long, 3 ins. sq., with quart of charcoal, 24 ins. in the ground, for $\frac{1}{4}$ sec. cor. marked $\frac{1}{4}$ S. 25 on W. and 30 on E. face, etc. All indications of the old cor. have disappeared.</p> |
| 80.00 | <p>Set a granite stone, 15×8×7 ins., 10 ins. in the ground, for cor., etc. From this point, the old sec. cor., a post, bears N. 50° E., 41 lks. dist. I destroy the cor.</p> |
| 40.00 | <p>N. 0° 3' W., bet. secs. 19 and 24. Set an oak post, 3 ft. long, 3 ins. sq., with charred stake, 24 ins., etc. From this point, the old $\frac{1}{4}$ sec. cor., a decayed post, bears N. 51$\frac{1}{2}$° E., 47 lks. dist. I destroy this post, and marks on old bearing trees.</p> |
| 80.00 | <p>Set a limestone, 18×8×5 ins., 12 ins. in the ground, etc. After diligent search no signs of the old cor. are found.</p> |

Resurvey of the E. bdy. of T. 25 N., R. 2 W., Willamette Meridian.

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|---------------------|---|
| Chains. | N. 0° 3' W., bet. secs. 13 and 18. |
| 40.00 | Set a cedar post, 3 ft. long, 3 ins. sq., with quart of charcoal, 24 ins., etc. I can find no traces of old cor. post, but find slight traces of pits N. 86° E. 46 lks. dist., which I destroy. |
| 80.00 | Intersect evident remains of old sec. cor., and set a limestone, 22×8×4 ins., 17 ins. in the ground, for cor., etc. The old cor. which was a post, has disappeared, but indistinct remains of the pits, nearly in their proper places, still remain. The new pits sufficiently obliterate the old ones. April 12, 1892: I set off 9° 6' N., on the decl. arc; and at about 1 min. before 12 M. l. m. t., observe the sun on the meridian; the resulting lat., is 47° 35' N. |
| 40.00 | N. 0° 3' W., bet. secs. 7 and 12. Set a cedar post, 3 ft. long, 3 ins. sq., with charred stake, 24 ins., etc. After diligent search I failed to find any trace of the old corner. |
| 80.00 | Set a limestone, 20×8×5 ins., with marked stone, 24 ins., etc. The old cor. which was a post, has been entirely destroyed by fire; no signs of pits. |
| | April 12, 1892: At 4 p. m., l. m. t., I set off 47° 36' on the lat. arc; —° —', on the decl. arc; and determine the meridian at the cor. of secs. 1, 6, 7, and 12. Thence I run |
| 40.00 | N. 0° 3' W., bet. secs. 1 and 6. Set a locust post, 3 ft. long, 3 ins. sq., with quart of charcoal, 24 ins., etc. After diligent search no old $\frac{1}{4}$ sec. cor. are found. |
| 79.83 | Intersect the old cor. of Tps. 25 and 26 N., Rs. 1 and 2 W., which is an oak post, burned off at the surface of the ground. I reestablish the cor. at the same point, as follows: Set a cedar post, 3 ft. long, 4 ins. sq., etc. April 12, 1892. |
| | Note: As a specimen of restoration of a missing corner on a township boundary by a subdividing deputy, the following field notes are given: |
| 40.00 | N. 89° 57' W., on a random line bet. secs. 7 and 18. Set temp. $\frac{1}{4}$ sec. cor. |
| 79.61 | The cor. of secs. 7, 12, 13, and 18 is not found, after careful search. I find the $\frac{1}{4}$ sec. cor. bet. secs. 13 and 18, which is a locust post, 1 ft. high, 3 ins. sq., marked and witnessed as described by the surveyor general. Thence I run |
| 40.00 | North, on a random line bet. secs. 13 and 18. Set temp. sec. cor. At this point I again make careful search for the sec. cor., which is described by the surveyor general as a post with pits and mound of earth W. of cor., but am unable to find any traces of post, pits, or mound. Thence, N. bet. secs. 7 and 12. |
| 79.95 | Intersect E. and W. line, 5 lks. E. of the $\frac{1}{4}$ sec. cor. bet. secs. 7 and 12, which is a sandstone, 5×10×4 ins. above ground, marked and witnessed as described by the surveyor general. Thence I run |
| 39.97 $\frac{1}{2}$ | S. 0° 2' E., on a true line bet. secs. 7 and 12. Over rolling land. Reestablished the cor. as follows: Set a cedar post, 3 ft. long, 4 ins. sq., with marked stone, 24 ins. in the ground, for cor. of secs. 7, 12, 13, and 18, marked T 25 N S 7 on N E., R 2 W S 18 on S E., S 13 on S W., and R 3 W S 12 on N W. face; with 2 notches on N. and 4 notches on S. edge; dig pits, 18×18×12 ins., in each sec., 5 $\frac{1}{2}$ ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor. April 18, 1892. |

SPECIMEN FIELD NOTES.

No. 5.

TITLE PAGE.

(See Plate III.)

FIELD NOTES

OF THE SURVEY OF THE

SUBDIVISION AND MEANDER LINES

OF

TOWNSHIP No. 15 NORTH, RANGE No. 20 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. 207,

DATED MARCH 22, 1893.

Survey commenced August 4, 1893.

Survey completed August 19, 1893.

[Second page.]

NAMES AND DUTIES OF ASSISTANTS.

[As in specimen on page 132.]

INDEX.

Township 15 north, range 20 east.

| | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
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| Meanders of lake in sec. 33..... | page 183. |
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NOTE.—When practicable, the diagram will show meander lines with the page references written upon them. Preliminary oaths to follow index as in previous examples.

Subdivision of T. 15 N., R. 20 E.

| | |
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| Chains. | <p>NOTE: See note on page 134, regarding omitted data.</p> <p>Survey commenced August 4, 1893, and executed with a Young & Sons light mountain transit, No. —, with solar attachment. The horizontal limb is provided with two double verniers placed opposite to each other, reading to single minutes of arc, which is also the least count of the verniers of the latitude and declination arcs.</p> <p>The instrument was examined, tested on the true meridian at Helena, found correct, and was approved by the surveyor general for Montana, August 1, 1893.</p> <p>I examine the adjustments of the transit, and correct the level and collimation errors;^a then, to test the solar apparatus, by comparing its indications, resulting from solar observations made during a. m. and p. m. hours, with a meridian determined by observations on Polaris, I proceed as follows:</p> <p>At the cor. of Tps. 14 and 15 N., Rs. 20 and 21 E.; latitude 45° 45' N., longitude 107° 54' W.; I set off 45° 45' N., on the lat. arc; 17° 1' N., on the decl. arc; and, at 4^h 6^m p. m., l. m. t., determine with the solar a meridian and mark a point thereof, on a stone firmly set in the ground, 5 chs. N. of the cor.</p> <p>At 10^h 24^m p. m. by my watch, which is 3^m 43^s slow of l. m. t., I observe Polaris at eastern elongation, in accordance with Manual of Instructions, and mark a point in the line thus determined, on a peg driven in the ground, 5 chs. N. of my station.</p> <p style="text-align: right;">August 4, 1893.</p> <hr/> <p>August 5: At 6 a. m., l. m. t., I lay off the azimuth of Polaris, 1° 48' to the west, and mark the meridian thus determined, by cutting a small groove in the stone set August 4, on which the meridian falls 0.4 ins. east of the mark determined by the solar.</p> <p>At 8^h 6^m a. m., l. m. t., I set off 45° 45', on the lat. arc; 16° 50' N. on the decl. arc; and mark a point in the meridian determined with the solar, by a cross on the stone already set 5 chs. N. of my station; this mark falls 0.3 ins. east of the meridian established by the Polaris observation.^b</p> <p>The solar apparatus, by p. m. and a. m. observations, defines positions for meridians, respectively about 0' 21" west and 0' 16" east ° of the meridian established by the Polaris observations; therefore, I conclude that the adjustments of the instrument are satisfactory.</p> <p>The magnetic bearing of the true meridian, at 8^h 30^m a. m., is N. 18° 15' W.; the angle thus determined gives the mag. decl. 18° 15' E.</p> <hr/> <p>From the Tp. cor. already described, I retrace North, on the 5th Guide Meridian and E. bdy. of sec. 36; and at 40.01 chs. intersect the $\frac{1}{4}$ sec. cor.; and at 79.98 chs., fall 1 lk. W. of the cor. of secs. 25, 30, 31 and 36; therefore the line bears north.</p> <p>From the Tp. cor. I run N. 89° 57' W. on the S. bdy. of sec. 36; at 39.99 chs., fall $\frac{1}{2}$ lk. N. of the $\frac{1}{4}$ sec. cor.; and at 80.01 chs. fall 1 lk. S. of the cor. of secs. 1, 2, 35, and 36, on S. bdy. of the Tp.; consequently the S. bdy. of sec. 36 bears N. 89° 57' W.</p> <p>Therefore the bearings are as stated by the surveyor general, and my chaining practically agrees with the field notes of the original survey.</p> |
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^a The instrument will not necessarily be in adjustment at the beginning of the survey because it was found correct when approved by the surveyor general. The deputy should clearly understand that he is required to know from personal tests and observations that his instrument is in adjustment when he commences work and at all other times when he employs said instrument to determine directions and run lines.

^b The observations here recorded have a twofold object; first, to determine the meridian; second, to test the solar apparatus thereon. When a transit is employed, meridians determined by Polaris observations will be regarded as reference or directing lines of the survey; and from them all other directions and bearings will be initiated by angular measurements on the horizontal limb of the instrument.

^c To determine these small angles in seconds of arc, divide the fallings expressed in inches by 0.019. (See footnote, page 141.)

Subdivision of T. 15 N., R. 20 E.

