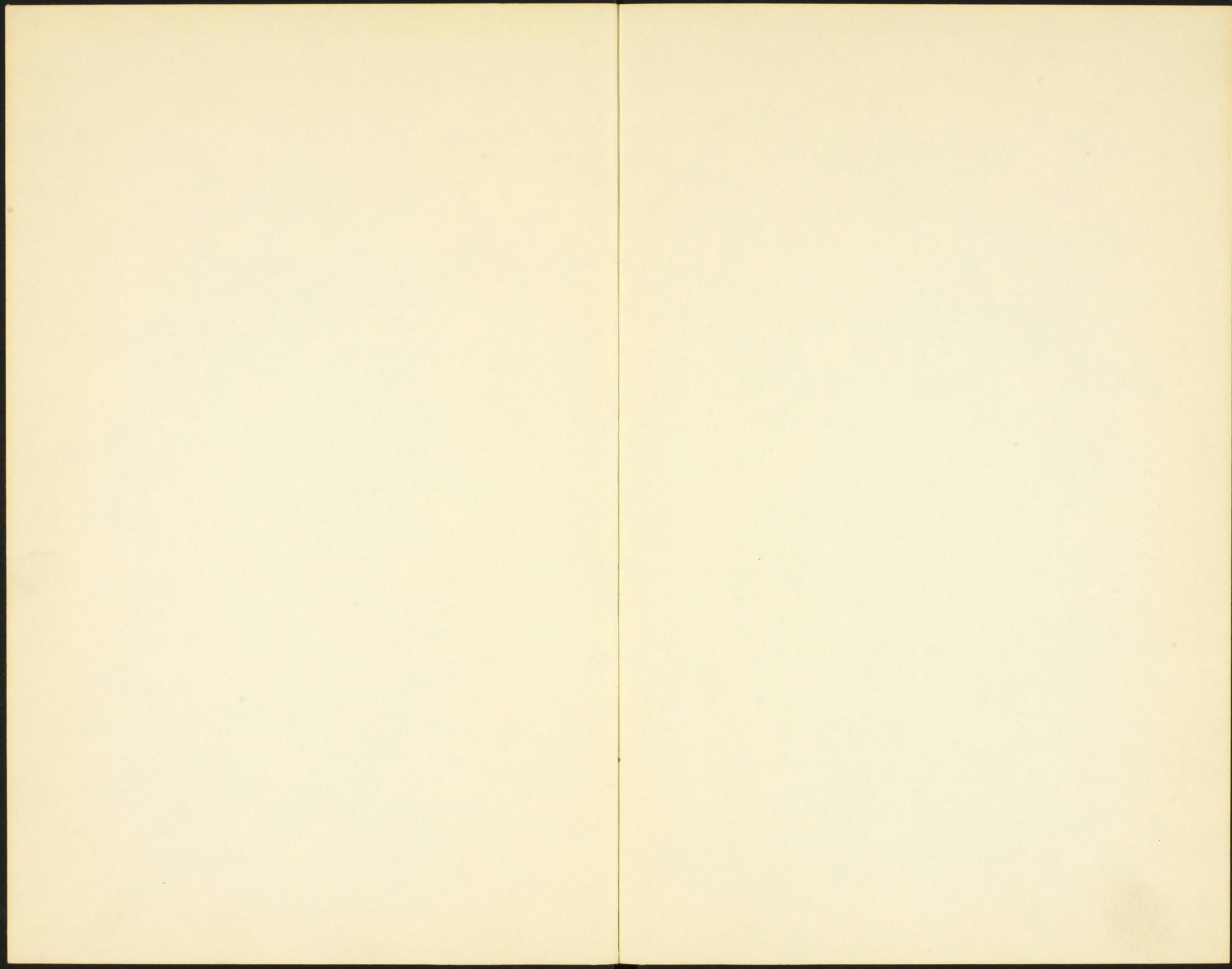


240 47

SURVEY OF DOMINION LANDS

6 S-P E C I A L





*Thomas Shanks*

*5/11/06*

DOMINION OF CANADA

**24047**

AMENDMENTS AND CORRECTIONS

TO THE

**MANUAL OF INSTRUCTIONS**

FOR THE

**SURVEY OF DOMINION LANDS**

1906



OTTAWA

GOVERNMENT PRINTING BUREAU

1906

Orders in Council dated  
the third day of February, 1903,  
the nineteenth day of February, 1904  
and the eleventh day of April, 1905.

new O. in C. - 12<sup>th</sup> May, 1908.

P.M.C. 10/5/07  
Mentioned in 47A-25-2  
in 46-25A-2?

Local board, ration and camp allowance.

Surveyor - \$2.35  
Assistant - 0.90  
Labourer - 0.65

Orders in Council } 12<sup>th</sup> May 1908  
                          } 6<sup>th</sup> Dec., 1909

*W.B. Symes*

DOMINION OF CANADA

AMENDMENTS AND CORRECTIONS

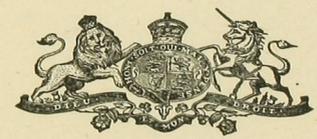
TO THE

# MANUAL OF INSTRUCTIONS

FOR THE

## SURVEY OF DOMINION LANDS

1906



OTTAWA  
GOVERNMENT PRINTING BUREAU

1906

AMENDMENTS  
TO THE  
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SURVEY OF DOMINION LANDS

14. In the survey of any township outlines or the subdivision of any township, the surplus or deficiency found on meridians when closing on the correction line is left in the last quarter-section adjoining said line; except on meridians closing on the first correction line, on which meridians the quarter-sections adjoining the correction line are given the theoretical depth of forty chains, the deficiency or surplus, as the case may be, being left in the quarter-sections adjoining the first base line or international boundary.

63. For the purposes of these instructions, the terms 'azimuth' and 'bearing' have the following meaning:—

The azimuth of a point B from another point A is the angle formed by the vertical plane containing A and B with the plane of the astronomical meridian passing through A, such angle being reckoned from north, round either east or west, to  $180^\circ$ . It follows that, except in the case of a meridian or the equator, the azimuth of a straight line changes as the initial point moves along the line and that a direction is not defined by an azimuth unless the initial point is specified or implied.

The bearing of a point B from another point A is the angle formed by the vertical plane containing A and B with the plane of a fixed astronomical meridian, which may or may not be the astronomical meridian passing through A, such angle being reckoned from north, round through east, south and west, to  $360^\circ$ , east being  $90^\circ$ , south  $180^\circ$ , west  $270^\circ$ , and north  $360^\circ$  or  $0^\circ$ . It follows that a straight line has the same bearing at all its points, but except in the case of a meridian or the equator, a direction is not defined by a bearing unless the meridian to which the bearing is referred is specified or implied.

Apart from the mode of reckoning the angle, the difference between the azimuth and the bearing of a line is that the azimuth is the angle of the line with the meridian of its initial point, while the bearing is the angle of the line with the meridian adopted for reference of all the bearings of the survey.

85. The meridian is carried only as far as the correction line where a temporary post is left. The corresponding meridian is then surveyed from the township corner on the next base to the same correction line, and the jog run between the ends of the two meridians on the proper bearing. The north and south closing error is distributed equally between the two quarter-sections adjoining and on each side of the correction line so as to make both quarter-sections of the same depth. An exception to the above method of procedure is given in clause 14. The monuments for township corners are

now permanently established. No monuments are erected by the surveyor of township outlines between the township corners on the correction line.

104. Connection is to be made with the corner of any group lot, mineral claim or other parcel of land previously laid out within the township and with the monuments of surveyed roads. In case of railways, connection is to be made with the nearest survey stake and the marks on it are to be noted.

105. A picket or hub called 'traverse hub' is firmly planted on every surveyed line near the point where the line intersects the bank of a lake or river which has to be traversed, as hereinafter explained.

142. Shallow marshes or marshes which occasionally dry up are not to be traversed. Marshes of which the edge varies ten chains or more, according to the height of the water, must not be traversed, the land being dealt with by selecting the quarter quarter-sections which more nearly include the land. The surveyor must, in such cases, indicate in his notes the quarter quarter-section lines which, in his opinion, may be adopted as separating the land which may be put to some use from that which is rendered altogether worthless by water.

A marsh producing hay must not be traversed.

145. A traverse of which the object is merely to ascertain an area may be made with a stadia or micrometer of an approved pattern, provided the closing error does not exceed one chain in one hundred chains. The stadia rod employed in making such a traverse must also be of an approved pattern and accurately graduated to at least links and tenths of links. The number of points of the bank or traversed line fixed by the survey shall be determined by the irregularity of the shore line, but such points shall not be more than ten chains apart on township surveys and five chains on other surveys. Distances measured by stadia or micrometer must not exceed one-half a mile. In chained traverses, offsets shall not be greater than four chains on township surveys and two chains on other surveys. Other traverses shall be chained unless permission is obtained to use the stadia or micrometer.

No blazes or permanent marks of any description are made on traverse lines.

152. A quarter-section corner is marked by a wooden post flattened on two sides and marked with the fraction  $\frac{1}{4}$  (fraction-wise) to identify it as a quarter-section post. The timber employed for the post must be sound and of the most durable variety obtainable. The post (fig. 8) is two feet six inches long and three inches wide on the flat face. It is driven eighteen inches into the ground, the flat faces facing in the direction of the line. The post is bevelled on top to turn rain. When wood for the post is not to be found within three miles from the site of a quarter-section corner, no post need be planted, the corner being indicated simply by the four pits, or mound and pits, as hereinafter provided.

A corner falling in a lake or marsh not over three feet deep is marked by a wooden post as above, but not less than five inches in diameter and long enough to be driven three feet into the ground and to show six inches above the water.

205 (c) The character of monuments. For wooden posts the kind of wood is stated. 'I.P.M.' is entered for 'iron post and mound,' 'I.P. Pits' for 'iron post and four pits,' 'Stone M.' for 'stone mound,' 'Wit. I.P.T.' for 'witness iron post and trench,' 'T.H.' for 'traverse hub.' The number of pits is stated when less than four. The above information is entered on each page for every corner shown thereon. When the corner was established by a previous survey, the fact must be stated and the character and state of preservation of the monument found on the ground must be given. If the corner was restored, the character of the new monument must also be given. The absence of remarks means that the corner has been established by the surveyor himself.

205 (d) The bearing and distance to a stake or post of any railway or highway survey crossed by the line, and also to every corner of any lot, mineral claim, reserve, etc., within the survey, so as to afford proper connection between the several surveys. The marks upon the post or stake must be entered in the notes.

245. The surveyor performing the original subdivision of a township shall make a separate report upon the timber to be found within the township. In his report, the surveyor shall state whether, in his judgment, from the knowledge gained on the ground, it would be desirable to reserve the timber for the needs of settlers or whether it would be advisable to set apart the same as a timber berth or as a timber reserve for the conservation of water supply. Should a timber berth be suggested, he is to give a general statement of the quality and extent of the timber over ten inches in diameter suitable for lumbering purposes. If reporting on several timbered townships, he is to make a statement of their relative value, taking into account the extent, quality and facilities afforded by streams, etc., for getting out the timber. When there is no wood in the township, the fact is to be stated. The report for each township must be on a separate sheet.

249. A surveyor of township outlines shall furnish a general report upon his operations and the resources of the district in which his work lies, for publication in the annual report of the Department of the Interior.

Attention is particularly drawn to the necessity of devoting care and attention to the preparation of general reports. The object is not merely to give an account of the surveyor's operations and the quality of the land, but to describe comprehensively the resources of the country visited and its industries, whether farming, stock-raising, lumbering, mining, etc., furnishing such details as may enable the prospective emigrant to choose judiciously the locality in which to settle according to his calling, and to form an idea of the expectations which he may reasonably entertain.

A general report is also required from all other surveyors employed by the day, such report to contain all the information concerning the season's operations of value to the Department of the Interior or to the public, which does not appear in the surveyor's plans or field notes.

298. The surveyor in charge of a survey party shall be allowed a special ration allowance of one dollar per day for the party, such allowance to be paid as long as the surveyor remains in the field. He shall further be allowed an ordinary ration allowance of fifty-five cents per day for himself and every member of his party while in the field.

299. For meals, board and hotel expenses of himself and party, the surveyor shall be allowed, in addition to the ration allowance, a sum of forty cents per day for himself and four cents per day for every other member of his party while in the field.

300. Camp equipage shall be owned and furnished by the surveyor. For its use, he shall be allowed while in the field forty cents per day for himself and six cents per day for every other member of the party.

302. When an assistant is regularly appointed as such by the Minister of the Interior, the board and camp equipage allowance for him shall be twenty-five cents and ten cents per day, respectively.

312. Section lines shall be paid for at the rate of three dollars and fifty cents per mile of line surveyed.

316. The part of a section line chained across a marsh, except on the ice, or measured across water by means of a triangulation, is, up to half a mile, paid as opening through woods when the body of water is surrounded by continuous woods.

319. Only the lines actually run and marked in the field are paid for.

A single payment only is made for the north and the south boundaries of townships, although they must always be run twice under the provisions of clause 94 of the Manual of Survey.

Nothing is allowed for random and trial lines, bases of triangles and offsets.

323. Section lines re-surveyed or retraced by direction of the Surveyor-General, or under the provisions of clauses 195 or 197 are paid for at the same rate as original section lines in the subdivision of a township, but no payment is made for the part of an outline chained under the provisions of clause 93 for testing the chainage.