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| Chains. | <p>I commence at the cor. of secs. 1, 2, 35, and 36, on the S. bdy. of the Tp., which is a sandstone, 6×8×5 ins. above ground, firmly set, and marked and witnessed as described by the surveyor general.</p> <p>Thence I run N. 0° 01' W., bet. secs. 35 and 36. Over level bottom land.</p> <p>4.50 Wire fence, bears E. and W.</p> <p>20.00 Enter scattering cottonwood timber, bears E. and W. F. G. Alexander's house bears N. 28° W.</p> <p>29.30 Leave scattering cottonwoods, bearing E. and W.; enter road, bears N.</p> <p>30.00 SE. cor. of F. G. Alexander's field; thence along west side of road.</p> <p>39.50 To crossroads, bears E. to Mound City; N. to Lake City. F. G. Alexander's house bears S. 40° W. The $\frac{1}{4}$ sec. cor. point will fall in road; therefore</p> <p>Set a cedar post, 3 ft. long, 3 ins. sq., with quart of charcoal, 24 ins. in the ground, for witness cor. to $\frac{1}{4}$ sec. cor., marked W C $\frac{1}{4}$ S 35 on W. and 36 on E. face; dig pits, 18×18×12 ins. N. and S. of post, 3 ft. dist.; and raise a mound of earth, 3$\frac{1}{2}$ ft. base, 1$\frac{1}{2}$ ft. high, W. of cor.</p> <p>40.00 Point for $\frac{1}{4}$ sec. cor. in road. Deposit a marked stone, 24 ins. in the ground, for $\frac{1}{4}$ sec. cor. The SE. cor. of Pat. Curran's field bears W., 5 lks. dist.</p> <p>40.50 Set a limestone, 15×8×6 ins., 10 ins. in the ground, for witness cor. to $\frac{1}{4}$ sec. cor., marked W C $\frac{1}{4}$ S on W. face; dig pits, 18×18×12 ins. N. and S. of stone, 3 ft. dist.; and raise a mound of earth, 3$\frac{1}{2}$ ft. base, 1$\frac{1}{2}$ ft. high, W. of cor.</p> <p>Thence along E. side of field. NE. cor. of Pat. Curran's field, bears W. 4 lks. dist.</p> <p>50.50 Leave road; which turns to N. 70° W., leads to ferry on Yellowstone River; thence to Lake City.</p> <p>57.50 Enter dense cottonwood and willow undergrowth, bears N. 54° E. and S. 54° W.</p> <p>72.50 Leave undergrowth, enter scattering timber, bears N. 60° E. and S. 60° W.</p> <p>80.00 Set a locust post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for cor. of secs. 25, 26, 35 and 36, marked T 15 N S 25 on NE., R 20 E S 36 on SE., S 35 on SW., and S 26 on NW. face; with 1 notch on S. and E. faces; from which An ash, 13 ins. diam., bears N. 22° E., 26 lks. dist., marked T 15 N R 20 E S 25 B T. A sycamore, 23 ins. diam., bears S. 71$\frac{1}{4}$° E., 37 lks. dist., marked T 15 N R 20 E S 36 B T. A walnut, 17 ins. diam., bears S. 64° W., 41 lks. dist., marked T 15 N R 20 E S 35 B T. A cottonwood, 13 ins. diam., bears N. 21$\frac{1}{4}$° W., 36 lks. dist., marked T 15 N R 20 E S 26 B T.</p> <p>Last 20.00 chs. of this mile subject to overflow, 2 to 4 ft. deep. Land, level bottom. Soil, alluvial; 1st rate. No stones were obtainable. Timber, scattering cottonwood, sycamore, ash, and walnut; undergrowth, cottonwood and willow. Dense undergrowth, 15.00 chs.</p> |
| 40.00 79.96 | <p>S. 89° 57' E., on a random line bet. secs. 25 and 36. Set temp. $\frac{1}{4}$ sec. cor. Intersect E. bdy. of Tp. 3 lks. N. of cor. of secs. 25, 30, 31, and 36, which is a sandstone, 5×8×5 ins. above ground, marked and witnessed as described by the surveyor general.</p> |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | Thence I run N. 89° 56' W., on a true line bet. secs. 25 and 36. Over level bottom land, through scattering timber. |
| 13. 00 | Leave scattering timber, bears N. and S. |
| 18. 60 | Cherry Creek, 12 lks. wide; clear water, 1 ft. deep; gentle current, sandy bottom; course N. |
| 20. 50 | Enter heavy timber, bears N. and S. |
| 32. 50 | Leave heavy timber, bears NW. and SE. |
| 39. 98 | Deposit a quart of charcoal, 12 ins. in the ground, for $\frac{1}{4}$ sec. cor.; dig pits, 18×18×12 ins., E. and W. of cor., 4 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, over deposit. In E. pit drive a cedar stake 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked $\frac{1}{4}$ S 25 on N. and 36 on S. face. |
| 46. 50 | Enter heavy timber, bears N. and S. |
| 76. 00 | Leave heavy, enter scattering timber, bears N. 25° E. and S. 25° W. |
| 79. 96 | The cor. of secs. 25, 26, 35, and 36. Land nearly level; mostly subject to overflow 2 to 5 ft. deep. Heavily timbered land, 41.50 chs. |
| <hr/> | |
| | N. 0° 1' W., bet. secs. 25 and 26. Over level bottom land, through scattering timber. |
| 25. 36 | Right bank of Yellowstone River. Set a locust post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for meander cor. of fracl. secs. 25 and 26, marked- M C on N., T 15 N on S., R 20 E S 25 on E., and S 26 on W. face; from which A cottonwood, 12 ins. diam., bears S. 18 $\frac{1}{4}$ ° E., 16 lks. dist., marked T 15 N R 20 E S 25 M C B T. A sycamore, 31 ins. diam., bears S. 74 $\frac{1}{2}$ ° W., 25 lks. dist., marked T 15 N R 20 E S 26 M C B T. |
| | Enter shallow channel, 1 to 2 ft. deep. |
| 26. 00 | Across shallow channel, 64 lks. wide, to sand bar parallel to river bank; thence on sand bar. |
| 32. 12 | To right bank of main channel, course E.; point for triangulation. |
| 40. 00 | Point for $\frac{1}{4}$ sec. cor. falls in river. To determine the dist. across, I set a flag on line, on left bank; then measure a base, N. 89° 59' E., 20.00 chs. to a point, from which the flag bears N. 49° 06' W.; from the flag the E. end of base bears S. 49° 6' E.; therefore, the dist. is $\tan. 40^\circ 55' \times \text{base}$, or $0.867 \times 20.00 = 17.34$ chs.; making the whole distance from meander cor., $0.64 + 6.12 + 17.34 = 24.10$ chs., which added to 25.36, makes |
| 49. 46 | To left bank of Yellowstone River; bank, 12 ft. high. Deposit a marked stone, 12 ins. in the ground for meander cor. of fracl. secs. 25 and 26, dig a pit, 36×36×12 ins., 5 ft. N. of cor. and raise a mound of earth, 4 ft. base, 2 ft. high, over deposit. In the pit drive a cedar stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked M C on S., T 15 N on N., R 20 E S 26 on W., and S 25 on E. face. |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | Thence over level bottom land. Some small cottonwoods, none within limits suitable for bearing trees. |
| 52. 60 | Leave bottom, begin ascent, bears E. and W. |
| 53. 60 | Top of ascent and edge of sandy plain, 40 ft. above river, bears E. and W. |
| 55. 70 | Wire fence, bears E. and W. |
| 62. 80 | Telegraph line, bears E. and W. |
| 80. 00 | Set a cedar post, 3 ft. long, 4 ins. sq., with marked stone, 24 ins. in the ground, for cor. of secs. 23, 24, 25, and 26, marked T 15 N S 24 on NE., R 20 E S 25 on SE., S 26 on SW., and S. 23 on NW. face; with 2 notches on S. and 1 notch on E. edge; dig pits, 18×18×12 ins. in each sec. 5½ ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor. |
| | Land level. Soil, alluvial and sandy; 1st and 2nd rate. Timber, cottonwood and sycamore. August 5: At this cor. I set off 16° 47' N., on the decl. arc; and, at 12 ^h 6 ^m , l. m. t., observe the sun on the meridian; the resulting lat. is 45° 47'. 0 or within 1' of the proper lat. |
| 40. 00 | S. 89° 56' E., on a random line bet. secs. 24 and 25. Set temp. ¼ sec. cor. |
| 79. 98 | Intersect E. bdy. of Tp. 3 lks. N. of cor. of secs. 19, 24, 25, and 30, which is a sandstone, 5×9×4 ins. above ground, marked and witnessed as described by the surveyor general. Thence I run N. 89° 55' W., on a true line bet. secs. 24 and 25. Over level land. |
| 20. 00 | Fletcher's Station bears S. 64° W. |
| 39. 99 | Set a cedar post, 3 ft. long, 3 ins. sq., with marked stone, 24 ins. in the ground, for ¼ sec. cor., marked ¼ S 24 on N. and 25 on S. face; dig pits, 18×18×12 ins., E. and W. 3 ft. dist.; and raise a mound of earth, 3½ ft. base, 1½ ft. high, N. of cor. Fletcher's Station bears S. 7° E. |
| 58. 00 | Short Creek, 3 lks. wide, alkali water, 8 ins. deep, course S. 20° E. |
| 79. 98 | The cor. of secs. 23, 24, 25, and 26. Land level. Soil sandy; 3rd rate. No timber. |
| | N. 0° 1' W., bet. secs. 23 and 24. * * * * * |
| | S. 89° 55' E., on a random line, bet. secs. 13 and 24. * * * * * |
| | N. 0° 1' W., bet. secs. 13 and 14. * * * * * |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | S. 89° 55' E., on a random line, bet. secs. 12 and 13. |
| 40.00 | Point for $\frac{1}{4}$ sec. cor. falls in Rancho San Blas. |
| 80.03 | Intersect E. bdy. of Tp. 7 lks. N. of the cor. of secs. 7, 12, 13, and 18, which is a sandstone 5×6×6 ins. above ground, marked and witnessed as described by the surveyor general. |
| | Thence I run |
| | N. 89° 52' W., on a true line bet. secs. 12 and 13. |
| | Over level land. |
| 31.49 | Intersect E. bdy. of Rancho San Blas, at a point from which the 5-mile post on the rancho bdy. bears S. 33° E. 7.00 chs. dist. |
| | Set a limestone, 15×8×5 ins., 10 ins. in the ground, for closing cor. of fracl. secs. 12 and 13, marked C C on E. and S B on W. and 4 grooves on S. face; dig pit crosswise on each line, 30×24×12 ins., N. 33° W., 3 ft., and 24×18×12 ins., E. of stone, 7 ft. dist.; and raise a mound of earth 4 ft. base, 5 ft. high, E. of cor. |
| | Thence across the rancho on a blank line. |
| 67.07 | Intersect W. bdy. of Rancho San Blas at a point, from which the 3 $\frac{1}{2}$ -mile post on the rancho bdy., bears N. 19 $\frac{1}{2}$ ° W., 12.20 chs. dist. |
| | Set a granite stone, 15×7×6 ins., 10 ins. in the ground, for closing cor. of fracl. secs. 12 and 13, marked S B on E., with 4 grooves on S. and C C on W. face; and raise a mound of stone 2 ft. base, 1 $\frac{1}{2}$ ft. high, W. of cor. Pits impracticable. |
| | This cor. is on a granite ridge 220 ft. above closing cor. on E. bdy. of the rancho. Thence over rough stony ground. |
| 76.00 | Begin descent of rocky slope, bears N. and S. |
| 80.03 | The cor. of secs. 11, 12, 13, and 14. |
| | This cor. is 40 ft. below top of ridge. |
| | Land level and mountainous. |
| | Soil sandy loam and stony; 3rd and 4th rate. |
| | No timber. |
| | Across Rancho San Blas, 35.58 chs. of blank line. |
| | Mountainous land, 12.96 chs. |
| <hr/> | |
| | August 5: At 4 ^h 35 ^m p. m., l. m. t., I set off 45° 49' on the lat. arc; 16° 45' N., on the decl. arc; and determine a meridian with the solar at the corner of secs. 11, 12, 13, and 14. |
| | Thence I run |
| | N. 0° 1' W., bet. secs. 11 and 12. |
| | Ascend over rough stony ground sloping W. |
| 11.00 | Top of ascent, bears about N. 50° W., and S. 50° E. |
| | Thence over level land. |
| 36.60 | Intersect W. bdy. of Rancho San Blas at a point from which the NW. cor. of the rancho bears N. 19 $\frac{1}{2}$ ° W., 7.40 chs. dist. and |
| | Set a cedar post, 3 ft. long, 4 ins. sq., with marked stone, 24 ins. in the ground, for closing cor. of fracl. secs. 11 and 12, marked |
| | S B on E., |
| | C C T 15 N R 20 E on S., and |
| | S 11 on W. face; dig pits, crosswise on each line, 30×24×12 ins., N. 19 $\frac{1}{2}$ ° W., 3 ft., and 24×18×12 ins., S. of stone, 7 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, S. of cor. |
| | Thence, across the rancho on a blank line. |
| 40.00 | The point for $\frac{1}{4}$ sec. falls in the rancho. |
| 44.32 | Intersect N. bdy. of Rancho San Blas at a point from which the NW. cor. of the rancho bears S. 73° W., 2.58 chs. dist. |
| | Set a juniper post 3 ft. long, 4 ins. sq., with a quart of charcoal, 24 ins. in the ground, for closing cor. of fracl. secs. 11 and 12, marked |
| | C C T 15 N R 20 E on N., |
| | S B on S., and |
| | S 11 on W. face; dig pits, crosswise on each line, 30×24×12 ins., S. 73° W., 3 ft., and 24×18×12 ins., N. of stone, 7 ft. dist., and raise a mound of earth, 4 ft. base, 2 ft. high, N. of cor. |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | Leave rancho, enter public land; thence, over rolling ground. |
| 59. 50 | Branch, 6 lks. wide, course SE. |
| 80. 00 | Deposit a marked stone 12 ins. in the ground, for cor. of secs. 1, 2, 11, and 12, dig pits, 18×18×12 ins., in each sec., 4 ft. dist. and raise a mound of earth, 4 ft. base, 2 ft. high, over deposit. In SE. pit drive a cedar stake 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked T 15 N S 1 on NE., R 20 E S 12 on SE., S 11 on SW., and S 2 on NW. face; with 5 notches on S. and 1 notch on E. edge. |
| | Land, mountainous and level. |
| | Soil stony, clay and loam; 3rd and 4th rate. |
| | No timber. |
| | Across Rancho San Blas, 7.72 chs. of blank line. |
| | Mountainous land, 11.00 chs. |
| | S. 89° 52' E., on a random line bet. secs. 1 and 12. |
| | * * * * * |
| | N. 0° 1' W., on a random line bet. secs. 1 and 2. |
| 40. 00 | Set temp. $\frac{1}{4}$ sec. cor. |
| 79. 77 | Intersect N. bdy. of Tp. at cor. of secs. 1, 2, 35, and 36, which is a limestone, 6×6×5 ins., above ground, marked and witnessed as described by the surveyor general. |
| | Thence I run |
| | S. 0° 1' E. on a true line bet. secs. 1 and 2. |
| | Over rolling land. |
| 30. 50 | Ravine, 3.50 chs. wide, 30 ft. deep, course N. 70° E. |
| 39. 77 | Deposit a marked stone, 12 ins. in the ground, for $\frac{1}{4}$ sec. cor.; dig pits, 18×18×12 ins. N. and S. of cor., 4 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, over deposit. |
| | In S. pit drive a cedar stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground marked $\frac{1}{4}$ S. 2 on W. and 1 on E. face. |
| 79. 77 | The cor. of secs. 1, 2, 11, and 12. |
| | Land, rolling. |
| | Soil, clay and loam; 3rd and 4th rate. |
| | No timber. |
| | Aug. 5, 1893. |
| | From the cor. of secs. 2, 3, 34, and 35, on S. bdy. of the Tp., which is a locust post, 4 ins. sq., 12 ins. high, marked and witnessed as described by the surveyor general, I run |
| | N. 0° 2' W., bet. secs. 34 and 35. |
| | * * * * * |
| | S. 89° 57' E. on a random line bet. secs. 26 and 35. |
| 40. 00 | Set temp. $\frac{1}{4}$ sec. cor. |
| 48. 13 | To left bank of Yellowstone River, set temp. meander cor. |
| | To determine the dist. across*, I set a flag on line on right bank of the river; then measure a base line S. 22° 58' E. 15.00 chs. to a point, whence the flag bears N. 41° 47' E. From the flag the S. end of the base bears S. 41° 47' W.; by separate measurement of each angle they are found respectively 68° 59', 64° 48', and 48° 16'; their sum |

*The triangulation will always be made on the random line when a random line is run. See page 68, and Plate I, fig. 4.