Lines re-surveyed or retraced without authority are not paid for. The fact that a line is obliterated or that a monument cannot be found is no sufficient authority to re-survey or retrace the line.

324. A further payment at the rate of twenty-five cents per pit in prairie, and forty cents per pit in the woods, is made for erecting a boundary monument, such payment covering the cost of planting and marking the post, building the mound and otherwise completing the monument. A witness trench is paid as four pits. A stone mound is paid for as four pits in the woods. A long quarter-section post planted in a marsh is reckoned as two prairie pits (fifty cents).

326. A payment at such rate as the Surveyor-General may allow, but not exceeding two dollars per mile of township outline or section line surveyed, may be made for the determination of the astronomical direction of the lines of the survey.

328. A surveyor requiring iron posts for use on the surveys of Dominion lands must obtain from the Surveyor-General an order for the delivery of the posts. They are supplied free of cost at Winnipeg and at every other place where they are kept in stock. Posts not used, if not returned to stores, are charged to the surveyor at forty cents each.

The Surveyor-General's order is merely for the delivery of the posts; shipping directions must be sent to the storeskeeper by the surveyor.

335. A rigid inspection of the work is made. On receipt of a report from the Inspector of Surveys, that the survey is being improperly executed, payments on account of the contract are stopped and steps are taken to recover the advances from the contractor and from his sureties, but when the deficiencies are of such a nature that they can be remedied by the contractor, he may be warned to correct them, and payments on account may be continued for a reasonable time.

#### GENERAL DIRECTIONS.

336. All payments are made by cheques issued in favour of the payee or in favour of a bank to be placed to his credit. It is useless to ask bank bills or post office orders; they cannot be sent.

A payment may be divided into several cheques, if desired.

An application for a payment must contain explicit directions as to whether a credit or a cheque is wanted, and where it is to be sent.

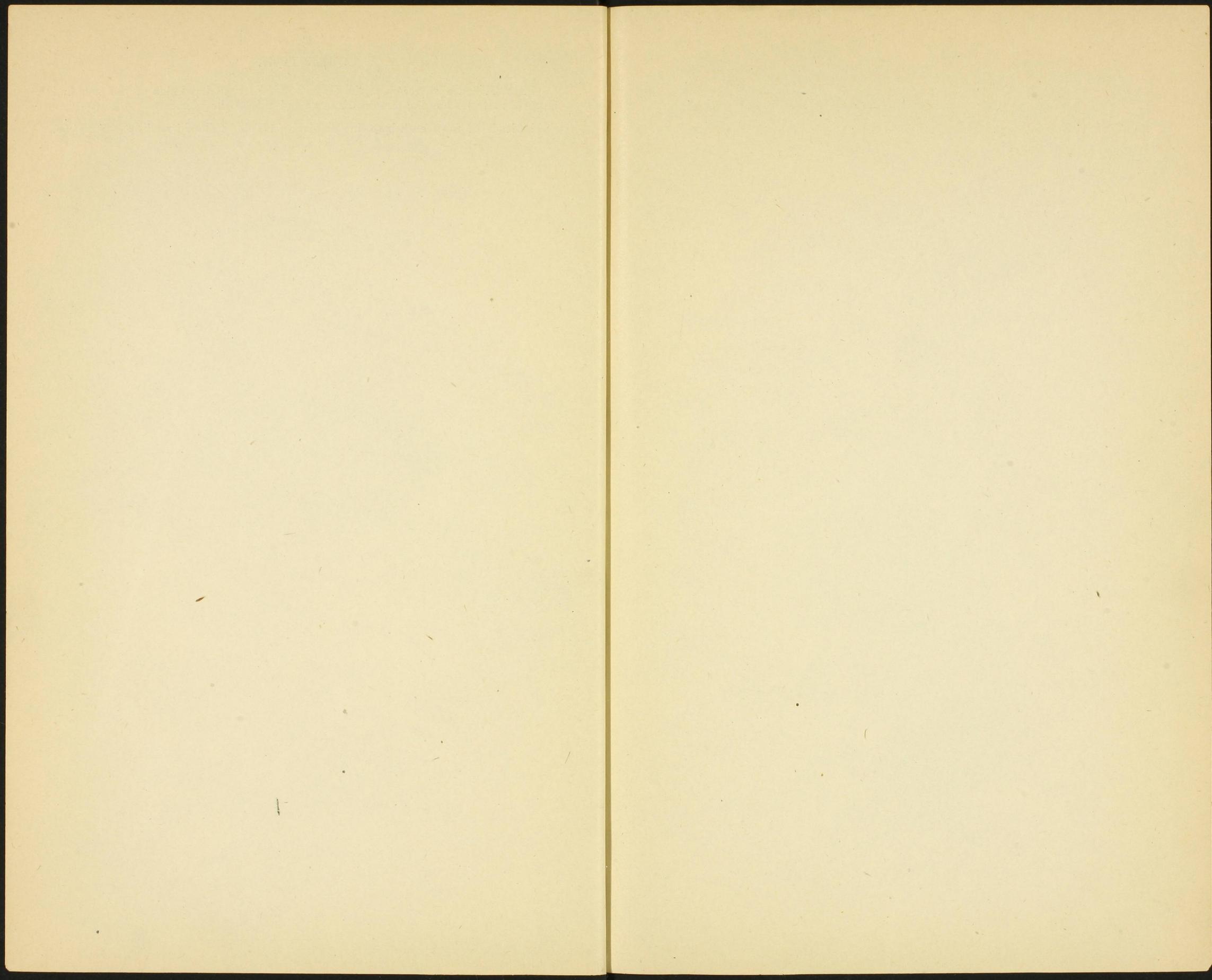
Credits will, on request, be telegraphed to banks having branches in Ottawa, ~~except the bank of British North America.~~

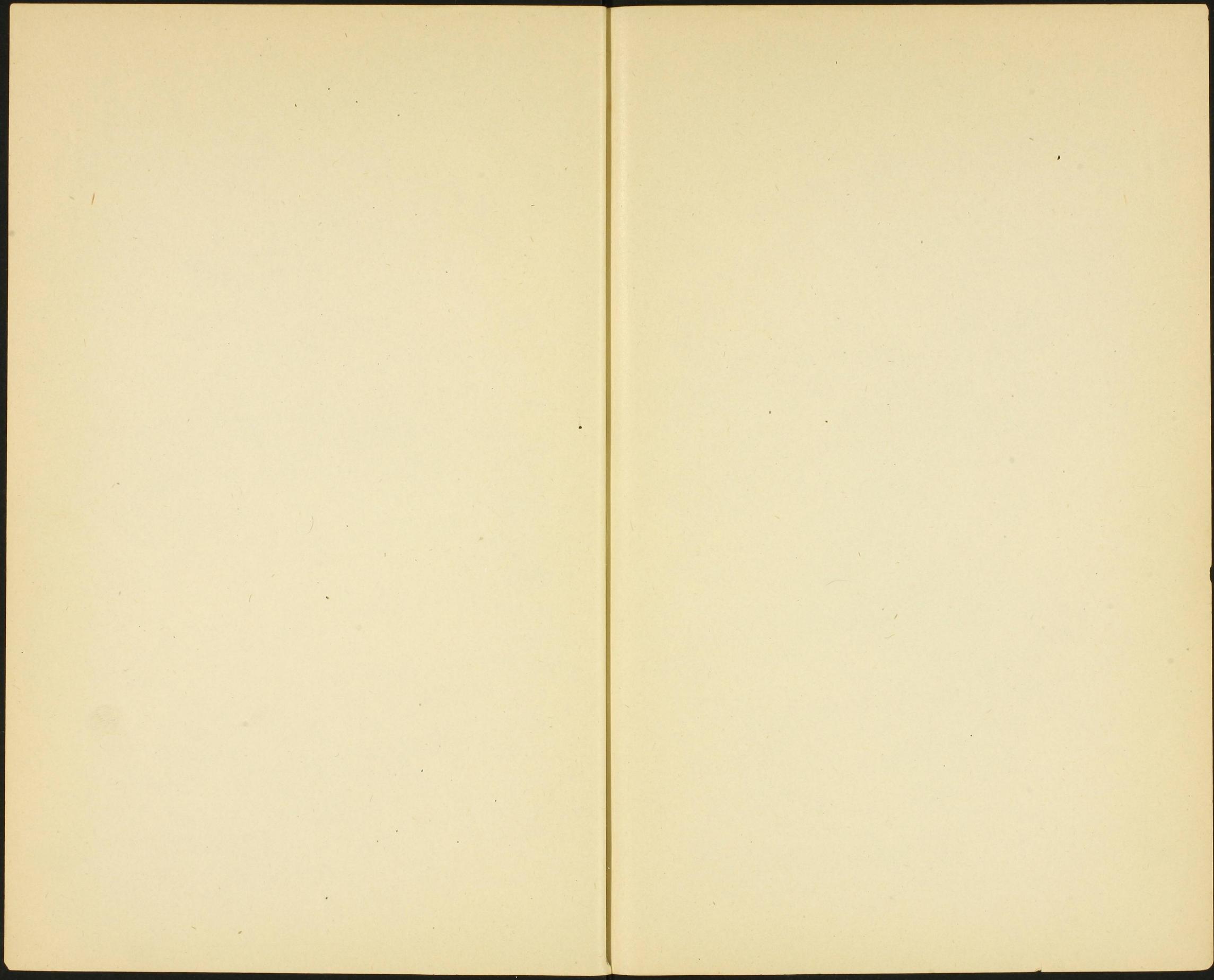
No money is placed to the credit of third parties without a power of attorney as provided in clause 338.

## CORRECTION.

Page 32, figure 22, refers to the diagram on the right hand side of the page and figure 23 refers to the diagram on the left hand side of the page.

Latitude of fourteenth base line as given in Table I should read  $53^{\circ} 32' 29'' \cdot 09$ .





Department of the Interior,  
Topographical Surveys Branch,  
Ottawa.

MEMORANDUM:

Organization of Survey Parties.

The surveys of Dominion Lands are made either by Surveyors paid by the day or by Surveyors working under contract at certain rates per mile of line surveyed.

Every survey party, whether working by the day or under contract, is in charge of a Dominion Land Surveyor. In order to obtain a commission as a Dominion Land Surveyor, it is necessary to pass a preliminary examination, to serve three years as pupil to a Dominion Land Surveyor including not less than twelve months on a survey party, and then to pass a final examination. In the case of graduates in engineering and those of the Royal Military College, the time of service as pupil is reduced to one year.

When employed by the day, the salaries or wages of the members of the party and all expenses while in the field are paid by the Government. Such a party consists of an assistant, a number of labourers and a cook. Parties are generally organized in March or April.

The assistant must be a pupil who has passed the preliminary examination with a view to qualifying as a Dominion Land Surveyor. The salary is three dollars per day; it commences on the day when the assistant joins the party at the place where it is being organized and ceases when he is discharged at the same place. He is not allowed fares or other travel expenses to come from his home to the above place or to return home.

When the pupil is also a graduate in engineering of some recognized University or a graduate of the Royal Military College, the salary is four dollars a day and travel expenses are allowed from home and return.

All persons qualified for the position of assistant who applied for employment last spring were appointed. It is probable that places can be found next spring for all those who are qualified. Applications must be made to the Department of the Interior.

Information concerning examinations may be obtained from F. D. Henderson, Secretary of the Board of Examiners for Dominion Land Surveyors, Department of the Interior, Ottawa.

The labourers and the cook are selected by the Surveyor in charge. Their salaries are fixed by the Department and average \$35. to \$40. per month for the season, according to the location of the survey. They must furnish their own blankets. The cook averages \$50. per month for the season. All are engaged at the place where the party is being organized: they must go there and come back therefrom at their own expense.

With the exception of the assistant and the cook, no man is appointed on a party in a special capacity. It is therefore useless to apply for a place of chainman, leveller, picketman, etc.: every man must do the work allotted to him by the Chief of the party.

A list of all applications for employment on survey parties received by the Department is printed early in the spring and sent to the Surveyors appointed to take charge of parties, so that they may have an opportunity of communicating with the applicants. The list contains the name of each applicant, his address and such particulars as he may give concerning his qualifications.

Another list, containing the name of every surveyor appointed to take charge of a party, his address and the location of the survey, is also printed and a copy mailed to each applicant.

A person engaged by the day is paid for every day that he is with the party in the field, including Sundays.

Every member of the party is required to sign an agreement binding himself to serve until the end of the survey.

Surveyors working under contract engage whoever they please and make their own terms with their employees. The Government has no control over them.

Surveyor-General.

T Y P E M E M O R A N D A

WRONG  
MONUMENTS

The monument at the ---- Corner section  
---- is returned variously as I.P.M. and  
I.P.Pits. Which is correct?

A similar remark applies to the ----  
Corners sections ----.

The monument at the ---- Corner section  
---- is given variously as I.P.M. and Wit.  
I.P.M. 2 N.

Mr. ---- should be asked to state which  
is correct and if a witness monument was  
established to give the nature and position  
of the obstruction.

OMISSION  
OF  
CORNER  
MONUMENTS

The monument for the ---- corner section  
---- is omitted from the notes of the ----  
boundary section ----. Can this be supplied?  
(See clause 202 of the Manual).

CHAINAGE TO  
WITNESS  
MONUMENTS

There is a Wit.I.P.M. at 55.00 chains on  
the east boundary section 35 marked 25 N,  
but the chainage of the east boundary section  
35 is given in the notes as 79.93 chains.  
Either the chainage or the marking on the  
post is wrong. What corrections are nec-  
essary?