Subdivision of T. 15 N., R. 20 E.

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| Chains. | <p>being 180° 03', or 3' too great. I diminish each angle by one-third of the excess and compute the distance across the river, as follows: $\frac{\sin 64^\circ 47'}{\sin 48^\circ 15'} \times \text{base, or } \frac{0.905 \times 15}{0.746} = 18.19 \text{ chs.}; \text{ also,}$ 48.13+18.19 makes</p> <p>66.32 To right bank of river; set temp. meander cor. 80.06 Intersect N. and S. line, 3 lks. S. of cor. of secs. 25, 26, 35, and 36; thence I run N. 89° 58' W., on a true line bet. secs. 26 and 35. Over lever bottom land, through scattering timber.</p> <p>13.74 To right bank of Yellowstone River. Set a limestone, 19×7×5 ins., 15 ins. in the ground, for meander cor. of fracl. secs. 26 and 35, marked M C on W. face, with 1 groove on S. face; from which A sycamore, 19 ins. diam., bears N. 49½° E., 26 lks. dist., marked T 15 N R 20 E S 26 M C B T. A cottonwood, 13 ins. diam., bears S. 38½° E., 21 lks. dist., marked T 15 N R 20 E S 35 M C B T.</p> <p>31.93 To left bank of Yellowstone River. A sycamore, 13 ins. diam., for meander cor. of fracl. secs. 26 and 35, I mark M C on E., T 15 N on W., R 20 E S 35 on S., and S 26 on N. side; dig a pit, 36×36×12 ins., 8 ft. W. of tree, and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor.</p> <p>37.50 Leave scattering timber, bears NW. and SE. 40.03 Set a cedar post, 3 ft. long, 3 ins. sq., with marked stone, 24 ins. in the ground, for ¼ sec. cor. marked ¼ S 26 on N. and 35 on S. face; dig pits, 18×18×12 ins., E. and W. of post, 3 ft. dist.; and raise a mound of earth, 3½ ft. base, 1½ ft. high, N. of cor.</p> <p>80.06 The cor. of secs. 26, 27, 34, and 35. Land, level. Soil, alluvial and sandy; 1st and 3rd rate. Timber, sycamore and cottonwood.</p> |
| | <p>N. 0° 2' W., bet. secs. 26 and 27.</p> <p style="text-align: center;">* * * * *</p> |
| | <p>S. 89° 58' E., on a random line bet. secs. 23 and 26.</p> <p style="text-align: center;">* * * * *</p> |
| | <p>N. 0° 2' W., bet. secs. 22 and 23.</p> <p style="text-align: center;">* * * * *</p> |
| | <p>S. 89° 56' E., on a random line bet. secs. 14 and 23.</p> <p style="text-align: center;">* * * * *</p> |
| | <p>N. 0° 2' W., bet. secs. 14 and 15.</p> <p style="text-align: center;">* * * * *</p> |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | S. 89° 53' E., on a random line bet. secs. 11 and 14. * * * * * |
| | N. 0° 2' W., bet. secs. 10 and 11. Over gradually ascending ground. |
| 28. 00 | Ravine, 18 ft. deep, course S. 30° E. |
| 30. 50 | Begin ascent over stony ground, bears E. and W. |
| 40. 00 | Set a granite stone, 16×6×6 ins., 11 ins. in the ground, for $\frac{1}{4}$ sec. cor. marked $\frac{1}{4}$ on W. face; and raise a mound of stone, 2 ft. base, 1 $\frac{1}{2}$ ft. high, W. of cor. Pits impracticable. |
| 42. 00 | This $\frac{1}{4}$ sec. cor. stands on S. slope of ridge, 50 ft. above the sec. cor. Top of sharp rocky ridge, 20 ft. above the $\frac{1}{4}$ sec. cor., bears N. 75° E. and S. 75° W. |
| 43. 50 | Begin descent. |
| 48. 50 | Foot of descent, 25 ft. below top of ridge, bears E. and W.; thence, ascend along SE. slope of spur. |
| 53. 00 | Enter heavy oak and pine timber, bears E. and W. |
| 60. 00 | A point, 200 ft. above $\frac{1}{4}$ sec. cor.; thence descend into ravine 50 ft. deep, course S. 35° E.; ascend very steep slope to |
| 80. 00 | A pine, 27 ins. diam., for cor. of secs. 2, 3, 10 and 11, I mark T 15 N S 12 on NE., R 20 E S 11 on SE., S 10 on SW, and S 3 on NW. side, with 5 notches on S. and 2 notches on E. side; from which An oak, 12 ins. diam., bears N. 22° E., 17 lks. dist., marked T 15 N R 20 E S 2 B T. A pine, 14 ins. diam., bears S. 65 $\frac{1}{2}$ ° E., 21 lks. dist., marked T 15 N R 20 E S 11 B T. A pine, 15 ins. diam., bears S. 41 $\frac{1}{2}$ ° W., 27 lks. dist., marked T 15 N R 20 E S 10 B T. An oak, 14 ins. diam., bears N. 48 $\frac{1}{4}$ ° W., 23 lks. dist., marked T 15 N R 20 E S 3 B T. This cor. stands on a SE. spur of the Little Snowy Mountains, 560 ft. above cor. of secs. 10, 11, 14, and 15. Land, mountainous. Soil, stony; 4th rate. Timber, oak and pine. Mountainous or heavily timbered land, 59.50 chs. |
| | S. 89° 49' E., on a random line bet. secs. 2 and 11. |
| 40. 00 | Set temp. $\frac{1}{4}$ sec. cor. |
| 80. 17 | Intersect N. and S. line, 23-lks. S. of the cor. of secs. 1, 2, 11, and 12. Thence I run N. 89° 59' W. on a true line bet. secs. 2 and 11. Over rolling land. |
| 19. 00 | Enter heavy oak timber, bears N. 10° E. and S. 10° W. |
| 19. 90 | Branch, 4 lks. wide, course S. 60° E. |
| 26. 00 | Begin ascent of mountain spur, bears about S. 20° W. |
| 40. 08 $\frac{1}{2}$ | Top of spur, 80 ft. above sec. cor. Set a cedar post, 3 ft. long, 3 ins. sq., 24 ins. in ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ S. 2 on N. and 11 on S. face; from which An oak, 11 ins. diam., bears S. 54 $\frac{1}{2}$ ° E., 24 lks. dist., marked $\frac{1}{4}$ S. 11 B. T. A pine, 13 ins. diam., bears N. 36 $\frac{1}{2}$ ° E., 18 lks. dist., marked $\frac{1}{4}$ S. 2 B. T. |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | Thence along south side of spur. |
| 57.00 | Leave heavy oak timber, bears N. and S.; descend abruptly. |
| 61.00 | Bottom of ravine, 40 ft. deep, course S. 60° E.; ascend very steep rocky slope. |
| 71.00 | Enter heavy pine timber, bears NE. and SW. |
| 80.17 | The cor. of secs. 2, 3, 10, and 11. Land, mountainous. Soil, sand and gravel; 4th rate. Timber, oak and pine. Mountainous or heavily timbered land, 61.00 chs. |
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| | N. 0° 2' W., on a random line bet. secs. 2 and 3. |
| 40.00 | Set temp. $\frac{1}{4}$ sec. cor. |
| 80.15 | Intersect N. bdy. of the Tp. 5 lks. W. of the cor. of secs. 2, 3, 34, and 35, which is a granite stone, 5×8×5 ins. above ground, marked and witnessed as described by the surveyor general. August 7: At 5 ^h 00 ^m p. m., l. m. t., I set off 16° 11' N., on the decl. arc; 45° 50', on the lat. arc; and determine a meridian with the solar, at the cor. of secs. 2, 3, 34, 35. |
| | Thence I run South on a true line bet. secs. 2 and 3. Over rolling ground on the summit of the southern end of the Little Snowy Mountains, 1,200 ft. high. |
| 5.00 | Begin descent of eastern slope of mountain. |
| 30.00 | Head of ravine, 200 ft. below sec. cor., course S. 60° E.; thence over broken ground. |
| 40.15 | Set a lava stone, 17×8×5 ins., 12 ins. in the ground, for $\frac{1}{4}$ sec. cor. marked $\frac{1}{4}$ on W. face; and raise a mound of stone, 2 ft. base, 1 $\frac{1}{2}$ ft. high, W. of cor. Pits impracticable. |
| 45.00 | Enter heavy pine timber, bears E. and W.; descend rapidly. |
| 54.00 | Head of ravine 170 feet below $\frac{1}{4}$ sec. cor., course SE.; thence ascend over rough stony ridges. |
| 80.15 | The cor. of secs. 2, 3, 10, and 11. Land, mountainous. Soil, rocky; 4th rate. Timber, pine and oak. Mountainous or heavily timbered land, 80.15 chs. |
| | August 7, 1893. |
| <hr/> | |
| | From the cor. of secs. 3, 4, 33 and 34, on S. bdy. of the Tp., which is a cedar post, 4 ins. sq., 12 ins. high, marked and witnessed as described by the surveyor general, I run N. 0° 3' W., bet. secs. 33 and 34. Over level land. |
| 2.00 | Creek 14 lks. wide, good water, course S. 65° E. |
| 40.00 | Set a cedar post, 3 ft. long, 3 ins. sq., with quart of charcoal, 24 ins. in the ground, for $\frac{1}{4}$ sec. cor. marked $\frac{1}{4}$ S 34 on E. and 33 on W. face; dig pits, 18×18×12 ins., N. and S. of post, 3 ft. dist., and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, W. of cor. |
| 45.50 | Branch 8 lks. wide, pure water, course N. 60° E.; enter meadow land. |
| 60.00 | Leave meadow land, bears E. and W. |
| 80.00 | Deposit a quart of charcoal 12 ins. in the ground, for cor. of secs. 27, 28, 33, and 34; dig pits, 18×18×12 ins., in each sec., 4 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, over deposit. In SE. pit drive a cedar stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked T 15 N S 27 on NE., R 20 E S 34 on SE., S 33 on SW., and S 28 on NW. face, with 1 notch on S. and 3 notches on E. edge. Land, level. Soil, rich loam; 1st rate. No timber. |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | S. 89° 57' E., on a random line bet. secs. 27 and 34. |
| 40.00 | Set temp. $\frac{1}{4}$ sec. cor. |
| 79.87 | Intersect N. and S. line, 3 lks. S. of the cor. of secs. 26, 27, 34, and 35. Thence I run N. 89° 58' W., on random line bet. secs. 27 and 34. Over level land. |
| 39.93 $\frac{1}{2}$ | Set a limestone, 20×7×5 ins., in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ on N. face; dig pits, 18×18×12 ins., E. and W. of stone, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, N. of cor. |
| 79.87 | The cor. of secs. 27, 28, 33 and 34. Land, level. Soil, sandy loam; 1st rate. No timber. |
| <hr/> | |
| | N. 0° 3' W., bet. secs. 27 and 28. Over level land. |
| 1.70 | Branch 7 lks. wide, good water, course SW. |
| 3.30 | Same branch, 7 lks. wide, course E. |
| 27.40 | Telegraph line, bears E. and W. |
| 30.00 | Road from Mound City to Lake City, bears N. 73° W. and S. 73° E. |
| 32.00 | Road from Mound City to Lake City, bears E. and W. |
| 40.00 | Set a locust post, 3 ft. long, 3 ins. sq., with marked stone, 24 ins. in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ S 28 on W. and 27 on E. face; dig pits, 18×18×12 ins., N. and S. of post, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, W. of cor. |
| 80.00 | Set an oak post, 3 ft. long, 4 ins. sq., with charred stake, 24 ins. in the ground, for cor. of secs. 21, 22, 27 and 28, marked T 15 N S 22 on NE., R 20 E S 27 on SE., S 28 on SW., and S 21 on NW. face, with 2 notches on S. and 3 notches on E. edge; dig pits, 18×18×12 ins., in each sec., 5 $\frac{1}{2}$ ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor. |
| | Land, level. Soil, sandy loam; 1st rate. No timber. |
| <hr/> | |
| | S. 89° 58' E., on a random line bet. secs. 22 and 27. |
| 40.00 | Set temp. $\frac{1}{4}$ sec. cor. |
| 79.89 | Intersect N. and S. line, 2 lks. S. of cor. of secs. 22, 23, 26 and 27. Thence I run N. 89° 59' W., on a true line bet. secs. 22 and 27. Over level land. |
| 39.94 $\frac{1}{2}$ | Set a limestone, 15×8×5 ins., 10 ins. in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ on N. face; dig pits, 18×18×12 ins., E. and W. of stone, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, N. of cor. |
| 79.89 | The cor. of secs. 21, 22, 27, and 28. Land, level. Soil, sandy loam; 1st rate. No timber. |
| <hr/> | |
| | N. 0° 3' W., bet. secs. 21 and 22. Over level land. |
| 13.90 | To the margin of an impassable swamp, bears E. and W. Set a cedar post, 3 ft. long, 3 ins. sq., with marked stone, 24 ins. in the ground, for witness point, marked W P on W. face; dig pits 18×18×12 ins., N. and S. of post, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, W. of cor. |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | To pass the swamp I offset as follows: East 18.00 chs. N. 0° 3' W. 26.10 chs. West, 5.00 chs. to a point on margin of swamp* 13.00 chs. E. of |
| 40.00 | The point for ¼ sec. cor. in swamp. N. 0° 3' W. 19.00 chs. West 13.00 chs. to a point on line bet. secs. 21 and 22; thence, S. 0° 3' E., 5.40 chs., to |
| 53.60 | North side of impassable swamp, on line. Set a juniper post, 3 ft. long, 3 ins. sq., with charred stake, 24 ins. in the ground, for witness cor. to ¼ sec. cor., marked W C ¼ S 22 on E. and 21 on W. face; dig pits, 18×18×12 ins., N. and S. of post, 3 ft. dist.; and raise a mound of earth, 3½ ft. base, 1½ ft. high, W. of cor. Thence, N. 0° 3' W., 26.40 chs., to the point for sec. cor., which falls in Old Military Road, bears N. 55° W. and S. 55° E. Therefore at |
| 79.40 | Set a juniper post, 3 ft. long, 4 ins. sq., with marked stone, 24 ins. in the ground, for witness cor. to cor. of secs. 15, 16, 21 and 22, marked W C T 15 N S 15 on NE., R 20 E S 22 on SE., S 21 on SW., and S 16 on NW. face, with 3 notches on S. and E. edges; dig pits, 18×18×12 ins., NE., SE., SW., and NW. of cor. 5½ ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor. |
| 80.00 | Deposit a quart of charcoal, 24 ins. in the ground, for cor. of secs. 15, 16, 21 and 22. Land, level. Soil, rich loam; 1st rate. No timber. |
| S. 89° 59' E. on a random line bet. secs. 15 and 22. | |
| * * * * * | |
| 0.60 | N. 0° 3' W. bet. secs. 15 and 16. Over level land. Deposit a marked stone, 12 ins. in the ground, for witness cor. to cor. of secs. 15, 16, 21 and 22; dig pits, 18×18×12 ins., NE., SE., SW., and NW. of cor., 4 ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, over deposit. In SE. pit drive a cedar stake, 2 ft. long, 2 ins. sq., 12 ins. in the ground, marked W C T 15 N S 15 on NE. R 20 E S 22 on SE., S 21 on SW., and S 16 on NW. face; with 3 notches on S. and E. edges. |
| 40.00 | Set a cedar post, 3 ft. long, 3 ins. sq., with charred stake, 24 ins., etc. |
| S. 89° 54' E. on a random line bet. secs. 10 and 15. | |
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| N. 0° 3' W. bet. secs. 9 and 10. | |
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* A Witness Corner to the ¼ sec. cor. would be established at this point, in case no witness corner could be placed on line within 20.00 chs. of the ¼ sec. cor.

Subdivision of T. 15 N., R. 20 E.

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| Chains. | S. 89° 59' E. on a random line bet. secs. 3 and 10. * * * * * |
| 40.00 | N. 0° 3' W. on a random line bet. secs. 3 and 4. Set temp. $\frac{1}{4}$ sec. cor. |
| 80.19 | Intersect N. bdy. of the Tp. 2 lks. E. of cor. of secs. 3, 4, 33, and 34, which is a granite stone, 6 × 8 × 4 ins. above ground, marked and witnessed as described by the surveyor general. August 10: At 5 ^b 5 ^m p. m., l. m. t., I set off 45° 50' on the lat. arc; 15° 19' N., on the decl. arc; and determine a meridian with the solar, at the cor. of secs. 3, 4, 33, and 34. Thence I run S. 0° 4' E. on a true line bet. secs. 3 and 4. Ascend spur extending west. |
| 7.00 | Top of spur, 20 ft. above sec. cor., bears E. and W.; descend. |
| 18.00 | Ravine, 20 ft. below top of ridge, course N. 85° W.; ascend spur. |
| 27.00 | Top of spur, 25 ft. above ravine, bears E. and W.; descend. |
| 36.00 | Ravine, 30 ft. below top of ridge, course N. 75° W.; ascend. |
| 37.50 | Enter heavy pine timber. |
| 40.19 | An oak, 9 ins. diam., for $\frac{1}{4}$ sec. cor., I mark $\frac{1}{4}$ S 3 on E. and 4 on W. side; from which A pine, 8 ins. diam., bears S. 14° E., 20 lks. dist., marked $\frac{1}{4}$ S 3 B T. An oak, 10 ins. diam., bears S. 75 $\frac{1}{2}$ ° W., 19 lks. dist., marked $\frac{1}{4}$ S 4 B T. |
| 47.00 | Top of spur, 65 ft. above ravine, bears N. 70° W. and S. 70° E.; descend. |
| 51.00 | Leave heavy pine timber, bears N. 70° W. and S. 70° E. |
| 58.00 | Foot of descent, 20 ft. below top of ridge, bears N. 85° W. and S. 85° E.; ascend. |
| 63.00 | Enter heavy pine timber, bears NW. and E. |
| 65.00 | Top of ridge, 150 ft. above foot of spur, bears E. and W.; descend. |
| 67.50 | Leave heavy pine timber, bears N. 60° W. and S. 60° E.; thence over broken, stony ground. |
| 74.00 | Begin ascent. |
| 80.19 | The cor. of secs. 3, 4, 9 and 10. Land, mountainous. Soil, stony; 4th rate. Timber, pine with some oak. Mountainous or heavily timbered land, 80.19 chs. |
| | August 10, 1893. |
| | This 11th day of August, 1893, I discharge James Banner and employ Edward Ensign, to perform the duties of flagman. No officer authorized to administer oaths, other than myself, being available, without great inconvenience, delay, and expense, I administer the required preliminary and final oaths. ROBERT ACRES, U. S. Deputy Surveyor. |
| | NOTE.—Clear Lake, a body of deep water, more than 25 acres in extent, not drainable or likely to dry up, situated about the middle of sec. 33, I prepare to meander, as follows: The sky is overcast and solar observations are impossible. I find the $\frac{1}{4}$ sec. cor. on S. bdy. of sec. 33, which is a limestone 5 × 8 × 5 ins., above ground, marked and witnessed as described by the surveyor general, on line with the section corners which are visible from said $\frac{1}{4}$ sec. cor.; therefore, from a sight on the SW. cor. of sec. 33, I turn off an angle of 89° 53' to the north, and run N. 0° 3' W., bet. the E. and W. halves of sec. 33. |

Subdivision of T. 15 N., R. 20 E.

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| Chains. 17. 80 20. 42 | <p>Over level land. Enter scattering timber, bears E. and W. To bank of Clear Lake. Set a cedar post, 3 ft. long, 3 ins. sq., 24 ins. in the ground, for special meander cor. of fracl. E. and W. halves of sec. 33, marked S M C on N., T 15 N on S., R 20 E S 33 on E., and S 33 on W. face; from which A maple, 8 ins. diam., bears S. $21\frac{1}{2}^{\circ}$ E., 15 lks. dist., marked T 15 N R 20 E S 33 S M C B T. An ash, 12 ins. diam., bears S. $72\frac{1}{4}^{\circ}$ W., 21 lks. dist., marked T 15 N R 20 E S 33 S M C B T.</p> <p>Land, level. Soil, rich loam; 1st rate. Timber, oak, ash, and maple. NOTE.—At 9 a. m., heavy rain prevents further work this day. August 11, 1893.</p> |
| | <p>August 12: At 7^h 4^m a. m., 1. m. t., I set off $45^{\circ} 45'$ on the lat. arc; $14^{\circ} 51'$ N., on the decl. arc; and determine a meridian with the solar at the cor. of secs. 4, 5, 32, and 33, on the S. bdy. of the Tp., which is a limestone, $6 \times 6 \times 4$ ins., above ground, marked and witnessed as described by the surveyor general. N. $0^{\circ} 4' W.$, bet. secs. 32 and 33. * * * * *</p> |
| | <p>S. $89^{\circ} 57' E.$, on a random line bet. secs. 28 and 33. * * * * *</p> |
| 3. 50 24. 00 | <p>From the $\frac{1}{4}$ sec. cor. bet. secs. 28 and 33, I run S. $0^{\circ} 3' E.$, bet. the E. and W. halves of sec. 33. Over level land. Spring branch, 8 lks. wide, pure water, course S. $80^{\circ} E.$ To bank of Clear Lake. Set a limestone, $20 \times 6 \times 6$ ins., 15 ins. in the ground, for special meander cor. of fracl. E. and W. halves of sec. 33, marked S M C on S. face; dig a pit, $36 \times 36 \times 12$ ins., 8 ft. N. of stone; and raise a mound of earth, 4 ft. base, 2 ft. high, N. of cor. Land, level. Soil, rich loam; 1st rate. No timber.</p> |
| | <p>N. $0^{\circ} 4' W.$, bet. secs. 28 and 29. * * * * *</p> |
| | <p>East, on a random line bet. secs. 21 and 28. * * * * *</p> |
| 40. 00 80. 00 | <p>N. $0^{\circ} 4' W.$, bet. secs. 20 and 21. Set a limestone, $18 \times 6 \times 6$ ins., 12 ins. in the ground, for $\frac{1}{4}$ sec. cor., etc. August 12: At the $\frac{1}{4}$ sec. cor., bet. secs. 20 and 21, I set off $14^{\circ} 46' N.$, on the decl. arc; and, at 12^h 05^m, 1. m. t., observe the sun on the meridian; the resulting lat. is $45^{\circ} 47'$, which is about the proper lat. Set a limestone $18 \times 18 \times 4$ ins., 12 ins. in the ground, for cor. of secs. 16, 17, 20, and 21, marked, etc. August 12, 1893.</p> |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | Heavy rain prevented work until afternoon August 14, 1893. The cor. of secs. 15, 16, 21, and 22, being plainly visible, I run for said cor. from last sec. cor. S. 89° 59' E., on a random line bet. secs. 16 and 21. |
| 12. 90 | To margin of impassable swamp; set a temp. witness point. * Then offset as follows: North, 9.50 chs.; then, on the offset line: S. 89° 59' E., 40.00 chs.; set temp. witness cor. to $\frac{1}{4}$ sec. cor.; S. 89° 59' E., 64.00 chs. (counted from sec. cor.); then South, 9.50 chs. to the random line, on which, at |
| 79. 92 | Intersect N. and S. line at cor. of secs. 15, 16, 21, and 22. Thence I run N. 89° 59' W., on a true line bet. secs. 16 and 21. Over level land. |
| 18. 30 | To margin of impassable swamp. Set a cedar post, 3 ft. long, 3 ins. sq., with charred stake, 24 ins. in the ground, for witness point, marked W P on N. face; dig pits, 18×18×12 ins., E. and W. of post, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, N. of cor. |
| 39. 96 | Thence, offset N., 9.50 chs.; then run on offset line N. 89° 59' W. Set a juniper post, 3 ft. long, 3 ins. sq., with marked stone, 24 ins. in the ground, for witness cor. to $\frac{1}{4}$ sec. cor., marked W C $\frac{1}{4}$ S 16 on N. and 21 on S. face; dig pits, 18×18×12 ins., E. and W. of post, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, N. of cor. |
| 67. 02 | Offset south 9.50 chs., to true line. Set an oak post, 3 ft. long, 3 ins. sq., with quart of charcoal, 24 ins. in the ground, for witness point, marked W P on N. face; dig pits, 18×18×12 ins., E. and W. of post, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, N. of cor. |
| 79. 92 | The swamp can be drained into Lin's Lake. The cor. of secs. 16, 17, 20, and 21. Land, level. Soil, rich loam; 1st rate. No timber. |
| N. 0° 4' W., bet. secs. 16 and 17. | |
| * * * * * | |
| S. 89° 59' E., on a random line bet. secs. 9 and 16. | |
| * * * * * | |
| N. 0° 4' W., bet. secs. 8 and 9. | |
| Over rolling land. | |
| 38. 00 | To S. bank of limestone quarry, bears E. and W. To pass the quarry, I offset 2.00 chs. E., then N. 0° 4' W. on the offset line. |
| 40. 00 | The point for $\frac{1}{4}$ sec. cor. falls in quarry. Continue offset line to 40.60 chs.; then, W. 2.00 chs., to true line. |
| 40. 60 | Set a limestone, 15×9×5 ins., 10 ins. in the ground, for witness cor. to $\frac{1}{4}$ sec. cor. marked W C $\frac{1}{4}$ on W. face; and raise a mound of stone, 2 ft. base, 1 $\frac{1}{2}$ ft. high, W. of cor. Pits impracticable. |
| 66. 00 | Middle of single track of the Montana and Manitoba Railroad, bears N. 42° E. and S. 42° W. |
| 68. 00 | Telegraph line, bears N. 42° E. and S. 42° W. |
| 80. 00 | Set a limestone, 17×9×5 ins., 12 ins. in the ground, for cor. of secs. 4, 5, 8, and 9, marked with 5 notches on S. and 4 notches on E. edge; dig pits, 18×18×12 ins., in each sec., 5 $\frac{1}{2}$ ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor. From this cor. the U. S. mineral monument in sec. 5 bears N. 59 $\frac{1}{2}$ ° W. Soil, thin and gravelly, with many limestone outcrops; 3rd and 4th rate. No timber. |