WITNESS  
MONUMENTS

The monument at the ---- corner section  
---- is given as Wit.I.P.M. ---- E, but the  
notes show this monument to be E of the true  
corner.

Mr. ---- should be asked what corrections  
are necessary and to state whether this post  
was marked in accordance with clause 181 of  
the Manual.

BEARINGS

The bearings of the N.boundaries sections  
32, 33, 34 and 35 of township ---- range ---  
are referred to as 270°01', 270°02', 270°01'

and 269°59' respectively, but the bearing of the N. outline of township ---- range ---- was returned originally as 270°00'.

Mr.---- should be asked if he has any reason for believing that the bearings returned for these lines are otherwise than returned in the original survey.

The bearings of the meridians of which the east boundaries sections ----,---- are parts are shown as theoretic. Mr.---- should be asked whether he struck the posts without deflection in every case.

The notes for the E. boundary section 1 state that the course was turned off from bearing 270°02' of the north boundary section 36, township ----, range ----, whereas the notes for the N. boundary section 36 give the bearing of this section side as 90°01'.

What corrections are necessary?

The bearing from which the course of N. boundary section 12 was turned has been omitted from the notes.

Can this information be supplied?

In the triangulation on the ---- boundary section ----, A is at --- chains, B is at --- chains; A---°---', B---°---', C---°---', and AC -- chains.

Data will not solve for chainage given.

The section numbers to the east and west (or N. & S.) of the --- boundary section ---- are omitted, or incorrectly stated, as the case may be.

Mr. --- should be asked to supply the correct section numbers and indicate where they belong.

MERIDIAN BEARINGS.

BEARING OF REFERENCE LINE

OMITTED BEARING OF REFERENCE LINE

TRIANGULATION

SECTION NUMBERS

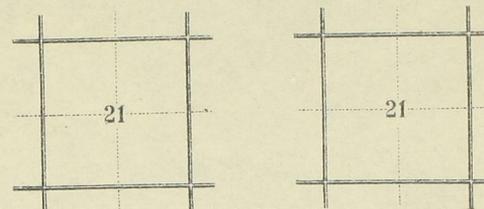
DATE OF  
SURVEYS

The dates of commencement and completion of the survey are omitted from the title page.

This information should be supplied.

BLOCK  
CLOSINGS

The block composed of sections ---- and ---- does not close within the limits of error allowed by the Manual. The information as returned is as follows:-



Mr. ---- should be asked to remove, if possible, this closing error.

OMISSIONS

The following omissions occur in the notes which Mr. --- should be asked to supply:-

E.By. sec.2, chainage of creek crossing,  
N." " 12, quarter section monument.

UNEQUAL  
QUARTER  
SECTIONS

The quarter section chainages on the N. by. section --- are given as 39.97 chs. and 39.91 chs.

Why were these not made equal?

CHAINAGE  
OF  
TOPOGRAPHY

The chainages of a slough at the quarter section corner --- boundary section --- are not shown in the notes. Mr. --- should be asked to supply this information.

DIFFERENCES

The following differences occur between the notes and the progress sketch which Mr. --- should be asked to explain:-

	Notes	Sketch
Bearing N.By. Sec. 19	269°45'	269°56'
Chainage " " 21	79.95	79.90

MISSING  
TRAVERSES

The subdivider to the --- shows a lake extending into sections --- of this township, but Mr. --- makes no mention of this. He should be asked why he did not traverse this lake.

COMPARISON  
OF TRAVERSE  
NOTES AND  
PLOT

The following discrepancies occur between the traverse notes and the traverse plot which Mr. --- should be asked to explain:-

Lake No.--	Course	Notes	Plot (app'x)
9-10		102°14'	105°00'
		6.00 chs.	7.50 chs.
Sta.8		97°35'	94°00'
		18.00 chs.	18.00 chs.

ACCOUNT

On account of --- omissions to take off-sets \$--- have been deducted from the account. (See clauses 149 and 329 of the Manual). Owing to this and other small differences the account has been changed from \$--- to \$---, still subject to the inspector's report.

Owing to a deduction of 1.1 miles of traverse at \$11.00 per mile, .75 miles of bush at \$20.00 per mile, and other small differences the account has been changed from \$--- to \$---, still subject to the inspector's report.

## AMENDMENTS

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# MANUAL OF INSTRUCTIONS

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## SURVEY OF DOMINION LANDS

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Should not surveys be given authority to mark corners by bearing trees where they think it advisable?

See letter to C. F. Kille 5/3/09. File 2890S.

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A marsh producing hay must not be traversed.

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Oct 23, 1907

ending. "re: organization" looks too much like  
"reorganization".

(re: might be omitted.)

4<sup>th</sup> Par. - "and all expenses are paid by the  
Government." This statement is  
misleading although modified in the  
succeeding paragraphs.

(? expenses while in the field)

5<sup>th</sup> Par. In this the name "assistant" is  
given to the person formerly called  
"articled pupil." Will this affect  
Cl. 302 of the Amendment?

yes

P. 2

1<sup>st</sup> Par. "graduate in engineering of some  
recognized university"

P. 3

Last Par.

S.S. thinks this  
is necessary

"The Government has no control  
over them." This might be omitted  
or put thus: "The Government does  
not interfere in this matter."

205 (d) The bearing and distance to a stake or post of any railway or highway survey crossed by the line, and also to every corner of any lot, mineral claim, reserve, etc., within the survey, so as to afford proper connection between the several surveys. The marks upon the post or stake must be entered in the notes.

245. The surveyor performing the original subdivision of a township shall make a separate report upon the timber to be found within the township. In his report, the surveyor shall state whether, in his judgment, from the knowledge gained on the ground, it would be desirable to reserve the timber for the needs of settlers or whether it would be advisable to set apart the same as a timber berth or as a timber reserve for the conservation of water supply. Should a timber berth be suggested, he is to give a general statement of the quality and extent of the timber over ten inches in diameter suitable for lumbering purposes. If reporting on several timbered townships, he is to make a statement of their relative value, taking into account the extent, quality and facilities afforded by streams, etc., for getting out the timber. When there is no wood in the township, the fact is to be stated. The report for each township must be on a separate sheet.

249. A surveyor of township outlines shall furnish a general report upon his operations and the resources of the district in which his work lies, for publication in the annual report of the Department of the Interior.

Attention is particularly drawn to the necessity of devoting care and attention to the preparation of general reports. The object is not merely to give an account of the surveyor's operations and the quality of the land, but to describe comprehensively the resources of the country visited and its industries, whether farming, stock-raising, lumbering, mining, etc., furnishing such details as may enable the prospective emigrant to choose judiciously the locality in which to settle according to his calling, and to form an idea of the expectations which he may reasonably entertain.

A general report is also required from all other surveyors employed by the day, such report to contain all the information concerning the season's operations of value to the Department of the Interior or to the public, which does not appear in the surveyor's plans or field notes.

298. The surveyor in charge of a survey party shall be allowed a special ration allowance of one dollar per day for the party, such allowance to be paid as long as the surveyor remains in the field. He shall further be allowed an ordinary ration allowance of fifty-five cents per day for himself and every member of his party while in the field.

299. For meals, board and hotel expenses of himself and party, the surveyor shall be allowed, in addition to the ration allowance, a sum of forty cents per day for himself and four cents per day for every other member of his party while in the field.

300. Camp equipage shall be owned and furnished by the surveyor. For its use, he shall be allowed while in the field forty cents per day for himself and six cents per day for every other member of the party.

302. When an assistant is regularly appointed as such by the Minister of the Interior, the board and camp equipage allowance for him shall be twenty-five cents and ten cents per day, respectively.

312. Section lines shall be paid for at the rate of three dollars and fifty cents per mile of line surveyed.

316. The part of a section line chained across a marsh, except on the ice, or measured across water by means of a triangulation, is, up to half a mile, paid as opening through woods when the body of water is surrounded by continuous woods.

*Note: When reporting the Personal Case is to be taken to change the notes in the book.*

319. Only the lines actually run and marked in the field are paid for.

A single payment only is made for the north and the south boundaries of townships, although they must always be run twice under the provisions of clause 94 of the Manual of Survey.

Nothing is allowed for random and trial lines, bases of triangles and offsets.

323. Section lines re-surveyed or retraced by direction of the Surveyor-General, or under the provisions of clauses 195 or 197 are paid for at the same rate as original section lines in the subdivision of a township, but no payment is made for the part of an outline chained under the provisions of clause 93 for testing the chainage.

Lines re-surveyed or retraced without authority are not paid for. The fact that a line is obliterated or that a monument cannot be found is no sufficient authority to re-survey or retrace the line.

324. A further payment at the rate of twenty-five cents per pit in prairie, and forty cents per pit in the woods, is made for erecting a boundary monument, such payment covering the cost of planting and marking the post, building the mound and otherwise completing the monument. A witness trench is paid as four pits. A stone mound is paid for as four pits in the woods. A long quarter-section post planted in a marsh is reckoned as two prairie pits (fifty cents).

326. A payment at such rate as the Surveyor-General may allow, but not exceeding two dollars per mile of township outline or section line surveyed, may be made for the determination of the astronomical direction of the lines of the survey.

328. A surveyor requiring iron posts for use on the surveys of Dominion lands must obtain from the Surveyor-General an order for the delivery of the posts. They are supplied free of cost at Winnipeg and at every other place where they are kept in stock. Posts not used, if not returned to stores, are charged to the surveyor at forty cents each.

The Surveyor-General's order is merely for the delivery of the posts; shipping directions must be sent to the storeskeeper by the surveyor.

335. A rigid inspection of the work is made. On receipt of a report from the Inspector of Surveys, that the survey is being improperly executed, payments on account of the contract are stopped and steps are taken to recover the advances from the contractor and from his sureties, but when the deficiencies are of such a nature that they can be remedied by the contractor, he may be warned to correct them, and payments on account may be continued for a reasonable time.

#### GENERAL DIRECTIONS.

336. All payments are made by cheques issued in favour of the payee or in favour of a bank to be placed to his credit. It is useless to ask bank bills or post office orders; they cannot be sent.

A payment may be divided into several cheques, if desired.

An application for a payment must contain explicit directions as to whether a credit or a cheque is wanted, and where it is to be sent.

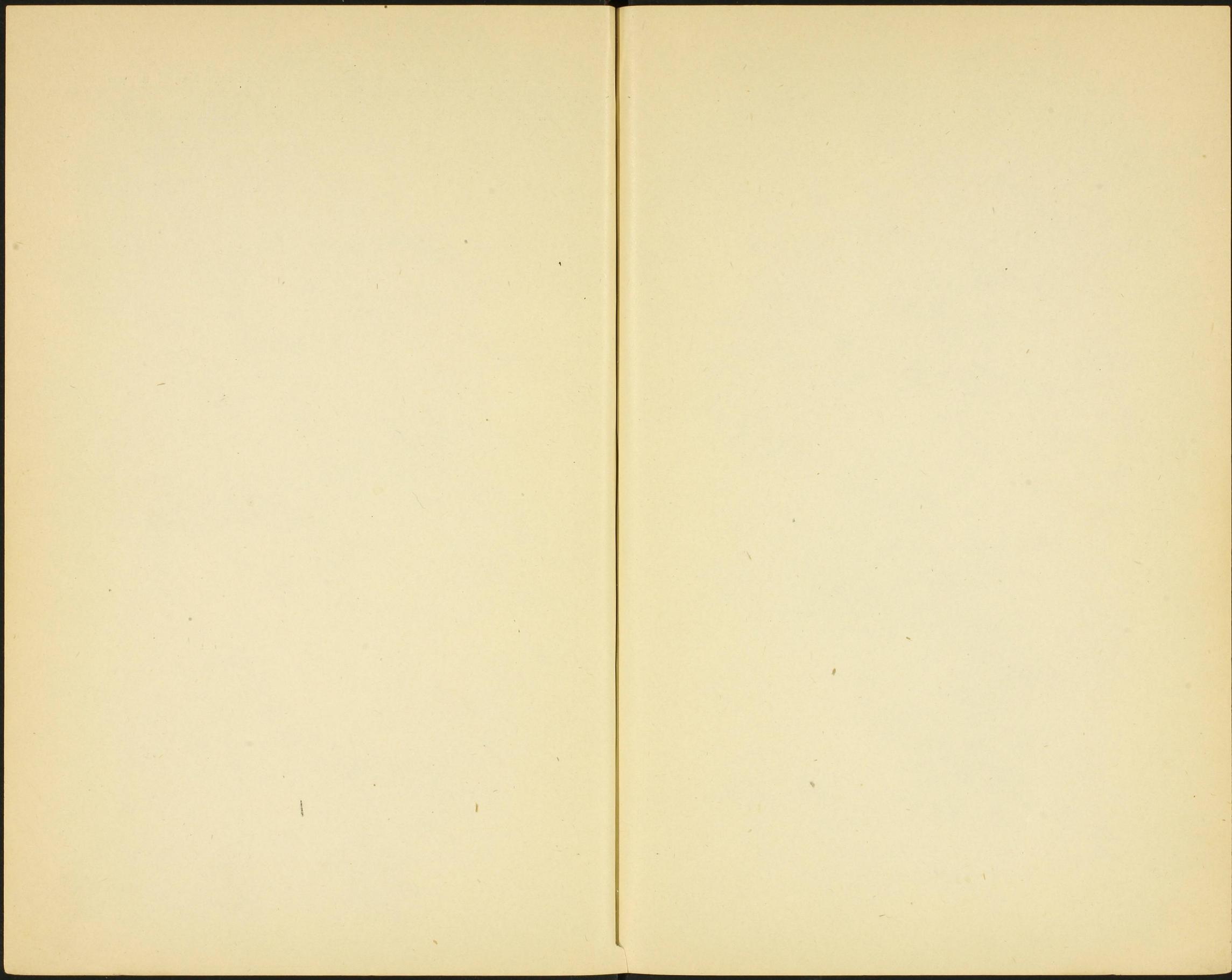
Credits will, on request, be telegraphed to banks having branches in Ottawa, except the bank of British North America.