* When offsets are made from random latitudinal section lines, temporary marks will be left for Witness Points and Witness Corners, as illustrated above.

Subdivision of T. 15 N., R. 20 E.

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| Chains. | <p>August 14: At 4^h 30^m p. m., l. m. t., I set off 45° 49' on the lat. arc; 14° 6' N. on the decl. arc; and determine a meridian with the solar, at the cor. of secs. 4, 5, 8 and 9.</p> <p>Thence I run S. 89° 55' E., on a random line bet. secs. 4 and 9.</p> <p style="text-align: center;">* * * *</p> |
| 40.00 | N. 0° 4' W., on a random line bet. secs. 4 and 5. |
| 79.96 | Set temp. $\frac{1}{4}$ sec. cor. Intersect N. bdy. of the Tp. 2 lks. W. of cor. of secs. 4, 5, 32, and 33. Thence I run S. 0° 3' E., on a true line bet. secs. 4 and 5. Over ridges and ravines; ascend. |
| 4.00 | Top of spur, bears E. and W.; descend. |
| 10.00 | Ravine 20 ft. deep, course E., ascend. |
| 16.00 | Top of spur, 40 ft. above ravine, bears S. 70° E. and N. 70° W.; descend. |
| 27.00 | Ravine, 30 ft. deep, course S. 80° E.; ascend. |
| 32.00 | Top of spur, bears S. 85° E. and N. 85° W.; descend. |
| 37.00 | Ravine, 25 ft. deep, course S. 65° E.; ascend. |
| 39.96 | Set a limestone, 15×6×6 ins., 10 ins. in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ on W. face; and raise a mound of stone, 2 ft. base, 1 $\frac{1}{2}$ ft. high, W. of cor. Pits impracticable. This cor. stands on the NE. slope of a spur descending southeasterly; ascend. |
| 50.00 | Top of spur, bears E. and W., about 35 ft. above $\frac{1}{4}$ sec. cor., bears E. and W.; descend. |
| 55.00 | Ravine, 20 ft. deep, course N. 55° E.; ascend. |
| 62.00 | Top of low spur, bears E. and W.; descend. |
| 74.00 | Foot of slope, bears N. 40° E. and S. 65° W. |
| 79.96 | The cor. of secs. 4, 5, 8, and 9. Land, mountainous. Soil, rocky; 4th rate. No timber. Mountainous land, 74.00 chs. |
| | August 14, 1893. |
| | <p>August 15: At 7^h 35^m a. m., l. m. t., I set off 45° 45' on the lat. arc; 13° 54' N., on the decl. arc; and determine a meridian with the solar at the cor. of secs. 5, 6, 31, and 32; which is a limestone, 5×8×6 ins. above ground, marked and witnessed as described by the surveyor general.</p> <p>Thence I run N. 0° 5' W., bet. secs. 31 and 32. Over level land.</p> |
| 6.50 | Trail, bears E. and W. The SW. cor. of James Parker's Desert Land Claim, which is an oak post, 2 ft. high, 6 ins. sq., marked J P D L C 3, bears N. 49 $\frac{1}{2}$ ° W. The SE. cor. of the same claim, which is a round pine post, 3 ft. high, 6 ins. diam., marked J P D L C 4, bears N. 66° E. |
| 40.00 | Set a locust post, 3 ft. long, 3 ins. sq., with marked stone, 24 ins. in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ S 31 on W., and 32 on E. face; dig pits, 18×18×12 ins., N. and S. of post, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, W. of cor. |
| 80.00 | Set a limestone, 20×7×5 ins., 15 ins. in the ground, for cor. of secs. 29, 30, 31 and 32, marked with 1 notch on S. and 5 notches on E. edge; dig pits, 18×18×12 ins., in each sec., 5 $\frac{1}{2}$ ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor. From this cor. the above described SW. cor. of James Parker's Desert Land Claim bears S. 29 $\frac{1}{4}$ ° W. The NW. cor., which is a post 3 ft. long, 5 ins. sq., marked J P D L C 2, bears N. 42° W. Land, level. Soil, sand; 4th rate. No timber. |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | S. 89° 57' E., on a random line bet. secs. 29 and 32. |
| 40. 00 | Set temp. $\frac{1}{4}$ sec. cor. |
| 79. 97 | Intersect N. and S. line 7 lks. N. of cor. of secs. 28, 29, 32 and 33. Thence I run N. 89° 54' W., on a true line bet. secs. 29 and 32. Over level land. |
| 14. 50 | Begin ascent, bears N. and S. |
| 16. 50 | Top of ascent and edge of sandy plain, bears N. and S. |
| 28. 50 | A fine spring of good water, 3 ft. diam., 1 ft. deep, bears S., 2.50 chs. dist. The NE. cor. of James Parker's Desert Land Claim, a mound of stone, without marks, bears N. 2 $\frac{3}{4}$ ° E. |
| 39. 98 $\frac{1}{2}$ | Set a sandstone, 18×6×5 ins., 12 ins. in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ on N. face; dig pits, 18×18×12 ins., E. and W. of stone, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, N. of cor. From this $\frac{1}{4}$ sec. cor. the SE. cor. of James Parker's Desert Land Claim bears S. 14 $\frac{1}{2}$ ° E. |
| 79. 97 | The cor. of secs. 29, 30, 31, and 32. Land, level. Soil, sand; 4th rate. No timber. |
| The cor. of secs. 25, 30, 31, and 36 on the W. bdy. of the Tp. being plainly visible, I run for said cor. | |
| 40. 00 | N. 89° 57' W., on a random line bet. secs. 30 and 31. Set temp. $\frac{1}{4}$ sec. cor. |
| 78. 35 | Intersect the W. bdy. of the Tp. at the cor. of secs. 25, 30, 31, and 36, which is a mound of earth, with stake and pit, marked and witnessed as described by the surveyor general. Thence I run S. 89° 57' E., on a true line bet. secs. 30 and 31. Over level land. |
| 38. 35 | Set a juniper post, 3 ft. long, 3 ins. sq., with charred stake, 24 ins. in the ground for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ S. 30 on N. and 31 on S. face; dig pits, 18×18×12 ins., E. and W. of post, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, N. of cor. From this $\frac{1}{4}$ sec. cor., the NW. cor. of James Parker's Desert Land Claim bears N. 23° E. |
| 78. 35 | The cor. of secs. 29, 30, 31, and 32. Land, level. Soil, sand; 4th rate. No timber. August 15: At this corner, I set off 13° 50' N. on the decl. arc; and at 12 ^a 4 ^m , l. m. t., observe the sun on the meridian; the resulting lat. is 45° 46'. |
| N. 0° 5' W., bet. secs. 29 and 30. Over level land. | |
| 40. 00 | Deposit a marked stone, 12 ins. in the ground, for $\frac{1}{4}$ sec. cor.; dig pits, 18×18×12 ins., N. and S. of cor., 4 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, over deposit. In S. pit drive a cedar stake, 2 ft. long, 2 ins. sq., marked $\frac{1}{4}$ S 29 on E. and 30 on W. face. From this $\frac{1}{4}$ sec. cor. the NE. cor. of James Parker's Desert Land Claim bears S. 80° E. |
| 56. 00 | Telegraph line, bears E. and W. |
| 59. 00 | Road leading to Lake City and Mound City, bears E. and W. |
| 76. 50 | Begin descent over rocky ground, bears E. and W. |
| 80. 00 | Set a sandstone, 15×8×6 ins., 10 ins. in the ground, for cor. of secs. 19, 20, 29, and 30, marked with 2 notches on S. and 5 notches on E. edge; and raise a mound of stone, 2 ft. base, 1 $\frac{1}{2}$ ft. high, W. of cor. Pits imprac- ticable. This cor. stands on stony ground sloping N., about 25 ft. below level of the plain. |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | S. 89° 54' E., on a random line bet. secs. 20 and 29. * * * * |
| | N. 89° 57' W., on a random line bet. secs. 19 and 30. * * * * |
| | N. 0° 5' W., bet. secs. 19 and 20. Descend over stony ground. |
| 2.00 | Foot of descent, 10 ft. below sec. cor., and 35 ft. below the sandy plain, bears E. and W. Thence gradual descent toward Lin's Lake. |
| 32.50 | Enter scattering timber, bears E. and W. |
| 40.00 | Set a cedar post, 3 ft. long, 3 ins. sq., 24 ins. in the ground, for $\frac{1}{4}$ sec. cor. marked $\frac{1}{4}$ S 19 on W. and 20 on W. face; from which A maple, 22 ins. diam., bears N. 22° W., 19 lks. dist., marked $\frac{1}{4}$ S 19 B T. An ash, 13 ins. diam., bears N. 70 $\frac{1}{2}$ ° E., 28 lks. dist., marked $\frac{1}{4}$ S 20 B T. |
| 44.50 | To bank of Lin's Lake. No stones available. Set a cedar post, 3 ft. long, 4 ins. sq., 24 ins. in the ground, for meander cor. of fracl. secs. 19 and 20, marked M C on N., T 15 N on S., R 20 E S 20 on E., and S 19 on W. face; from which A maple, 8 ins. diam., bears S. 22 $\frac{1}{2}$ ° E., 21 lks. dist., marked T 15 N R 20 E S 20 M C B T. An ash, 12 ins. diam., bears S. 56 $\frac{1}{4}$ ° W., 27 lks. dist., marked T 15 N R 20 E S 19 M C B T. |
| | Land, gently rolling. Soil, mostly rich loam; 1st rate. Timber, maple, ash and oak. August 15, 1893. |
| | August 16: At 7 ^h . 4 ^m . a. m., l. m. t., I set off 45° 48' on the lat. arc; 13° 36' N., on the decl. arc; and determine a meridian at the cor. of secs. 16, 17, 20 and 21; thence I run N. 89° 57' W., on a true line, bet. secs. 17 and 20. Over gently rolling land, descending toward Lin's Lake. |
| 16.40 | Telegraph line, bears N. and S. |
| 20.50 | Road to Lake City, bears N. and S. |
| 30.00 | Irrigating ditch, 8 lks. wide, course S. 60° W. Enter field cultivated by irrigation; extends N., 5.00 chs., and S. about 10.00 chs. |
| 36.50 | Leave field, enter scattering timber, bears N. 65° E. and S. 65° W. |
| 40.00 | Set a cedar post, 3 ft. long, 3 ins. sq., 24 ins. in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ S 17 on N. and 20 on S. face; from which A sycamore, 22 ins. diam., bears N. 22° W., 19 lks. dist., marked $\frac{1}{4}$ S 17 B T. An ash, 13 ins. diam., bears S. 70 $\frac{1}{2}$ ° W., 28 lks. dist., marked $\frac{1}{4}$ S 20 B T. |
| 43.20 | To bank of Lin's Lake. A sycamore, 18 ins. diam., for meander cor. of fracl. secs. 17 and 20, I mark M C on W., T 15 N on E., R 20 E S 17 on N., and S 20 on S side; from which An ash, 10 ins. diam., bears N. 40 $\frac{3}{4}$ ° E., 20 lks. dist., marked T 15 N R 20 E S 17 M C B T. A maple, 9 ins. diam., bears S. 49 $\frac{1}{2}$ ° E., 23 lks. dist., marked T 15 N R 20 E S 20 M C B T. |
| | Land, gently rolling. Soil, rich loam; 1st rate. Timber, ash, maple, and sycamore. |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | From the cor. of secs. 8, 9, 16, and 17, previously set, I run N. 89° 57' W., on a true line, bet. secs. 8 and 17. Over rolling land. |
| 39. 20 | Telegraph line, bears N. 28° W. and S. 28° E. |
| 40. 00 | Set a cedar post, 3 ft. long, 3 ins. sq., with charred stake, 24 ins. in the ground, for $\frac{1}{4}$ sec. cor., marked $\frac{1}{4}$ S 8 on N. and 17 on S. face; dig pits, 18×18×12 ins., E. and W. of post, 3 ft. dist.; and raise a mound of earth, 3 $\frac{1}{2}$ ft. base, 1 $\frac{1}{2}$ ft. high, N. of cor. |
| 55. 00 | Old Military Road, bears NW. and SE. The road branches about 2.00 chs. SE. |
| 60. 00 | Enter road, leading to Lake City, bears W.; thence, along middle of road. |
| 61. 00 | Middle of single track of the Montana and Manitoba Railroad, bears N. 60° E. and S. 60° W. |
| 63. 50 | Telegraph line, bears N. 60° E. and S. 60° W. |
| 80. 00 | The point for sec. cor. falls in wagon road; therefore Deposit a marked stone, 24 ins. in the ground, for corner of secs. 7, 8, 17 and 18. Land, rolling. Soil, sandy loam; 3rd rate No timber. |
| 0. 50 | From the cor. for secs. 7, 8, 17 and 18, which falls in road, I run S. 0° 5' E., bet. secs. 17 and 18. Over rolling land; descending towards Lin's Lake. Set a limestone, 15×8×7 ins., 10 ins. in the ground, for witness cor. to cor. of secs. 7, 8, 17 and 18, marked W C on NE. face; with 4 notches on S. and 5 notches on E. edge; dig pits, 18×18×12 ins., NE., SE., SW., and NW. of cor., 5 $\frac{1}{2}$ ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor. |
| 4. 00 | Telegraph line, bears N. 84° E. and S. 84° W. |
| 5. 20 | Middle of the single track of the Montana and Manitoba Railroad, bears N. 84° E. and S. 84° W. |
| 20. 19 | To bank of Lin's Lake. Set a limestone, 15×9×6 ins., 10 ins. in the ground, for meander cor. of frac. secs. 17 and 18, marked M C on S. face, with 5 grooves on E. face; and raise a mound of stone, 2 ft. base, 1 $\frac{1}{2}$ ft. high, N. of cor. Pits impracticable. Limestone crops out near the lake. Land, rolling. Soil, rocky; 4th rate. No timber. August 16: At this meander cor. I set off 13° 31' N. on the decl. arc; and at 12 ^h 4 ^m p. m., l. m. t., observe the sun on the meridian; the resulting lat. is 45° 48'. |
| 40. 00 | From the cor. of secs. 7, 8, 17 and 18, I run N. 89° 57' W., on a random line bet. secs. 7 and 18. |
| 77. 90 | Set. temp. $\frac{1}{4}$ sec. cor. Intersect W. bdy. of the Tp., 3 lks. S. of the cor. of secs. 7, 12, 13, and 18, which is a limestone, 6×8×6 ins. above ground, marked and witnessed as described by the surveyor general. Thence I run S. 89° 56' E., on a true line bet. secs. 7 and 18. Over gently rolling ground. |
| 17. 90 | Intersect the W. bdy. of Lake City, a townsite. Land already disposed of. Deposit broken glass as a memorial, 12 inches in ground, and set a sandstone 21×9×8 inches, 14 ins. in ground, for closing cor. of secs. 7 and 18, marked C O P L on W. and L C on E. face, from which Foundation stone, nearest corner of J. White's stone house, bears N. 34° E. 1.82 chs. dist., marked B O, with a cross; and hydrant near public school, unmarked, bears S. 22° E. 3.10 chs. |

Subdivision of T. 15 N., R. 20 E.

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| Chains. | The NW. cor. of the town-site, which is an oak post, 2 ft. above ground, 12 ins. sq., marked NW. cor L C bears N. 0° 5' W., 40.00 chs. dist. The SW. cor., which is a limestone, 8×6×6 ins., above ground, marked SW. cor L C bears S. 0° 5' E., 29.50 chs. dist. From closing cor. I continue on a blank line omitting topography, across Lake City. |
| 37.90 | Point for ¼ sec. cor. No corner set. |
| 52.10 | Intersect E. bdy. of Lake City. The NE. cor., which is a limestone, 14×9×7 ins. above ground, marked NE cor L C, bears N. 0° 5' W., 40.00 chs. dist. The SW. cor., which is a limestone, 9×6×6 ins. above ground marked SW cor L C, bears S. 0° 5' E., 7.53 chs. dist. Here set closing cor. of secs. 7 and 18. Deposit cast iron memorial, 25 inches in the ground and set granite stone 26×10×8 ins., 20 ins. in the ground, marked C C P L on E. and L C on W. face, from which NW. cor. of brick factory, marked X and B O bears S. 70° E. 2.15 chs. dist. Thence along the middle of the Mound City road. |
| 77.90 | The cor. of secs. 7, 8, 17, and 18. Land, gently rolling. Soil, sandy loam; 1st rate. No timber. |
| August 16, 1893. | |
| August 17: At 7 ^h 4 ^m a. m., l. m. t., I set off 45° 49' on the lat. arc; 13° 17' N., on the decl. arc; and determine a meridian with the solar, at the point for cor. of secs. 7, 8, 17 and 18, which falls in the road, previously described. Thence I run N. 0° 5' W., bet. secs. 7 and 8. | |
| 0.50 | Set a limestone 15×8×7 ins., 10 ins. in the ground, for witness cor. to cor. of secs. 7, 8, 17 and 18, marked W C on NE. face; with 4 notches on S. and 5 notches on E. edge; dig pits, 18×18×12 ins., NE., SE., SW., and NW. of cor., 5½ ft. dist.; and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor. * * * * * |
| 40.00 | Set limestone, etc. |
| 80.00 | Set a limestone, 20×8×4 ins., 15 ins. in the ground, for cor. etc. |
| S. 89° 57' E., on a random line bet. secs. 5 and 8. * * * * * | |
| N. 89° 56' W., on a random line bet. secs. 6 and 7. * * * * * | |
| N. 0° 5' W., on a random line bet. secs. 5 and 6. * * * * * | |
| 11 a. m., August 17, 1893. | |
| In order to locate Ivy Island, I proceed as follows: I begin at the meander cor. of fracl. secs. 17 and 20, at 12 ^h 45 ^m p. m., which being too near noon to secure accurate results with the solar, I take a back sight on the cor. of secs. 16, 17, 20 and 21, prolong the direction, N. 89° 57' W., bet. secs. 17 and 20, and set a flag on line, at high water mark, on the SE. side of the island. To determine the distance to the flag, I lay off a base line, S. 30° 32' W., 36.00 chs., to a point, at which the angle bet. flag and meander cor. measures 68° 01'; from the flag, the base line subtends an angle of 52° 31'. The sum of the three | |

Subdivision of T. 15 N., R. 20 E.

| | |
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| Chains. | <p>angles is $180^{\circ} 03'$; therefore the corrected angles, taken in the order of their measurement, are, respectively, $59^{\circ} 30'$, $68^{\circ} 00'$, and $52^{\circ} 30'$; and the distance is</p> |
| | $\frac{\sin. 68^{\circ} \times 36}{\sin. 52^{\circ} 30'} \text{ or } \frac{0.9272 \times 36}{0.7934} = 42.07 \text{ chs.}$ |
| | <p>From said meander corner, thence across lake.</p> |
| 36. 80 | <p>The point for cor. of secs. 17, 18, 19, and 20 falls in the lake; thence</p> |
| | <p>N. $89^{\circ} 57'$ W. bet. secs. 18 and 19.</p> |
| 5. 27 | <p>In place of the flag, I</p> |
| | <p>Set a limestone, $15 \times 8 \times 6$ ins., 10 ins. in the ground, for meander cor. of frac. secs. 18 and 19, marked M C on E. face, with 3 grooves on S. face; dig a pit, $36 \times 36 \times 12$ ins., 8 ft. W. of stone, and raise a mound of earth, 4 ft. base, 2 ft. high, W. of cor.</p> |
| | <p>Thence I run</p> |
| | <p>N. $89^{\circ} 57'$ W., on a true line bet. secs. 18 and 19.</p> |
| | <p>Over level land.</p> |
| 9. 38 | <p>Intersect W. shore of island, at high water mark.</p> |
| | <p>Set a limestone, $18 \times 8 \times 5$ ins., 12 ins. in the ground, for meander cor. of frac. secs. 18 and 19, marked M C on W. face; dig a pit, $36 \times 36 \times 12$ ins., 8 ft. E. of stone, and raise a mound of earth, 4 ft. base, 2 ft. high, E. of cor.</p> |
| | <p>August 17, 1893.</p> |
| <p>To locate a small island called Diamond Rock, in Lin's Lake, sec. 19, I proceed as follows:</p> | |
| | <p>From the meander cor. of secs. 19 and 24, on the W. bdy. of the township,</p> |
| | <p>I set a flag on the south point of the island, which bears N. $71^{\circ} 30'$ E.;</p> |
| | <p>then measure a base S. $48^{\circ} 01'$ E., 23.14 chs., to a point from which</p> |
| | <p>the flag bears N. 8° E.; which gives for the distance from M. C. to flag</p> |
| | $\frac{\sin. 56^{\circ} 01' \times 23.14}{\sin. 63^{\circ} 30'} \text{ or } \frac{0.8292 \times 23.14}{0.8949} = 21.44 \text{ chs., the required distance.}$ |
| 21. 44 | <p>In place of the flag, I</p> |
| | <p>Set a limestone, $15 \times 8 \times 6$ ins., 12 ins. in the ground, for an auxiliary meander cor. in sec. 19, marked A M C on S. face; dig a pit, $36 \times 36 \times 12$ ins., 8 ft. N. of stone, and raise a mound of earth, 4 ft. base, 2 ft. high, N. of cor.</p> |
| | <p>August 17, 1893.</p> |

*Meanders, T. 15 N., R. 20 E.**Meanders of the right bank of Yellowstone River, up stream.*

I commence at the meander cor. of fracl. secs. 25 and 30, on the E. bdy. of the Tp., which is a sandstone, 6×9×7 ins. above ground, marked and witnessed as described by the surveyor general.

At this cor., August 8, I set off 45° 46' on the lat. arc: 16° 1' N., on the decl. arc; and at 7^h 35^m a. m., l. m. t., determine a meridian with the solar.

Thence I run with meanders in sec. 25.

Through heavy timber.

S. 85° W. 13.00 chs. Bank 20 ft. high.

S. 72° W. 7.10 " Bank 9 ft. high.

S. 64½° W. 13.00 "

S. 40° W. 5.40 " Low bank 5 ft. high. At 1.00 ch., leave heavy timber, enter dense willow and cottonwood undergrowth, bears S.

S. 77¾° W. 7.00 " At 3.20 chs., mouth of Cherry Creek, 14 lks. wide, course N.

N. 76° W. 7.50 " Bank 7 ft. high. At 2.00 chs., leave dense undergrowth, enter heavy timber, bears S.

S. 80° W. 12.00 " At end of course, lower end of sand bar bears N., 2.00 chs. dist.

S. 81° W. 19.39 " Bank 4 ft. high. At 5.00 chs. leave heavy, enter scattering timber, bears S. To the meander cor. of fracl. secs. 25 and 26.

Land, river bottom.

Soil, alluvial; 1st rate.

Timber, cottonwood, sycamore, ash, and walnut.

Land heavily timbered or covered with dense undergrowth, 70.00 chs.

Thence in sec. 26.

Through scattering timber.

S. 81° W. 8.70 chs. Bank 8 ft. high.

S. 70¾° W. 4.90 " At 2.30 chs., upper end of bar bears N. about 2.00 chs. dist.

S. 44¾° W. 3.60 "

S. 21° W. 3.50 "

S. 5¼° W. 4.20 "

South 4.30 "

S. 9¼° E. 3.80 "

S. 34¾° E. 5.27 " To meander cor. of fracl. secs. 26 and 35.

Land, level.

Soil, alluvial; 1st rate.

Timber, scattering ash, hickory, walnut, and cottonwood.

Thence in sec. 35.