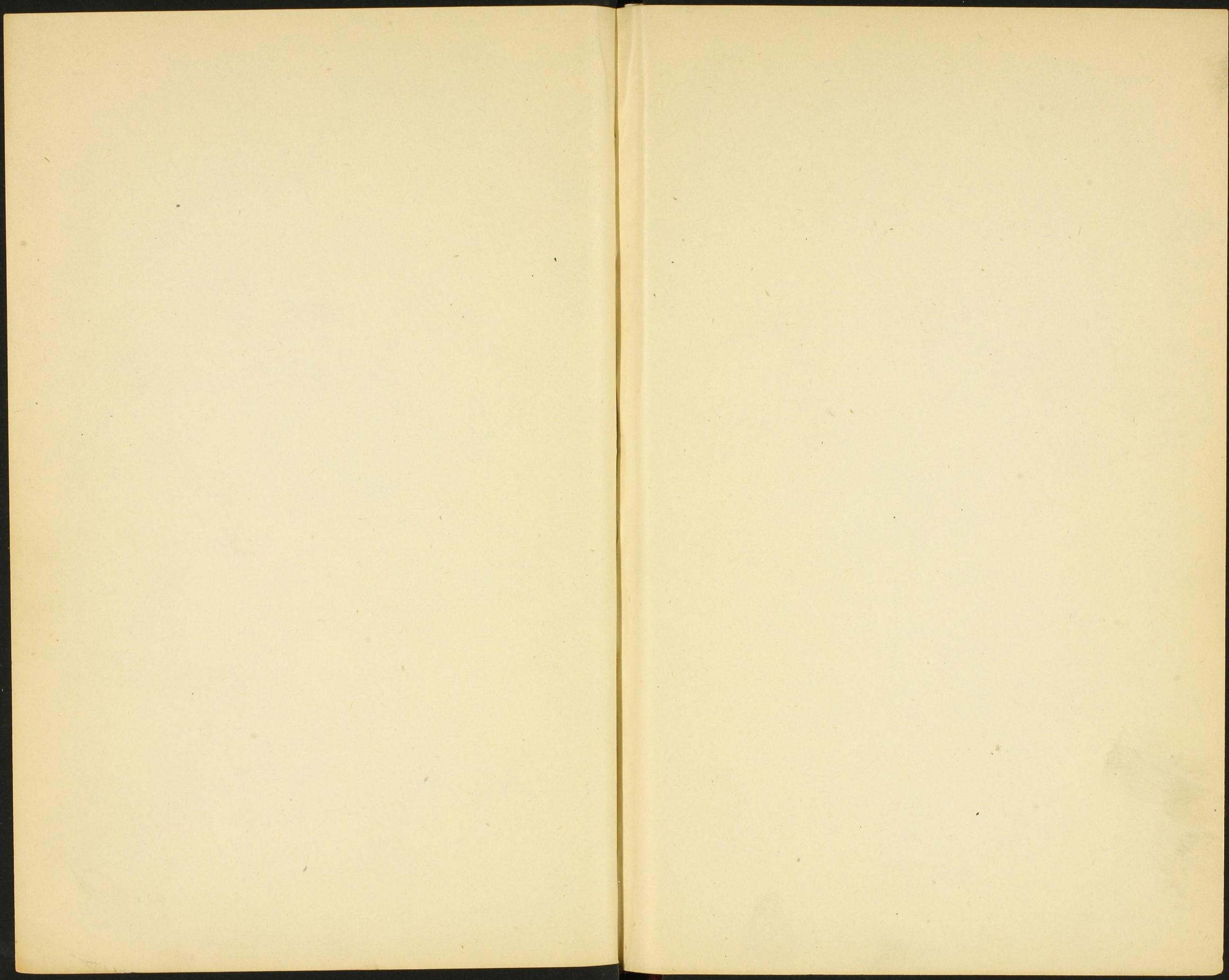
No money is placed to the credit of third parties without a power of attorney as provided in clause 338.

## CORRECTION.

Page 32, figure 22, refers to the diagram on the right hand side of the page and figure 23 refers to the diagram on the left hand side of the page.

Latitude of fourteenth base line as given in Table I should read  $53^{\circ} 32' 29'' \cdot 09$ .





Thomas Shanks

2/1/06

DOMINION OF CANADA

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MANUAL

OF

INSTRUCTIONS

FOR THE

SURVEY OF DOMINION LANDS

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ISSUED BY THE AUTHORITY OF THE HONOURABLE  
THE MINISTER OF THE INTERIOR

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OTTAWA  
GOVERNMENT PRINTING BUREAU  
1905

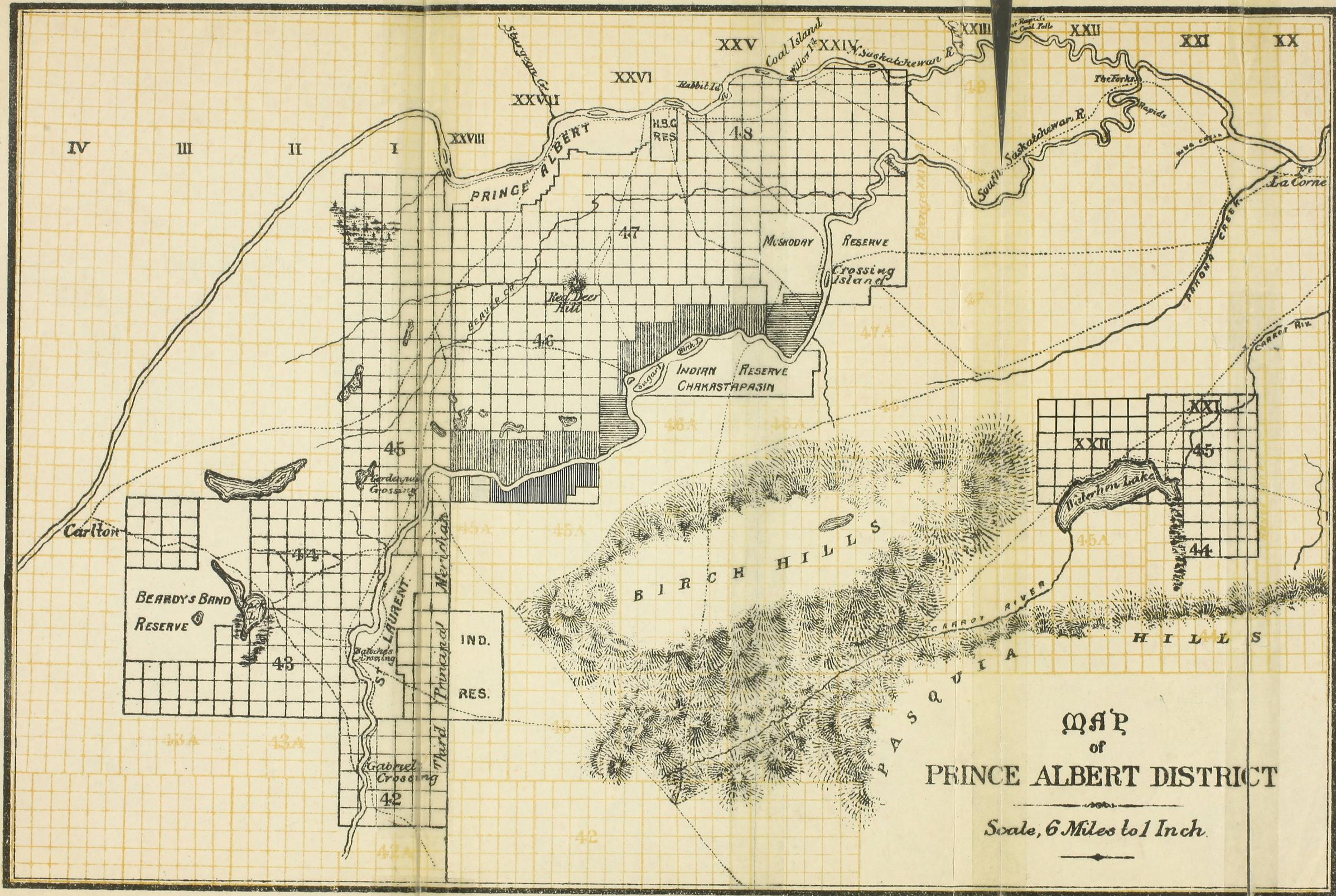
NOTICE TO DOMINION LAND SURVEYORS.

This Manual has been prepared for the guidance of Surveyors of Dominion Lands who are to be governed by its provisions in making any survey of these lands, in so far as they are applicable to the particular survey then being executed.

Any Dominion Land Surveyor subscribing the affidavit mentioned in clause 121 of the Dominion Lands Act is to consider this Manual and the instructions embodied therein, as forming part of the instructions of the Surveyor-General referred to in the said affidavit.

E. DEVILLE,  
*Surveyor-General.*

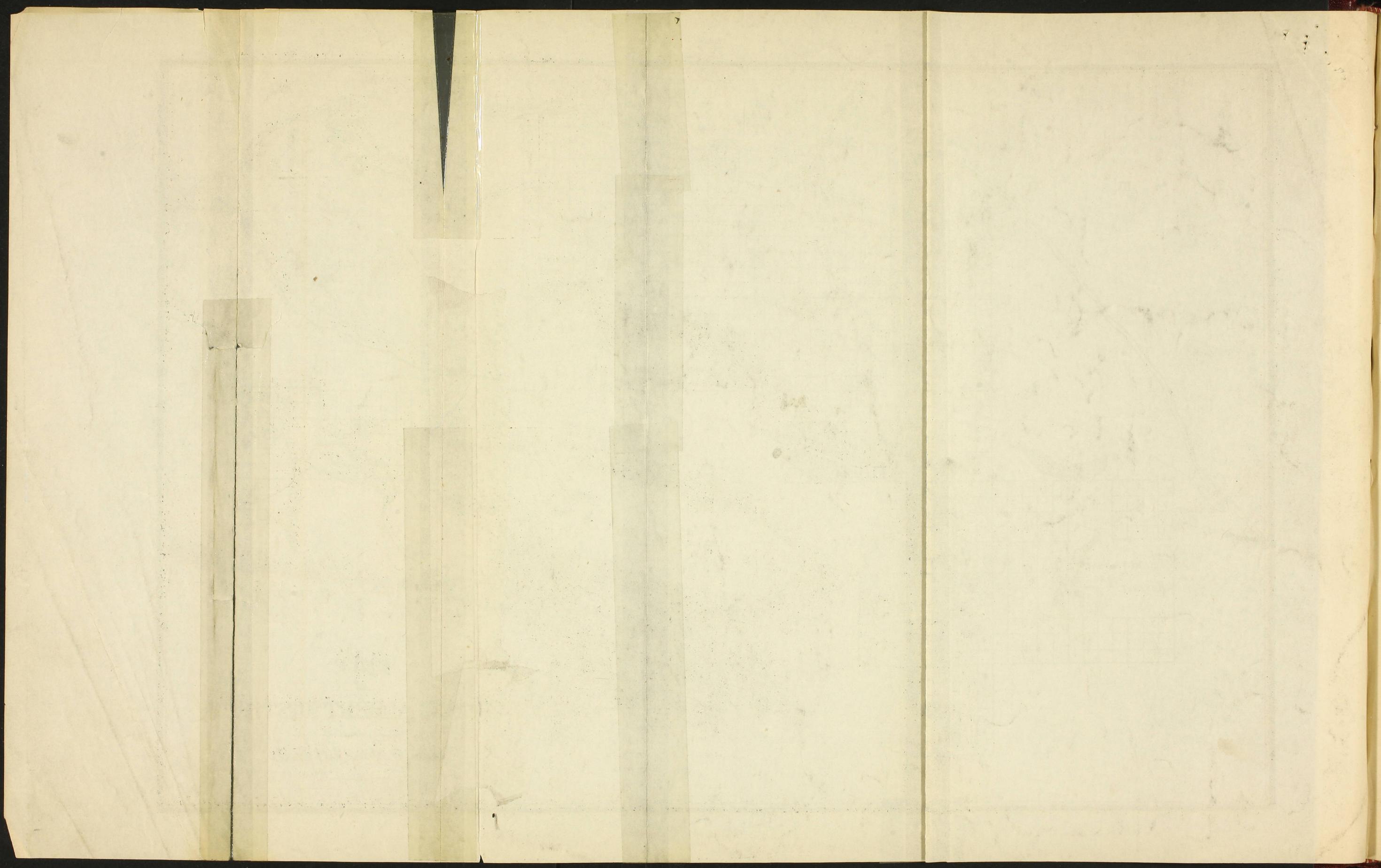
DEPARTMENT OF THE INTERIOR,  
April 3, 1905.



MAP  
of  
PRINCE ALBERT DISTRICT

Scale, 6 Miles to 1 Inch.