August 8: At the meander cor. of fracl. secs. 26 and 35, I set off 15° 57' N., on the decl. arc; and at 12^h 5^m p. m., l. m. t., observe the sun on the meridian; the resulting lat. is 45° 46'.

Through scattering timber.

S. 28° E., 8.80 chs. Bank 8 ft. high.

S. 0¾° E., 7.70 " At 4.30 chs., leave scattering timber, enter dense cottonwood and willow undergrowth, bears N. 60° E.

S. 6¼° W. 10.00 " Low bank 4 ft. high. At end of course, road to Mound City, bears S. 70° E. Ferry, and road to Lake City, bears N. 75° W.

*Meanders, T. 15 N., R. 20 E.**Meanders of the right bank of Yellowstone River, up stream.*

| | | | |
|---------|----------|---|--|
| S. 31° | W. 12.00 | “ | At 5.50 chs. leave dense undergrowth, bears N. 65° E.; enter Pat Curran's field, bears E. At end of course, house bears S. 62° E., 5.00 chs. dist. |
| S. 38° | W. 5.50 | “ | Bank 13 ft. high. At 5.10 chs., leave Pat Curran's field, fence bears E. At 5.30 chs. middle of road, bears E. |
| S. 43½° | W. 7.70 | “ | At 1.50 chs., NW. cor. of Alexander's field, bears E., 0.50 chs. dist. |
| S. 47½° | W. 6.50 | “ | |
| S. 37½° | W. 2.00 | “ | |
| S. 58° | W. 2.10 | “ | |
| S. 42½° | W. 5.40 | “ | At 3.30 chs., wire fence, bears SE. |
| S. 47° | W. 4.80 | “ | |
| S. 50° | W. 4.90 | “ | |
| S. 57° | W. 9.50 | “ | |
| S. 48½° | W. 16.68 | “ | To meander cor. of frac. secs. 2 and 35, on S. bdy. of the Tp., which is a limestone 5×8×6 ins. above ground, marked and witnessed as described by the surveyor general. |

Land, nearly level.

Soil, alluvial; 1st rate. Land north of Curran's field subject to inundation, 2 to 5 ft. deep.

Timber, scattering ash, walnut, and cottonwood.

Dense undergrowth, 18.90 chs.

August 8, 1893.

Meanders of the left bank of Yellowstone River, down stream.

I commence at the meander cor. of frac. secs. 2 and 35, on the S. bdy. of the Tp., which is a limestone 6×7×5 ins. above ground, marked and witnessed as described by the surveyor general.

At this cor., August 9, I set off 45° 45' on the lat. arc; 15° 44' N., on the decl. arc; and at 7^h 5^m a. m., l. m. t., determine a meridian with the solar.

Thence I run with meanders in sec. 35.

Over level bottom land.

| | | | |
|---------|----------|------|---|
| N. 38½° | E. 9.10 | chs. | Bank 12 ft. high. From the meander cor. the S. end of sand ridge in sec. 34, bears N. 16½° W. |
| N. 31½° | E. 20.00 | “ | At end of course, NE. end of sand ridge bears N. 3° E. |
| N. 51° | E. 14.00 | “ | Sand ridge parallel to river, bears NW., about 25 chs. dist. |
| N. 61½° | E. 15.00 | “ | At end of course, S. end of sand ridge bears S. 87½° W. NE. end bears N. 64° W. |
| N. 35½° | E. 7.50 | “ | |
| N. 42° | E. 9.40 | “ | |
| N. 19° | E. 7.10 | “ | At end of course, road to Lake City, bears N. 83° W. Ferry landing here. |
| N. 5½° | W. 8.90 | “ | Bank 9 ft. high. At 1.50 chs. enter scattering timber, bears NW. |
| N. 29° | W. 12.95 | “ | To the meander cor. of frac. secs. 26 and 35. |

Land, level.

Soil, sandy loam; 1st and 2nd rate.

Timber, scattering ash, cottonwood, and sycamore.

*Meanders, T. 15 N., R. 20 E.**Meanders of the left bank of Yellowstone River, down stream.*

August 9: At this meander cor. I set off $15^{\circ} 39' N.$, on the decl. arc; and at $12^h 05^m$, l. m. t., observe the sun on the meridian: the resulting lat. is $45^{\circ} 48'$, the true lat., nearly.

Thence in sec. 26.

Through scattering timber.

N. $22\frac{1}{2}^{\circ}$ W. 6.00 chs. Bank 12 ft. high.

N. $9\frac{1}{2}^{\circ}$ W. 6.40 "

North 8.60 " At 6.00 chs. leave scattering timber, bears W.; thence over sandy loam.

N. $11\frac{1}{2}^{\circ}$ E. 7.50 "

N. 25° E. 7.00 "

N. 40° E. 7.60 " Bank 15 ft. high.

N. 57° E. 5.70 "

N. $69\frac{1}{2}^{\circ}$ E. 7.90 " At 4.40 chs. enter scattering timber, bears N. Along the last six courses the bank is rapidly wearing away by action of the current which sets strong against the bank.

N. $74\frac{1}{2}^{\circ}$ E. 7.40 "

N. $76\frac{1}{2}^{\circ}$ E. 6.81 " To the meander cor. of fracl. secs. 25 and 26.

Land, level.

Soil, alluvial; 1st and 2nd rate.

Timber, scattering cottonwood, sycamore and black walnut.

Thence in sec. 25.

Through scattering timber.

S. $86\frac{1}{2}^{\circ}$ E. 9.70 chs. Bank 12 ft. high.

S. 74° E. 10.00 "

S. $82\frac{1}{2}^{\circ}$ E. 6.00 " At 5.00 chs. leave scattering timber, bears NW.

N. $82\frac{1}{2}^{\circ}$ E. 8.00 " At end of course, wire fence, bears N. 60° W.

N. $69\frac{1}{2}^{\circ}$ E. 7.30 " Bank 7 ft. high.

N. 61° E. 4.10 " At 2.90 chs., mouth of short creek, 10 lks. wide, course S. 30° E.

N. $53\frac{1}{2}^{\circ}$ E. 8.30 "

N. $66\frac{1}{2}^{\circ}$ E. 10.00 "

N. $77\frac{1}{2}^{\circ}$ E. 5.50 " Bank 9 ft. high.

N. 89° E. 13.00 "

N. 35° E. 3.79 " Bank 11 ft. high. To meander cor. of secs. 25 and 30 on E. bdy. of the Tp., which is a cedar post, 1 ft. high, 4 ins. sq., marked and witnessed as described by the surveyor general.

August 9, 1893.

Meanders of Clear Lake in Sec. 33.

I commence at the special meander cor. bet. the E. and W. halves of sec. 33, on the N. side of the lake.

Thence I run with meanders in E. $\frac{1}{2}$ of sec. 33.

Over rolling ground.

S. 53° E. 17.00 chs. Bank 10 ft. high. At 11.00 chs. enter scattering timber, bears NE.

S. 3° E. 13.00 " Bank 8 ft. high. At 12.50 chs. leave scattering timber, bears NE.

S. $0\frac{1}{2}^{\circ}$ W. 7.20 " At end of course, outlet of lake, 10 lks. wide, course SE.

S. 70° W. 15.11 " At 2.00 chs., enter scattering timber, bears S. To the special meander cor. bet. E. and W. halves of sec. 33, on S. side of the lake.

*Meanders, T. 15 N., R. 20 E.**Meanders of Clear Lake in Sec. 33.*

Thence in W. $\frac{1}{2}$ of sec. 33.

N. $63\frac{1}{4}^{\circ}$ W. 10.00 chs. Bank 8 ft. high. At 7.00 chs. leave scattering timber, bears SW.

N. 13° W. 21.00 " Bank 6 to 7 ft. high. At end of course, stream of clear, pure water, 8 lks. wide, enters lake, course S. 70° E. Along this line I discovered remarkable fossil remains of animals, well worth the attention of naturalists.

N. 52° E. 17.34 " Bank 7 to 10 ft. high, enter scattering timber. At 8 chs., leave scattering timber, bears W. To special meander cor. on N. side of lake.

This is a beautiful lake of pure, clear water, with well-defined banks, 6 to 10 ft. high. Water about 14 ft. deep.

Land, rolling.

Soil, 1st rate.

Timber, scattering maple, oak, and elm.

August 12, 1893.

Meanders of the east end of Lin's Lake, in Secs. 17, 18, 19, and 20.

I commence at the meander cor. on W. bdy. of the Tp., which is a limestone $6 \times 8 \times 4$ ins., above ground, marked and witnessed as described by the surveyor general.

August 18: At $8^h 4^m$ a. m., l. m. t., I set off $45^{\circ} 48'$ on the lat. arc; $12^{\circ} 56' N.$, on the decl. arc; and determine a meridian with the solar, at the above described meander corner.

Thence I run with meanders in sec. 19.

Along gravelly beach.

S. 56° E. 7.20 chs.

S. $46\frac{1}{2}^{\circ}$ E. 3.40 "

S. 44° E. 2.40 "

S. $43\frac{1}{2}^{\circ}$ E. 5.70 "

S. $45\frac{1}{2}^{\circ}$ E. 4.40 "

S. $44\frac{1}{2}^{\circ}$ E. 5.80 "

S. $45\frac{1}{2}^{\circ}$ E. 2.00 "

S. $49\frac{1}{2}^{\circ}$ E. 4.00 "

S. $54\frac{1}{2}^{\circ}$ E. 5.00 "

S. $67\frac{1}{2}^{\circ}$ E. 2.00 "

S. $77\frac{1}{2}^{\circ}$ E. 6.60 "

N. $85\frac{1}{2}^{\circ}$ E. 2.00 "

N. $77\frac{1}{2}^{\circ}$ E. 11.00 " At 6.50 chs., A. J. Smith's house bears S. 15° E., 1.00 ch. dist.

S. $77\frac{1}{2}^{\circ}$ E. 7.20 " At beginning of course enter scattering timber, bears SE.

S. 74° E. 21.11 " To the meander cor. of fracl. secs. 19 and 20.

Land, level.

Soil, away from the beach, sandy loam, 2nd rate.

Timber, maple, ash, and oak.

August 18: At this meander cor. I set off $12^{\circ} 52' N.$, on the decl. arc; and at $12^h 4^m$ p. m., l. m. t., observe the sun on the meridian; the resulting lat., $45^{\circ} 47'$.

*Meanders, T. 15 N., R. 20 E.**Meanders of the east end of Lin's Lake, in Secs. 17, 18, 19, and 20.*

Thence in sec. 20.

Along gravelly beach, through scattering timber.

S. $89\frac{3}{4}^{\circ}$ E. 6.10 chs.

N. 57° E. 12.00 " At 5.00 chs., leave scattering timber.

N. $37\frac{1}{4}^{\circ}$ E. 10.50 "

N. 46° E. 5.00 " At end of course enter scattering timber, bears E.

N. $23\frac{1}{4}^{\circ}$ E. 9.90 "

N. $39\frac{3}{4}^{\circ}$ E. 10.48 " To the meander cor. of fracl. secs. 17 and 20.

Land, level.

Soil, gravelly on beach; away from beach rich loam; 1st rate.

Timber, maple, ash, oak, and sycamore.

August 18, 1893.

August 19: At 7^h 3^m a. m., l. m. t., I set off $45^{\circ} 48'$ on the lat. arc; $12^{\circ} 38'$ N., on the decl. arc; and determine a meridian at meander cor. of fracl. secs. 17 and 20.

Thence in sec. 17.

Along gravelly beach, through scattering timber.

N. 19° E. 10.00 chs.

N. $15\frac{3}{4}^{\circ}$ E. 10.00 " At 6.50 chs., mouth of branch 7 lks. wide, the outlet of pond in sec. 16.

N. 80° W. 6.00 "

N. $68\frac{1}{4}^{\circ}$ W. 7.10 "

N. 88° W. 6.70 " At end of course, leave scattering timber, bears NE.

N. $38\frac{1}{4}^{\circ}$ W. 9.50 " At end of course, fence, bears N. 43° E.; enter irrigated field.

N. $27\frac{1}{4}^{\circ}$ W. 5.00 "

N. $27\frac{1}{4}^{\circ}$ W. 8.00 "

N. $10\frac{1}{4}^{\circ}$ W. 6.00 "

N. $38\frac{1}{2}^{\circ}$ W. 2.80 "

N. $46\frac{1}{4}^{\circ}$ W. 9.50 " At 2.00 chs., leave irrigated field, bears N. 43° E.

N. $33\frac{1}{2}^{\circ}$ W. 3.74 " To meander cor. of fracl. secs. 17 and 18.

Land, level.

Soil, gravelly on beach; away from beach, rich loam, rocky near meander cor.; 1st and 3rd rate.

Timber, maple, ash, oak, and sycamore.

Thence in sec. 18.

Along gravelly beach.