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SYSTEM OF SURVEY

AND

INSTRUCTIONS TO SURVEYORS

**CHAPTER I.**  
**SYSTEM OF SURVEY.**

GENERAL DESCRIPTION.

1. The Dominion lands are laid off in quadrilateral townships containing thirty-six sections, each of six hundred and forty acres or one square mile, subject to the deficiency or surplus from the convergence or divergence of meridians, as hereinafter mentioned, together with allowances for roads in certain cases.

2. The sections are bounded and numbered as shown by the following diagram :—

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

Fig. 1. Division of a township into sections.

3. The lines bounding a township on the east and west sides are true meridians, and those on the north and south sides are chords of the parallels of latitude passing through the corners of the township.

4. The townships number in regular order, northerly from the international boundary or forty-ninth parallel of latitude, and lie in ranges which are numbered east and west from a meridian line styled the Principal Meridian, and west from other initial meridians styled the Second, Third . . . . . Meridians, according to their order westward from the Principal Meridian.

5. The Principal Meridian passes about twelve miles west of the city of Winnipeg in approximate longitude  $97^{\circ} 27' 09''$  west of Greenwich.

The Second Meridian is placed in longitude  $102^{\circ}$  (very nearly), the Third in  $106^{\circ}$  and so on, each initial meridian after the second being four degrees west of the preceding one.

There is also the Coast Meridian of British Columbia upon which are based the townships of the 'Fifth System,' hereinafter described.

6. The sections are laid out of the precise width of eighty chains on certain lines called '*base lines*,' with a road allowance adjoining each section, and the meridians between the townships are drawn from such bases, north or south, to the depth of two townships, that is to say, to the correction lines hereinafter mentioned. The townships south of the base measure therefore in an east and west direction more than four

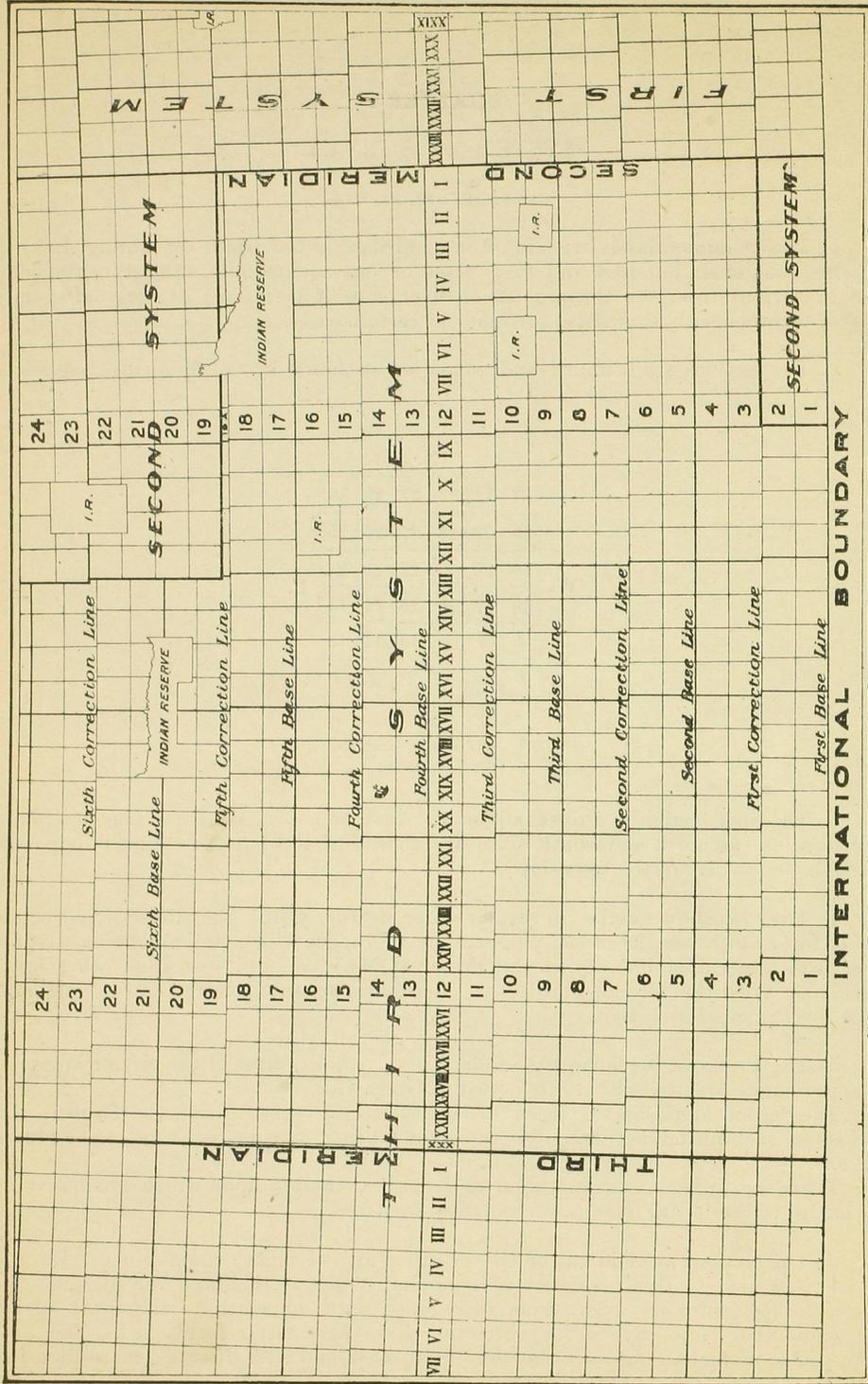


Fig. 2. Illustrating the subdivision of the country into blocks and townships.

hundred and eighty chains together with the roads, while those north of the base measure less than this. The interval between a base line and the next one is equal to the depth of four townships.

7. The 'correction lines' are those upon which the 'jog' resulting from the want of parallelism of meridians, is allowed, or, in other words, they are those township lines running east and west which are equidistant from the bases at the depth of two townships. The interval between the correction lines is equal to the depth of four townships.

8. The first base line is the forty-ninth parallel of latitude or international boundary; the second base is between townships four and five; the third between townships eight and nine; the fourth between townships twelve and thirteen; the fifth between townships sixteen and seventeen, and so on, northerly, in regular succession.

9. The first correction line is between townships two and three; the second between townships six and seven; the third between townships ten and eleven, and so on, northerly, in regular succession.

10. Each section is divided into quarter sections of one hundred and sixty acres, or one-half mile square, more or less.

11. To facilitate the descriptions for letters patent of less than a quarter section, the quarter sections composing every section in accordance with the boundaries of the same as planted or placed in the original survey, are supposed to be divided into quarter quarter sections of forty acres, and such quarter quarter sections are styled legal subdivisions and are bounded and numbered as shown in the following diagram of a section:—

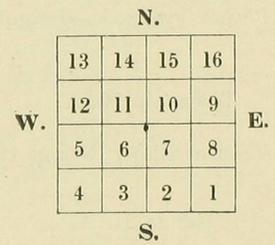


Fig. 3. Division of a section into quarter quarter sections.

12. Preliminary to the subdivision into sections of any given portion of country, the same is laid out into townships by projecting the base lines and the meridian outlines from the base lines to the correction lines and connecting by straight lines the township corners on the meridians.

13. In the case of the townships between the first and second bases, the meridians are surveyed south from the second base to the first correction line, and thence south to the first base line, giving the 'jogs' their theoretical lengths.

14. In the survey of any township outlines or the subdivision of any township, the surplus or deficiency found on meridians when closing on the correction line is left in the last quarter section adjoining said line; except on meridians, across townships one and two, on which meridians the quarter sections adjoining the correction line are given the theoretical depth of forty chains, the deficiency or surplus, as the case may be, being left in the quarter sections adjoining the first base line or international boundary.

*meridian outline*  
*two*  
*must be*  
*On all the meridians of 1/4 of one*

15. In the case of the fractional range adjoining an initial meridian, when the initial meridian intersects the 'jog' (that is when there is one more range south of the correction line than north of it), the last quarter section on the meridian township outline surveyed from the south is made of the same depth as that on the next meridian township outline on the east. See Fig. 5.

16. On the township outlines, at the time of the survey, all township, section and quarter section corners are marked, which corners govern respectively in the subsequent subdivision of the block or township.

#### SYSTEMS OF SURVEY IN DIFFERENT DISTRICTS.

17. All Dominion lands in Manitoba, the North-west Territories and British Columbia, are laid out in the manner above described, but the number of road allowances between sections and their width are not the same in all parts of the country. There are also differences in the methods of subdividing townships. Hence arise different 'systems of survey,' five in all, styled the 'first,' 'second,' &c., system of survey.

18. The instructions hereinafter are drawn up for the third system, but, unless otherwise expressly provided, apply also to the other systems.

19. Since in all the systems of survey the townships and ranges are based upon the forty-ninth parallel and the initial meridians, and are not, on account of the varying widths of the road allowances, of the same dimensions, there occur fractional townships and ranges at the junction of different systems.

20. The fractional township or range between two townships or ranges surveyed according to different systems, when its number is the same as the number of the adjoining one surveyed under the former system, is designated by that number, followed by the letter A, as for instance :

Township 19, A,

for the fractional township between townships 18 and 19 west of the second meridian, and

Range 21, A,

for the fractional range between ranges 20 and 21 west of the second meridian.

21. The line between two parts of the country surveyed according to different systems is established as a correction line, that is to say, posts are planted on both sides of the road allowance on such line, each row governing the position of the boundary lines on its own side. Such road allowance is one chain and fifty links wide, except in the case of the dividing line between the third system of survey in the North-west Territories, and the fourth system in force in the 'Railway Belt' in British Columbia hereinafter described: here the road allowance between the systems is one chain wide. Between the fourth system and the fifth system, no road allowance is left, but a double row of posts is planted on the line dividing the systems, to govern the townships and sections on each side respectively.

#### FIRST SYSTEM OF SURVEY.

22. In the first system of survey there is a road allowance of one chain and fifty links on every section line.

23. The township, therefore, measures on each side four hundred and eighty-nine chains, subject to the deficiency or surplus resulting from the converging or diverging meridians.

24. In the survey of a township the deficiency or surplus resulting from the want of parallelism of the meridians is set out and allowed in the range of quarter sections adjoining the western boundary of the township. It follows that generally the lines bounding sections on the east or west sides are not meridians, but lines parallel to the eastern boundary of the township. All quarter section sides are theoretically forty chains, except in the western range of quarter sections of a township and in the sections adjoining a correction line which are subject to the discrepancies of the survey.

25. The operation of the first system of survey is restricted to the area bounded as follows, viz. :—

To the south, by the international boundary line, to the west by the second meridian, as far as the eighth correction line; by said correction line as far as the meridian between ranges twenty-eight and twenty-nine west of the principal meridian; by said meridian between ranges twenty-eight and twenty-nine, as far as the seventh correction line; by said correction line as far as the meridian between ranges seven and eight east of the principal meridian; by said meridian between ranges seven and eight east as far as the north boundary of township nineteen; by the north boundary of township nineteen in ranges eight, nine and ten east of the principal meridian as far as the meridian between ranges ten and eleven east of the principal meridian; by said meridian, between ranges ten and eleven east, as far as the third correction line; by the said correction line, as far as the eastern boundary of the province of Manitoba; by said eastern boundary as far as the international boundary line.

Also township 44, R. 21; Tp. 45, R. 21, 22, 26, 27, 28; Tps. 46 and 47, R. 24, 25, 26, 27 and 28; Tp. 48, R. 24, 25, 26 and 27, west of the second meridian.

Townships 42 to 47 inclusive, R. 1; and Tps. 43 and 44, R. 2 and 3, west of the third meridian.

#### SECOND SYSTEM OF SURVEY.

26. The second system of survey is similar in all respects to the first system, except in regard to the deficiency or surplus from the converging or diverging meridians which is distributed equally among all quarter sections as in the third system.

27. The operation of the second system of survey is restricted to Tps. 1 and 2, R. 1 to 8 inclusive; Tps. 19 to 30, R. 1 to 12 inclusive; and Tps. 27 to 30, R. 13 to 16 inclusive; the above ranges being all west of the second meridian.

#### THIRD SYSTEM OF SURVEY.

28. The third system of survey covers all the territory not expressly reserved for the other systems.

29. Road allowances of one chain in width are allowed on every section line running north and south and on every alternate section line running east and west, that is, along the north and south boundaries of the township and along the second and fourth section lines north of the south boundary of the township.

30. The township, therefore, measures along its east and west boundaries, four hundred and eighty-three chains, and along its north and south boundaries four hundred and eighty-six chains, subject to the deficiency or surplus from the converging or diverging meridians, as the case may be.

31. The deficiency or surplus from the converging or diverging meridians is distributed equally among all quarter sections involved, so that the lines bounding sections on the east and west sides are true meridians, and those on the north and south sides are parallel to the north and south boundaries of the township.

32. In the survey of township outlines, the surplus or deficiency found on meridians when closing on the correction line is divided equally between the quarter sections adjoining that line, except in the case of the closing on the first correction line where the deficiency or surplus, as above stated, is carried to the first base line, or forty-ninth parallel of latitude.

FOURTH SYSTEM OF SURVEY, OR SYSTEM OF SURVEY IN RAILWAY BELT, BRITISH COLUMBIA.

33. The system adopted for the survey of the lands within the belt of twenty miles on each side of the Canadian Pacific Railway in British Columbia, is the third system of the North-west Territories, modified by adding to each quarter section of 160 acres, an allowance of three acres for roads, instead of locating this allowance on the section lines.