N. $38\frac{3}{4}^{\circ}$ W. 15.00 chs. Bank 6 ft. high.

N. $63\frac{3}{4}^{\circ}$ W. 5.00 " At end of course, middle of main track of Montana and Manitoba Railroad, 70 lks. N.

S. 84° W. 13.00 " Bank 8 ft. high. At 12.00 chs., SE. cor. of Lake City. Thence on a blank line along water front of deeded townsite, omitting topography.

S. $64\frac{1}{4}^{\circ}$ W. 19.00 "

S. 43° W. 13.00 "

S. $55\frac{1}{4}^{\circ}$ W. 4.00 "

S. $74\frac{3}{4}^{\circ}$ W. 4.70 "

S. 79° W. 5.60 "

S. $86\frac{1}{4}^{\circ}$ W. 12.31 " Bank 5 ft. high. At 0.42 chs., SW. cor. of Lake City. Enter public land.

To the meander cor. of fracl. secs. 13 and 18, on W. bdy. of the Tp. which is a juniper post, 1 ft. high, 4 ins. sq., marked and witnessed as described by the surveyor general.

Land, gently rolling.

Soil, sandy loam; 1st rate. No timber.

I return to the meridian established Aug. 4 from Polaris. At 4 p. m. I set off $-\circ -'$ on the decl. arc, and test the adjustment of my solar, finding it gives the same meridian as before, and adjustments correct.

August 19, 1893.

*Meanders, T. 15 N., R. 20 E.**Meanders of Ivy Island in Secs. 18 and 19.*

I commence at the meander cor. of fracl. secs. 18 and 19, on the east side of the island.

August 17: At 3 p. m., l. m. t., I set off $45^{\circ} 48'$ on the lat. arc; $13^{\circ} 9' N.$, on the decl. arc; and determine a meridian at this meander cor.

Thence I run with meanders in sec. 19 along gravelly beach.

S. $47\frac{1}{4}^{\circ}$ W. 2.50 chs. Low bank, 2 ft. high.

N. 52° W. 2.82 chs. To meander cor. bet. fracl. secs. 18 and 19.

Soil, gravel; off beach, loam, 1st rate. No timber.

Thence in sec. 18.

Along gravelly beach.

N. $5\frac{1}{2}^{\circ}$ W. 2.90 chs.

N. 35° W. 1.60 " Row of 2 cottages and pavilion, parallel to beach, 1.50 chs. dist.

S. $45\frac{1}{4}^{\circ}$ W. 1.40 " At beginning of course, hotel bears N. 30° W.; at end of course, cottage bears N. 30° W., 2.00 chs. dist.

S. 56° W. 2.30 " Row of cottages, parallel to beach, 2.00 chs. dist.

N. $73\frac{1}{4}^{\circ}$ W. 4.50 "

N. 38° W. 6.40 " At 2.00 chs., bank 3 ft. high; at 3.00 chs., bank 15 ft. high; narrow rocky beach.

N. 12° E. 4.20 " Bank, 25 ft. high; large rocks along narrow beach.

N. $59\frac{1}{4}^{\circ}$ E. 5.30 " Bank, rock nearly vertical, 35 ft. high; narrow beach of rock and gravel.

East 2.60 "

S. 36° E. 3.80 " At end of course, bank, 30 ft. high; narrow beach of rock and gravel.

S. $56\frac{1}{4}^{\circ}$ E. 6.40 " At 2.00 chs., bank 9 ft. high; at 3.00 chs., 5 ft. high. Scattering timber off beach.

S. 29° E. 7.00 " Low bank 4 ft. high. Scattering timber off beach.

S. $47\frac{1}{4}^{\circ}$ W. 3.40 " To the meander cor. of fracl. secs. 18 and 19.

Land, high on north part of island, low on SE. part.

Soil, rich loam on east end; stony on west end of island; 1st and 3d rate.

Timber, oak, maple, and ash; undergrowth on west end of island, hazel bushes and tangle of grape vines and wild ivy on the high ground; a few scattering water elms and sycamores on low part of island.

August 17, 1893.

Meanders of a small island, called Diamond Rock, in Sec. 19.

I commence at the auxiliary meander cor. on south side of the island.

Thence with meanders in sec. 19.

N. $16\frac{1}{2}^{\circ}$ W. 2.70 chs.

N. $61\frac{1}{4}^{\circ}$ E. 2.90 "

S. $48\frac{1}{4}^{\circ}$ E. 3.50 "

S. $27\frac{1}{2}^{\circ}$ W. 2.20 "

N. 85° W. 3.30 " To auxiliary meander cor. and place of beginning.

Land, level.

Soil, gravelly loam; 3rd rate.

No timber.

This island is about 4 ft. above the water, not subject to inundation; has no vegetation, except grass; and is without improvements.

August 17, 1893.

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 in the central part of the township 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 is an arid plain, and irrigation will be necessary.

Cottonwood, sycamore, ash, and other kinds of timber are found along the Yellowstone River, and scattered along the creeks. The Little Snowy Mountains are covered with a dense growth of pine, oak, and fir timber, many of the trees being very large.

There is one limestone quarry in secs. 8 and 9 which affords excellent building stone, 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, and gold in secs. 4 and 5.

The township is well watered by the Yellowstone River, which runs through the southeastern portion, and by many small springs and brooks. The eastern end of Lin's Lake, comprising only a small portion thereof, is included in this township. This lake is about 10 miles long, and its greatest width is about 4 miles. The water is clear and pure, and varies in depth from 10 to 200 feet.

Ivy Island, in Lin's Lake, contains nearly seventeen acres of land. About the middle of the island is a fine large spring of pure, cold water, which supplies the hotel and cottages situated on the south shore. This island is a favorite resort for residents of Lake City and the surrounding country.

The town of Lake City, the county seat of Humboldt County, contains a courthouse, three 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. 16, 17, 19, and 25.

James Parker's desert-land claim in sec. 32 may be irrigated by an artesian well, which is now being driven.

ROBERT ACRES,
U. S. Deputy Surveyor.

(NOTE: At the end of each book of field notes, or each set of books forming the returns of a deputy's survey, the list of names and duties of his assistants, and the final oaths of the deputy and his assistants, will be attached, in conformity to the model shown with the survey of the third standard parallel, on page 144. When the returns shall have been found correct by the surveyor general, he will append to each of the original field books 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, December 1, 1893.

The foregoing field notes of the survey of [here describe the survey], executed by Robert Acres under his contract No. 87, dated March 22, 1893, having been critically examined, and 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.

SURVEYS OF PRIVATE LAND CLAIMS.

372. 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 full at the commencement of the field notes of such survey.

373. 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.

374. In all matters concerning the obtaining of true meridians and recording true courses of lines, the instructions given in previous pages are to govern the survey of private land claims.

375. 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.

376. 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.

377. At the beginning point upon the 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 or chiseled.

378. 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.

379. 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. (See definition of meander lines, section 153.)

380. 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.

381. As far as practicable, bearings and distances must be taken from each of the corners or stations to two or more rocks or 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.

Witness corners will be established, where necessary, in the same manner as required in the instructions for the survey of public lands.

382. In all cases where the lines of the grant boundary surveys intersect 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 reestablished.

383. 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.

384. 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 reestablish the same.

385. The field notes must embrace a full, clear, and concise statement of the deputy's reasons for his location and establishment of each boundary.

386. 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.

The deputy must particularly note all facts relative to present inhabitancy of the land and designate all tracts occupied by actual settlers or residents.

387. 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.

388. 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.

389. The deputy will note all objections to his survey that may be brought to his knowledge, and the surveyor general will promptly report to the Commissioner of the General Land Office all complaints made to him, and send up all protests filed in his office, together with a full report thereon.

390. Official plats, copies or tracings of the survey of private land claims will not be furnished to any person until the cost of surveying and platting the same shall have been paid to the United States.

APPENDIX RELATIVE TO ACCOUNTS FOR SURVEYING AND EXAMINATION.

391. U. S. surveyors general and deputy surveyors are required to comply strictly with the following instructions:

All surveying accounts transmitted to the General Land Office for adjustment must be in duplicate and in a separate letter from that forwarding the plats and field notes of the survey. The name of the deputy surveyor, date and number of the contract, the amount of the estimated liability, and whether said liability is limited or not, should be noted on the face of the deputy's account.

The amount of the account and the appropriation from which it is to be paid should be stated both in the letter of transmittal and in the account rendered. The deputy's affidavit that the survey was executed by him, and that it was just and correct, should be attached to the account.

The date of the surveyor general's approval should appear in the certificate thereto, and the destination of the draft or drafts, the name of the payee or payees, with the post-office address, should be added.

392. When the survey is chargeable to "Deposits by individuals for surveying the public lands," it should be so stated, and the deposit to which the field work is chargeable should be listed by number and date of certificate of deposit, with number of township and range for which the deposit is made, and the amount of each certificate.

When the amount of an account is in excess of the liability of the contract, a copy of office letter authorizing the excess must always accompany the account.

393. When stating an expense account for examination in the field or office on surveys, the number of the contract under which the survey was made, the name of the surveyor, with the number of township and range examined, should be inserted in the account, accompanied by a copy of letter of authorization, said account and vouchers to be furnished in duplicate and to have the affidavit of the examiner as to the correctness of the charges and the approval of the surveyor general attached.

394. When surveys are continued and executed beyond the time limited in the contract and the contract has expired, and there has been no properly-granted extension of time thereto, the compensation of the deputy surveyor for the lines of survey executed after the expiration of the contract will be reduced, and said lines completed at such rates as the Commissioner of the General Land Office may in his judgment determine to be proper, taking into consideration the value of the work and the limitations of the appropriation from which the account must be paid.

395. The field notes of a U. S. deputy surveyor, which are the data upon which his surveying account is stated by the surveyor general, and subsequently adjusted by the Commissioner of the General Land Office, should describe the surface, soil, etc., at the end of each mile or fractional mile of survey, and should state the number of chains and links which are "mountainous," "heavily timbered," or covered with "dense undergrowth," using always the exact phraseology of the appropriation act which establishes the rates for said lines of surveys.

By dense undergrowth is meant thick bushes, boughs, or other vegetable growth of such height as to obstruct the use of the transit, and require cutting away to obtain sights along line; also bushes, brush, vines or other vegetation which is of such tangled and difficult character as to seriously impede the work of chaining the line.

Connecting lines, showing closing distances to closing corners, will be paid for at the minimum rate allowed in the contract for that class of line which is run to the closing corner, unless otherwise specially provided in the contract.

396. The practice of allowing deputies to retrace any and all lines which they may deem necessary in connection with their work, and compensating them therefor, has been modified by a circular to surveyors general, issued June 15, 1898, regarding resurveys and retracements.

If it becomes necessary to retrace any of the exterior lines in order to properly close their lines of survey, it must be done at the deputy's own expense as a legitimate contingent in executing the contract. If it should be found to be absolutely necessary to resurvey and retrace any portion of the exterior township lines, except such as are clearly provided for in the articles on pages 78 to 82, and in the circular on retracements, above referred to, the deputy should report the facts immediately to the surveyor general and await further instructions. The facts as reported to him will be promptly laid before the Commissioner of the General Land Office, specifying the number of miles of retracement required, and, if such resurvey is authorized, the deputy will be immediately notified. In no other case will any resurvey be paid for which is not specifically authorized by the Commissioner.

397. The surveyor general will furnish the deputy, before taking the field, full instructions as a part of his contract, in the matter of resurveys and retracements.

PROCEDURE OF COUNTY AND PRIVATE SURVEYORS IN RESTORING LOST AND OBLITERATED CORNERS AND SUBDIVIDING SECTIONS.

398. The General Land Office assumes no control or direction over the acts of local and county surveyors in the reestablishment of extinct corners of original surveys, nor will it issue to them instructions in such cases. It follows the general rule that disputes, arising from uncertain or erroneous location of corners, originally established by the United States Government, are to be settled by the proper local authorities or by amicable adjustment; and to aid in this result it furnishes a circular pamphlet which the office desires to be considered as merely advisory and explanatory of the principles which should prevail in performing such duties.

399. The proper or equitable position of any boundary line between the claims of persons, where the lands have been disposed of, is beyond the jurisdiction of the General Land Office, especially where the line is affected by corners established since the original survey, by county surveyors or others, and not directly authorized by that office.

400. Surveyors who have been United States deputies should bear in mind that in their private capacity they must act under somewhat different rules of law from those governing original surveys, and should carefully distinguish between the provisions of the statute which guide a Government deputy and those which apply to retracement of lines once surveyed. The failure to observe this distinction has been prolific of erroneous work and injustice to land owners.

The circular on "Restoration of lost and obliterated corners, and subdivision of sections," mentioned above, dated March 14, 1901, is furnished to applicants.

DEPARTMENT OF THE INTERIOR,
Washington, December 30, 1901.

Approved:

E. A. HITCHCOCK,
Secretary

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