34. This allowance is provided for by making each quarter section on the base lines 40 chains and 50 links, and on the meridians 40 chains and 25 links.

35. The dimensions of the townships are therefore the same as those in the third system of survey, namely, four hundred and eighty-three chains north and south, and four hundred and eighty-six east and west. Since the townships of the third and fourth systems are based upon the forty-ninth parallel and the same initial meridians, there is no fractional township or range between them where the systems adjoin one another, but the northern boundary of the fourth system township coincides with the line of posts marking the southern limit of the road allowance on the southern boundary of the third system township adjoining it to the north, and the eastern boundary of the fourth system township coincides with the western limit of the road on the western boundary of the third system township next east of it.

36. In the fourth system of survey correction lines are marked by a double row of posts to govern the positions of the boundary corners of the townships, sections and quarter sections on each side of the line.

37. The correction line is established by projecting the township lines from the base lines on each side of the correction line, and dividing the surplus or deficiency equally between the quarter sections on each side of the correction line. The corners thus established for the townships south of and adjoining the correction line are joined by straight lines, upon which are placed the posts marking the township, section and quarter section corners for townships on both sides of the correction line.

38. In the case of these correction lines the rule prescribed for re-establishing lost corners on a township outline in Manitoba and the North-west Territories (see sub-clause *b* of clause 126 of the Dominion Lands Act) is modified, in that the straight line joining the corners of the township south of the correction line must govern the alignment of the posts.

39. The western limit of the third system follows the summit of the Rocky Mountains, which is the boundary between the North-west Territories and the province of British Columbia, except between the northern boundary of township 25, range 15, and the eastern boundary of township 31, range 19, west of the 5th meridian, where the following lines separate it from the fourth system, namely:

That part of the northern boundary of township 25, range 15, which lies west of the summit of the Rocky Mountains; then, in succession, the eastern boundary of town-

ship 26, range 16, to 7th correction line; the 7th correction line as far as the southeast corner of township 27, range 17; the eastern boundaries of townships 27 and 28, range 17; the northern boundary of township 28, range 17; the eastern boundaries of townships 29 and 30, range 18; the 8th correction line as far as the southeast corner of township 31, range 19; the eastern boundary of township 31, range 19, as far as the summit of the Rocky Mountains; thence northerly along the said summit; all these ranges being west of the fifth meridian.

40. All Dominion lands to the west of the above described boundary are surveyed under the fourth system, excepting the territory in which the fifth system, hereinafter described, is in force.

FIFTH SYSTEM OF SURVEY.

41. Certain townships in the railway belt in the lower valley of Fraser river, previous to the transfer of the lands to the Dominion, were surveyed by the provincial government according to the local system of survey. The townships are six miles square and are divided into 36 sections, as in the other systems. There are no allowances for roads. The basis of the system is the forty-ninth parallel and a meridian which passes near the junction of Fraser and Pitt rivers. This meridian is called the Coast Meridian. The townships are individually numbered, and not according to the general system of townships and ranges. The common designation of a township is 'Township No. . . . ., E. C. M.' or 'W. C. M.' (east or west of coast meridian.)

42. The boundary of the fifth system is as follows:—Beginning at the point where the eastern boundary of township 25, E. C. M., intersects the international boundary between Canada and the United States; thence northerly upon the eastern boundaries of townships 25 and 26, E. C. M., to the northeast corner of said township 26; thence easterly upon the southern boundary of township 27, E. C. M. to the southeast corner of said township 27; thence northerly upon the eastern boundary of said township 27 to the first correction line of the Dominion lands system of survey; thence westerly upon the said correction line to the seventh meridian of the Dominion lands system of survey; thence northerly upon the said seventh meridian to the northern boundary of township 24, E. C. M.; thence westerly upon the northern boundaries of townships 24, 21, 18, 15 and 12 to the southeast corner of section 6, in township 42, E. C. M.; thence northerly upon the eastern boundaries of sections 6, 7, 18, 19, 30 and 31, in said township 42 to the northern boundary of said township; thence westerly upon the northern boundary of said township 42 to the southeast corner of township 41, E. C. M.; thence northerly upon the eastern boundary of said township 41, to the northeast corner of section 12, in said township; thence westerly upon the northern boundaries of sections 12 and 11, in said township 41, to the northwest corner of section 11, in said township; thence southerly upon the western boundaries of sections 11 and 2, in said township 41, to the northern boundary of township 40, E. C. M.; thence westerly upon the northern boundaries of township 40, E. C. M. and township 39, W. C. M., to the western limit of the forty-mile railway belt; thence southerly following upon the said western limit to the international boundary between Canada and the United States; thence easterly upon the said international boundary to the point of beginning.

SETTLEMENT SURVEYS.

43. Lands bordering on any river or lake, or other body of water, or on a public highway, and upon which settlements are in existence, may be laid out and divided into lots of a certain frontage or depth in such manner as appears desirable. In each settlement, the lots are numbered in regular order from one upwards, each lot being given a separate number.

44. The width of the lots in a settlement is laid out on a line, called the base line, established near the front of the settlement and perpendicular to the side lines of the lots.

The base line is offsetted as required, and its course is changed where it is necessary to do so in order to follow the general trend of the settlement.

45. The side lines of a settlement lot are parallel lines except at the places, if any, where the course of the base line changes. Subject to the same exception, the rear boundary of a settlement lot is parallel to the base line.

46. Boundary monuments are established at the intersections of the base and rear lines by the side lines of the lots.

47. A road sixty-six feet in width is laid out across the settlement in the most convenient location, also such further roads of the same width as may be necessary to give access to every settlement lot.

#### GROUP LOTS.

48. In remote parts of the country, separate lots, not exceeding one hundred and sixty acres each, may be laid out, each lot being designated by an individual number, by the number of the group to which it belongs and by the name of the province or district.

A group includes all the lots in a territory of convenient size.

49. A group lot is in the form of a rectangle, the length of which does not exceed twice the breadth. A departure from this rule is allowed when the lot is bounded by a road, the shore of a lake or stream, or by another lot, in which case it is made as nearly rectangular as circumstances admit.

50. The breadth of a group lot fronting on a road or on a navigable river or lake must not be made greater than the depth.

51. As far as practicable, the boundaries of a group lot are straight lines running north and south, or east and west.

52. A group lot does not exceed one hundred and sixty acres. When a larger area is to be covered, it is subdivided into such a number of lots that none exceeds one hundred and sixty acres.

#### TOWN SITES.

53. A town site is made by the subdivision into town lots of a section, group lot or settlement lot, or of portions thereof.

In unsurveyed territory, the land is laid out into sections, settlement lots, or group lots, before the survey of the town site is commenced.

54. The streets and avenues of a town site cross at right angles.

The ordinary width of both streets and avenues is one chain, or sixty-six feet, but the main streets or avenues may be made one chain and fifty links, or ninety-nine feet.

The direction of the streets and avenues is made to conform to the natural features of the ground, the avenues following what is expected to be the direction of the main traffic.

55. One of the streets called 'Centre Street,' is laid out through what is expected to become the centre of the town. The other streets are laid out parallel to, and are numbered from Centre Street, the designation east or west, or north or south, being added

to the number of the street for indicating on what side of Centre Street is the street in question.

The avenues are laid out and numbered in the same manner as the streets.

56. In a town site fronting on navigable waters, an avenue ninety-nine feet wide is laid out along the shore, from which the numbering of the other avenues may commence.

57. The distance between the middle of two adjoining avenues is four chains; between the middle of two adjoining streets, it is ten chains, except when avenues or streets are more than sixty-six feet wide, in which case the above distances are increased accordingly.

58. A town block is the land comprised between two streets and two avenues. It is nine chains in length and three chains in width.

Blocks are numbered in regular succession from one upwards.

59. A block is subdivided into eighteen town lots, each one chain wide, and one chain and fifty links deep; they are numbered from one to eighteen in each block.

60. Posts are planted at all block and lot corners on the streets and avenues, but not in the interior of blocks, except in special cases in irregular blocks.

61. The method of laying out town sites is modified to suit circumstances, as appears desirable.

## CHAPTER II.

### FIELD WORK.

#### DIRECTION AND MEASUREMENT OF LINES.

62. The surveys of Dominion lands are astronomical, that is to say, the direction of the lines is referred to the astronomical meridian. The use of the magnetic needle for running such lines, or the limits of townships, sections or lots, or for establishing the boundaries of property of any kind or for ascertaining the courses of traverses in subdivision surveys, is not allowed, but it may be used as a check against errors, for sketching and for work of a like character.

63. In these instructions 'bearing' means the angle formed by a line with the astronomical meridian, this angle being reckoned from north, round through east, to  $360^\circ$ , east being  $90^\circ$ , south  $180^\circ$ , west  $270^\circ$  and north  $360^\circ$  or  $0^\circ$ . 'Azimuth' means the angle of a line with the astronomical meridian, such angle being reckoned from north, round either east or west, to  $180^\circ$ .

64. All azimuths and bearings shall be recorded in degrees and minutes, or degrees and decimals, as explained above.

65. All bearings in a township shall be referred to the astronomical meridian passing through the centre of the township, that is to say, the bearing returned for any line within the township shall be the angle formed by that line with the central meridian, such angle being reckoned from  $0^\circ$  to  $360^\circ$ .

66. Under the above rules, the bearing returned in the field notes of the subdivision for the western boundary of a township is the true astronomical bearing of such boundary plus the convergence for three sections. The bearing returned for the eastern boundary is the true astronomical bearing minus the convergence for three sections.

67. In the subdivision of a township of the third system of survey, the bearings returned in the field notes for the meridional boundaries of sections would, if the survey were perfectly accurate, be as shown in Fig. 6, calculated for township 29. The bearing of the central meridional section line would be due north. The bearings of the meridional section lines of the easterly half of the township would be west of north, and those of the westerly half would be east of north. The other section lines would be returned either as due east ( $90^\circ$ ) or due west ( $270^\circ$ ).

In the first system of survey, the meridional boundaries of sections, with the exception of the western outline of the township, are parallel to the eastern outline. Were the subdivision of the township perfectly accurate, all the meridional boundaries would be returned with the same bearing,  $359^\circ 57'$  or thereabouts.

68. In subdivision surveys, the convergence of meridians may be taken as one minute of arc per section on the international boundary. Thus the convergence between the central line and the exterior boundary of township one, or the angle formed by these two lines is three minutes, that is to say, three times the convergence for one section.

For townships farther north, the approximate value is taken from the diagram in the Astronomical Field Tables. The exact value of the convergence for one range is given in Table I under the heading 'Deflection.'

69. The point where an astronomical observation is made for ascertaining the direction of the meridian must be located by the survey. Where necessary or desirable, the bearings are referred to the meridian of a point other than the point of observation by adding or subtracting, as the case may be, the angular convergence of the meridians.

The change of meridians is made by adding the convergence to the bearings when the place of the astronomical observation is west of the meridian of the survey, and by subtracting the convergence when the place of observation is east of the meridian. Let it be assumed, for instance, that the bearing of the north boundary of section six, township one, found by astronomical observation at the northeast corner of the section is  $269^\circ 57'$ : the bearing to be used in subdividing the township and to be entered in the field notes is  $269^\circ 59'$ , that is to say, the observed bearing plus the convergence for two sections, which in this case is two minutes. Had the observation been made at the northeast corner of section one and  $270^\circ 05'$  found for the bearing of the north boundary of the section, the bearing referred to the central meridian would be  $270^\circ 02'$ , that is to say, the observed bearing minus the convergence for three sections, which is three minutes.

70. The bearings of every survey shall all be referred to a single meridian so that the angle of any two lines of the survey may be given by the difference of their bearings.

A survey extending over such a distance in longitude that the application of the above rule would be inconvenient may be divided into several portions, each with a separate meridian, but the angular change in the bearings in passing from one meridian to the next one, and the place where such change is made must be carefully noted.

71. Except in the survey of town sites, all lengths or distances shall be expressed in chains and links. In the survey of a town site, the lengths may be either all expressed in feet or all expressed in chains and links, but in no case shall both measures be used in one survey. Heights and depths shall in all cases be expressed in feet.

72. Measurements shall be made with steel band chains, tested frequently during use by comparison with the subsidiary standard of the surveyor. Steel bands provided with means of adjustment shall be corrected: in using bands not so provided, allowance shall be made for the error of the band.

The subsidiary standard is not to be used on field work, but is to be carefully preserved for purposes of comparison.

73. Previous to entering on their duties the chainmen shall be sworn according to the form below, and such oath shall be filed with the returns of the survey:

I, A. B., do solemnly swear that I will discharge the duty of chaining and measuring with exactness according to the best of my judgment and ability, and that I will render a true account of my chaining and measuring to C. D., Dominion Land Surveyor, by whom I have been appointed to such duty. So help me God.

(Signed) A. B.

74. In chaining over uneven ground, should the same be so broken as not to permit of the full chain being levelled, the measurement shall be made with such portion thereof as may be easily levelled, and particular care shall be taken at such times, in plumbing and dropping the pins, in order to obtain the accurate horizontal measurement.

Lines over sloping ground may be measured either by levelling the chain, as directed above, or by chaining along the surface of the ground, measuring the slope with a clinometer and applying the requisite correction.

75. In case the survey line be obstructed by a lake, pond, deep marsh or other obstacle, the surveyor shall pass it by right-angled offsets, or, if more convenient, shall ascertain the distance across by triangulation. The angle opposite to the base should

be, whenever practicable, at least thirty degrees. It must never be less than fifteen degrees. The three angles of the triangle must be measured and recorded.

76. All lines established as boundaries in woods are to be well opened out and to be further marked by blazed trees. A tree is blazed on three sides, namely, on the side on which the line passes, and on the two adjacent sides. Blazes are not to be omitted when there are trees more than two inches in diameter within fifty links from the line.

77. Under the provisions of clause 129 of the Dominion Lands Act, the boundary lines of townships, sections, legal subdivisions, lots, &c., are declared to be the lines defined by the mounds, posts or monuments placed or planted at the angles thereof.

Blazed lines, therefore, are not legal boundaries. When the closing error of a trial line opened out in the woods is less than the maximum error allowed for such a line, the post may, except on township boundaries, be established by offsetting without opening the true line. In order that the post may be readily found, it is connected with the trial line by opening an oblique line making an angle not greater than 5° with the trial line. Blazes are omitted from the last portion of the trial line, the oblique line being blazed instead. Offsetting the posts in this manner is, however, allowed only when the trial line strikes within fifty links of the corner; any trial line striking more than fifty links from the corner must be resurveyed, opened out and blazed, as provided in clauses 89, 94 and 99, whether the discrepancy be due to an error in the outlines or to any other cause.

#### TOWNSHIP OUTLINES.

78. Whenever the nature of the country permits, the first operation in laying out a given portion of country for settlement consists in the survey of 'blocks.'

In the first system of survey, a block contains four townships, being bounded by a base line, a correction line and two meridians. The base line is first surveyed, then the meridians, and the correction line across the two ranges is surveyed, first as a trial line, then as a true line. The block is 'quartered' into townships by straight lines by the township subdivider. Otherwise the manner of survey is the same as under the third system, and since very little of the territory in which this system is in force remains to be surveyed, no further description of it is necessary.

79. In the second system, the block contains sixteen townships included between successive correction lines and meridians four ranges apart. All the territory of this system having been already laid out into townships, no description of the method of survey of blocks is necessary.

In the third system a block embraces sixteen townships, bounded by two base lines and the meridians, four ranges apart, from them to the intermediate correction line.

80. The surveyor of township outlines divides the block into townships by projecting the interior meridians of the block, and surveys the other outlines of the townships by joining the corresponding corners on the meridians by straight lines, although this latter operation is very generally left for the surveyor charged with the duty of subdividing the townships into sections.

81. Frequently, however, mountains, large lakes, or other natural obstacles prevent the survey of the block as a whole. In such cases the interior lines of the block are projected according to the general rules in so far as they apply to the case.

82. The eastern and western exterior boundaries of the blocks are broken lines, each consisting of two meridians separated by the 'jog' at the correction line. The northern and southern limits (base lines) are parts of a polygon described on a parallel of latitude, by laying off, as chords thereto, the successive township sides, forming, as the case may be, the northern or southern outline of the block.

83. The road allowances along meridians are in all cases to be of the prescribed theoretic width. That the distribution of excess or defect is among the sections, and is not applied to the roads, does not materially affect the bearing of the north and south lines involved; the displacement at the extremes—but two-thirds of a link on each mile—being less than ordinary chaining is at all accurate enough to indicate.

84. In surveying meridian exteriors the surveyor of township outlines commences at one of the township corners of the base line. He carefully measures one or two miles of the base before beginning the subdivision of the block; this enables him to compare his chaining with that of the lines previously run.

85. The meridian is carried only as far as the correction line where a temporary post is left. The corresponding meridian is then surveyed from the township corner on the next base to the same correction line, and the jog run between the ends of the two meridians on the proper bearing. The north and south closing error is distributed equally between the two quarter sections adjoining and on each side of the correction line so as to make both quarter sections of the same depth. The monuments for township corners are now permanently established. No monuments are erected by the surveyor of township outlines between the township corners on the correction line.

86. Any difference in the chainage of two meridians causes corresponding deviations on the east and west lines joining the same; great care must therefore be bestowed on the measurements and every precaution taken to ensure accuracy.

87. In running across a block between two base lines or in establishing a meridian outline from a base line to the correction lines on both sides, the surveyor shall observe for azimuth at least once upon every meridian.

88. Surveyors of township outlines are requested to plant firmly and carefully the pickets marking their instrumental stations near the township corners, so that the subdivider may readily obtain the correct direction for starting his lines.

#### SUBDIVISION OF TOWNSHIPS.

89. A township is subdivided by first projecting the meridians, and then joining the corresponding section corners on them, first by trial and then by true lines. Table VI may be used for correcting the trial line; it gives the deflection of a line for deviations from one to one hundred and forty-nine links at the end of eighty-one chains. Except on township boundaries, posts may be offsetted from trial lines as provided in clause 77.

90. The only section lines to be surveyed, established and permanently marked as boundaries, are those along which the road allowances are. Their total length for a township of the third system is forty-two miles and twenty-seven chains, more or less, exclusive of township outlines, and for a township of the first or second system sixty-one miles and ten chains, more or less.

91. In the fourth system the lines to be surveyed are those corresponding to those surveyed in the third system; that is, all the north and south, and the alternate east and west section lines.

92. Before starting for his survey, the subdivider receives from the head office or from the surveyor of outlines, diagrams of the outlines previously surveyed. Should these diagrams not be forthcoming, the subdivider must call attention to the matter and ask for them.

93. Upon arriving at the township corner from which the survey is to be started, the subdivider measures carefully a mile of the township outline. This enables him to compare his chaining with that of the lines previously run, and to adjust his measurements so as to strike the corners on the outlines, but he must not make any change in his chain, and the distances recorded in the field book must be those actually found on the ground after proper tests of the chain with the subsidiary standard.

The surveyor endeavours to find the pickets marking the instrumental stations on the outline which are better guides for direction than the monuments.

94. The meridian exterior of a township, having been established by the surveyor of township outlines, the subdivider commences his operations by running the north and the south boundaries of the township if they have not been previously surveyed.

In order to do so, he joins, by a trial line, the opposite township corners on the meridians, and then plants the posts permanently on the true line, making all quarter sections equal. It is to be observed that the whole line across the township must be resurveyed as a true line: offsetting the posts in the manner described in clause 77 is not allowed for the boundaries of townships. Table VI gives the number of minutes by which the course of the trial line is to be altered in order to strike the post. The course of the true line, not of the trial line, is to be entered in the field notes.

Only one side of a correction line is to be surveyed at one time.

95. In running the north or the south limit of the road allowance along a correction line when the opposite limit has been previously established, the subdivider may find that owing to irregularities in the prior survey, the road allowance is, at some points, less than eighty links wide. In such a case he must correct the irregularities as provided in clause 196, or, if this cannot be done, he must deflect his own line at some section or quarter section corner so as to leave a road allowance of normal width.

When a correction line has to be deflected across the last fractional range in order to close on an initial meridian, the south or the north side, as the case may be, of the road allowance is broken in such a way as to leave the full width of one chain for the road (one chain and a half in the first and second systems of survey).

The general case is represented in Fig. 4.

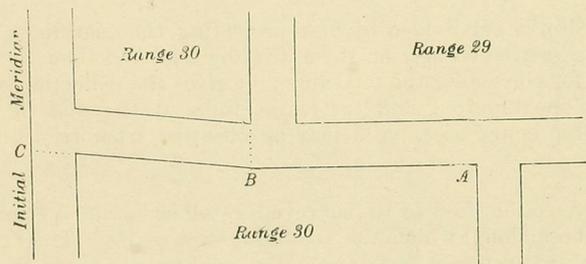


Fig. 4.

The northeast corner, A, of the last range is joined by a straight line to a point, B, one chain south of the post at the west end of the 'jog,' and this last point is again joined by a straight line to the corresponding post, C, of the initial meridian. The northern boundary of the township is thus a line, ABC, broken at B.

Another position of the lines is shown in Fig. 5, the initial meridian intersecting the 'jog.' The southeast corner, A, of the last range on the north side of the correction line, is joined by a straight line to a point, B, one chain north of the post at the eastern end of the 'jog,' and this last point is again joined by a straight line to the cor-

responding post, C, of the initial meridian. The southern boundary of the township is thus a line, ABC, broken at B.

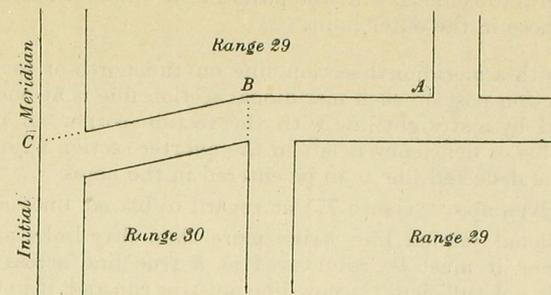


Fig. 5.

96. It has been explained, in the exposition of the system of survey, that sections in all the systems except the first, are of unequal width, on account of the convergence or divergence of meridians. To better illustrate this fact the convergence has been exaggerated in Fig. 6.

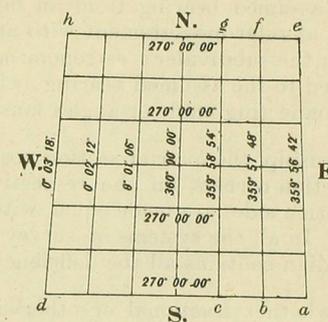


Fig. 6.

The angle formed by the meridional section lines with the east and west lines is different for each line, and varies uniformly from one corner of the township to the other. The surveyor shall not, therefore, start his meridional section lines at right angles to the township lines, but he must, in each case, calculate the angle formed by the lines from the data supplied to him on the diagram of township outlines or from his own measurements.

Supposing, for instance, the bearings of *ae* and *dh* to be  $359^{\circ} 59'$  and  $0^{\circ} 05'$ , the meridional section lines at *b*, *c*, &c., shall be run upon bearings of  $360^{\circ}$ ,  $0^{\circ} 01'$ ,  $0^{\circ} 02'$ ,  $0^{\circ} 03'$  and  $0^{\circ} 04'$ . These courses are turned off the line *ad*, the bearing of which is either given on the diagram of outlines or has been ascertained by the subdivider in surveying it.

The bearings on Fig. 6 are the theoretical bearings for township 29.

97. In the first system of survey, as already stated, the lines between sections are not true meridians, but are parallel to the eastern boundary of the township, and make with the south boundary of the township angles equal to the southeastern angle of the township. All the meridional lines are therefore to be started upon the same bearing, that is to say, upon the bearing of the eastern outline (referred to the central meridian).

98. In starting from a correction line, the surveyor shall give to the adjoining quarter section a depth proportional to those of the quarter sections at each end of the tier, as shown on the diagram of the township outlines.

He must be careful to connect with the posts in the inner limit of the road allowance, and not with those in the outer limit.

99. In closing with a meridional section line on the north or south boundary of a township, the last section post on such meridional section line is at once planted permanently and connected by a straight line with the section corner on the outline of the township. The surplus or deficiency is left in the quarter section adjoining the outline. The true course of the deflected line is to be entered in the notes.

The directions given above (clause 77) in regard to blazed lines apply in this case.

Should a meridional section line strike more than fifty links and less than one chain from the corner, it must be resurveyed as a true line across the last section. Offsetting the posts is not sufficient; a new line must be run and, if in the woods, opened throughout. Should the line strike more than one chain and less than one chain and fifty links from the corner, the line must be resurveyed across the two last sections, and so on, adding one more section for every increase of fifty links in the closing error.

The line run from one section corner along the northern limit of a section must strike within fifty links of the opposite section corner. The line is offsetted as allowed by clause 77. Should the line strike more than fifty links from the section corner, it must be resurveyed and, if in the woods, opened out.

A line started upon an assumed bearing from an outline surveyed by another surveyor must be connected by angular measurement with at least one line of which the bearing has been deduced from the subdivider's astronomical observations, so that the proper correction may be applied to the assumed bearing before entering it in the office copy of the field notes. The connecting angle or angles must be recorded.

100. In subdividing a township, the quarter section posts on east and west lines are placed midway between the section corners on the respective meridional section lines, that is to say, both quarter section sides are made equal, with the exception noted above for the first system of survey. In all the systems of survey also, the quarter section on the east side of an initial meridian contains all the deficiency.

101. When a township, whether fractional or otherwise, adjoins lands surveyed under a different system, all lines within such township must be stopped at the inner side of the road allowance dividing the two systems and a corner post or monument erected at the point of intersection. In no case must a line be extended across the aforesaid road allowance.

102. A road allowance of the same width as in the adjoining township is, if necessary, to be left on the boundaries of all Indian reserves. In determining whether a road allowance is necessary or not, the two most important considerations to be taken into account are, firstly, that every quarter section shall be accessible by a road, and secondly, that settlers shall have the means of going from one part of the township to another by a reasonably direct route, thus overcoming the inconvenience which might result from the closing of some of the regular roads by the reserve.

The intersections of the section lines with that side of the road allowance which adjoins the township are to be indicated by proper posts or monuments. When a reserve not yet surveyed is to be formed of a certain number of full sections, the surveyor, in establishing the same, shall plant the posts as usual on the west and south boundaries; but on the north and east sides they are to be planted in the north or east limit of the road allowance. The side of the road allowance adjoining the township is the only one to be posted by the surveyors employed by the Department of the Interior. If no road allowance is left, all surveyed lines closing on the Indian reserve are to be posted on the reserve limit.

Indian reserve boundaries and other lines must be retraced, when the areas of the quarter sections adjoining cannot be found without such a survey.

103. As a general rule, no lines are to be run in Indian reserves. Should it be necessary, in surveying a base line or other important governing line, to cross an Indian reserve, no posts are to be planted, nor permanent marks of any kind to be left within the boundaries of the reserve.

104. Connection is to be made with the corner of any group lot, mineral claim or other parcel of land previously laid out within the township and with the monuments of surveyed roads and with properly identified points of railway surveys.

105. A picket or hub called 'traverse hub' is firmly planted on the surveyed line near the point where the line intersects the bank of a lake or river which has to be traversed, as hereinafter explained.

106. Owing to the mountainous character of British Columbia, it is impracticable to survey the base lines and block and township outlines as on the prairie. All the surveys are based upon a traverse survey made along the railway line from which the positions of the corners of the sections through which the railway passes have been computed.

These positions have been tabulated and printed in a list of 'Positions of Stations on the C. P. R. Traverse,' copies of which are furnished to surveyors making surveys in the railway belt.

In this list the actual position of the instrument in the traverse survey is given by reference to the northeast corner of the section in which the point lies.

107. The surveyor first finds the instrumental station, and then measures the given distances east and north; this gives him the point at which he is to place the section corner post.

The instrumental station was usually on or near the track, and hence the hub is generally not to be found, being covered with ballast. Reference is made in the list to bearing trees or posts, called C. P. T. (Canadian Pacific Traverse) posts. The given bearings and distances from the station to the post enable the surveyor to locate the station when he finds the bearing post.

Surveyors are warned that some of these bearing posts have been moved; to avoid error, it is necessary to connect with two or more of them.

108. When the section corner has been placed in the manner aforesaid, the survey of the section lines is continued therefrom by laying off the theoretical widths and depths of sections.

109. Where cairns or posts have been established by the trigonometrical survey in the mountains, the sectional survey may be based, in like manner, on their tabulated positions.

110. The outer limit of the railway belt follows section lines shown on the sectional maps of the belt.

In making a survey for the purpose of determining the limits of the belt, the surveyor may run township or section lines, or make a traverse of some stream, road or lake leading to the limit, from which he can locate the section lines in that vicinity, but the survey must be checked by another surveyed line forming a closed circuit.

111. In subdividing townships, at least one astronomical observation for ascertaining the direction of the meridian shall be made in each township, but two or more are desirable. A record of the observations and of their calculations shall be furnished.

In an ordinary subdivision survey, the section lines are run as trial lines between posts previously established. When the weather is not favourable for observing, the subdivision may be commenced with an assumed meridian, using for instance, the bearing of one of the township outlines given on the diagram of outlines. The astronomical observation is taken when a favourable opportunity occurs, but no change is made in the field notes until the subdivision of the township has been completed, when all the bearings entered are corrected by adding or subtracting, as the case may be, the error of the assumed meridian deduced from the astronomical observation, due allowance being made for convergence when the observation is made elsewhere than on the central meridian of the township.

112. Except as provided hereunder, the limit of error allowed in the plot of every block of two sections in a township is fifty links. Should the plot not close within fifty links, the section lines around the block must be retraced, so as to obtain the correct bearings and lengths.

*or more of the boundary of a block have been*  
The exception is when one side of the sections is an outline surveyed by another surveyor in which case the closing error may, owing to an error on the outline, be in excess of fifty links. Should this error exceed one chain and fifty links, the outline must be resurveyed or retraced, as directed by clauses 195, 196 and 197.

The limit of error allowed in the plot of a traverse between two traverse hubs is fifty links; should the error exceed fifty links, the courses of the traverse must be retraced.

The closing errors of these plots are checked in the examination of the field notes.

A surveyor is expected to do his work with reasonable care. No survey will be accepted in which the number of errors denotes carelessness, although each individual error may be under fifty links.

113. No township or section line, except in subdivided townships the section lines along which there are no road allowances, is to be surveyed without instructions from the Surveyor-General. In the Railway Belt in British Columbia, instructions are required for all township or section lines without exception.

A surveyor who is requested to survey such lines must apply for instructions before commencing the survey.

#### SETTLEMENT SURVEYS.

114. Before proceeding with the survey of a settlement, the surveyor shall make a rough compass survey of the road or shore upon which the settlers are located and shall make inquiries as to the claims of each. Upon the plan of the compass survey, he shall endeavour to lay out the land into lots of such size and shape as will best meet the wishes and legitimate claims of the occupants. It is essential that each settler shall remain in possession of his improvements and the lots should be laid out accordingly, as far as it can be done. A lot must not, as a rule, exceed one hundred and sixty acres. The base line is located approximately upon the plan, placing it close to the improvements.

115. The surveyor now proceeds with the survey of the base line. The direction of the meridian is ascertained by an astronomical observation before commencing the survey or a conventional meridian is assumed, and the bearings are corrected after the survey is completed.

The surveyor shall observe at least twice for azimuth during the course of the survey.

The base line is run at right angles to the direction of the lots, and is offsetted along the lot lines when it is necessary to do so for keeping close to the improvements.

The limits of the lots are marked upon the base line.

116. The rear line is next established parallel to the base line and the rear corners of the lots marked. Connection is made at suitable intervals between the base and the rear line by running some of the lot lines.

117. The front of the lots, whether the shore of a lake, a river or a road, is now traversed. To be suitable as a water front, the river or lake must have well defined banks; the edge of a marsh is inadmissible as a boundary and must be replaced by straight lines. The middle of an unnavigable river may, when the river is well defined, be adopted as a boundary.

118. The survey is completed by laying out the public highway across the settlement, and such additional roads as are necessary for giving access to all the lots or for other purposes. The survey of the roads is connected to the base or rear lines at suitable intervals.

#### SURVEY OF GROUP LOTS.

119. Before undertaking the survey of a group lot, the surveyor shall apply for a lot number.

120. An astronomical observation for ascertaining the direction of the meridian is to be made before commencing the survey, unless the said direction can be obtained from the lines of an adjoining survey previously confirmed.

121. Having fixed upon the initial corner of the lot, the surveyor shall run from this corner and mark the limits of the lot. Where a part of the limit is over inaccessible ground, the limit is run as far as it can be done, and the corner is indicated by a witness monument which is connected to the next limit by a traverse. Proper monuments are erected at the other corners. Except as stated above, all the boundaries of the lot must be surveyed.

122. Where the shore of a lake or stream forms a boundary, it is traversed, and a monument is established near the shore upon each of the lot lines.

123. The survey must be connected to some previously confirmed survey, if within two miles, and with all previously established survey monuments within ten chains from the limits of the lot.

In the absence of any confirmed survey within two miles, the lot shall be connected to some prominent, permanent and well defined natural feature.

#### TOWN SITE SURVEYS.

124. A town site is laid out by surveying both sides of the streets and both sides of the avenues, and marking the corners of the lots. No post is to be located by offset from a surveyed line.

One of the four corners at the intersection of a street and of an avenue is marked by an iron post; the marks at other corners are wooden posts.

Natural boundaries for town lots are undesirable; when adopted, they must be well defined and carefully traversed.

125. The survey is properly connected with the boundaries of the section or lot in which the town site is situated.

#### SURVEY OF PUBLIC HIGHWAYS.

126. A public highway is surveyed either along the centre of the highway or along one of its outer limits. In a wooded country it is preferable to follow the centre line, while in prairie it is more convenient to follow one of the limits.

127. The starting and closing points of the highway must be connected to some corner or monument of Dominion land surveys; connection is also made with a section or quarter section corner upon every surveyed section line intersected, and with lot corners at suitable intervals in settlements or group lots.

128. In running his lines, the surveyor shall set the transit so as to give by direct reading the bearings of the lines in the manner hereinafter described for traverse surveys.

129. When the survey is made along one of the limits of the highway, a monument is to be established at every instrumental station. The position of the corner in the opposite limit of the highway is determined by taking the mean of the bearings of the front and back courses, and either adding or subtracting 90°.

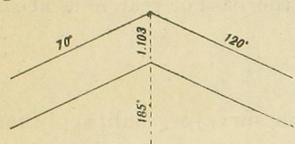


Fig. 7.

$$\frac{70^\circ + 120^\circ}{2} + 90^\circ = 185^\circ$$

Had the survey been made along the other limit of the road, the bearing would be :

$$\frac{70^\circ + 120^\circ}{2} - 90^\circ = 5^\circ$$

The distance in chains along the bearing to the opposite limit is, for a highway one chain wide, equal to the secant of one-half the difference of the bearings of the front and back courses. Thus in the example above given (Fig. 7) one-half the difference of bearings is :

$$\frac{120^\circ - 70^\circ}{2} = 25^\circ$$

the secant of which is 1.103.

The distance to the opposite limit is therefore one chain ten links and three-tenths of a link.

This distance is given for differences of bearings from 0° to 120° in Table VIII. This table, printed on cardboard for carrying in the pocket, may be had upon application to the head office.

130. When the survey is made along the centre of the highway, the corners are located in the manner above described in both limits of the highway, but the distance measured along the bisecting line to the right and to the left of the instrumental station is only one-half of the tabular distance.

131. Additional monuments are placed to define the highway when the instrumental stations are more than twenty chains apart.

In some cases, the monuments upon one of the limits of the road are omitted; the surveyor is informed when they are not needed.

## TRAVERSES.

132. In connection with surveys of Dominion lands, traverses are made for the following purposes :—

For defining the boundaries and the contents of a parcel of land fronting upon a river or lake.

For ascertaining the area of the portion of a parcel of land occupied by a body of water and thereby rendered useless for farming.

For connecting a point or line of a survey with another point or line of the same, or of another survey, or with some other reference object.

133. The traverse of a water front of a parcel is made for ascertaining the contents of the parcel and as a means of identification of the water boundary.

Other traverses, such as that of a lake entirely within a quarter section, are made only for the purpose of ascertaining the quantity of land subject to sale and to be paid for by the purchaser.

134. The courses of a traverse are not boundaries of the parcels fronting on bodies of water. In the case of a lake or navigable stream, the boundary is the edge of the bed of the lake or stream, which edge is called the *bank*.

The bed of a body of water has been defined as the land covered so long by water as to prevent vegetation, and the bank is the line where vegetation ceases. The *shore* is the space between the bank and the water.

In making traverse surveys, the surveyor must bear in mind the following rules determining the ownership of lands fronting upon bodies of water and the rights of the owners.

135. The grantee of a parcel of land fronting upon a lake or river acquires not only the land actually surveyed, but also the right to future additions to the parcel which may result from gradual alluvion or dereliction resulting from natural causes.

Where the land is slowly and imperceptibly added to, either by alluvion or by the recession of the water of a river or lake, whether navigable or not, the new land thus formed belongs to the riparian owner in front of whose land it is formed, and the process is held to be imperceptible where its effects are so gradual that it is not discernible from moment to moment, though the fact that there has been an increase in the land may be perceptible from year to year or at shorter intervals. The converse is also true, that lands gradually encroached upon by the water upon which they border cease to the extent of the encroachment to belong to the former owner.

On the other hand, sudden and sensible additions to or subtractions from lands arising from similar causes do not cause any change in ownership.

136. Riparian owners whose lands border upon unnavigable waters are held to be the owners of the bed of such waters in front of their holdings *ad filum aque*. Their rights in this regard may depend to some extent upon the precise terms of the description by which their lands have been conveyed to them.

137. From the foregoing it follows that for a lake or navigable river the line to be traversed is the bank. For a river which is not navigable, but which is adopted as a boundary, the line to be traversed is the middle of the main channel, 'middle' being in the sense not of midway between the banks, but of the line following the centre of the main body of water flowing in the channel. In the first case, a parcel fronting on the river does not include the bed, nor does it include the adjoining islands unless the survey shows distinctly that the islands are included. A parcel fronting on an unnavigable stream includes the river bed and the adjoining islands as far as the middle of the stream.

138. The edge of a marsh, or any other natural feature which is not susceptible of a precise definition, is inadmissible as a boundary. When a parcel of land extends to such a feature, as in settlements or group lots, the limit is to be defined by one or several straight lines, the corners being indicated by witness monuments if their positions are unsuitable for the erection of monuments.

139. In subdividing townships, such rivers as are specially mentioned in the instructions and all lakes over twenty acres in extent, together with any islands containing not less than twenty acres, are to be accurately surveyed.

140. The bank of a river is referred to as the *right* or *left* bank, according as it is to the right or to the left, looking down the stream.

141. The area occupied by the bed of a river is deducted from the area of a subdivision when the river, although not navigable, is over three chains wide. In such a case, both banks of the river are traversed, the traverse of the middle being omitted, but the islands less than 20 acres in extent may be included in the adjoining fractional subdivisions.

142. Shallow lakes or marshes which occasionally dry up are not to be traversed.

Marshes of which the edge varies ten chains or more, according to the height of the water, do not require traversing, as the land may be dealt with by selecting the legal subdivisions which more nearly include the land suitable for farming. A marsh producing hay must not be traversed.

143. A traverse survey is commenced at one of the traverse hubs planted by the surveyor while running the section or lot lines, and is closed upon the next traverse hub or upon a section, quarter section or lot corner. The traverse of a lake or island lying entirely within a section or lot must be properly connected with the rest of the survey.

144. In running his lines the surveyor shall set his transit so as to give by direct reading the bearings of the lines, that is to say, the instrument must be so placed that it shall read  $0^\circ$  when the telescope is pointing north,  $90^\circ$  for east,  $180^\circ$  for south, and  $270^\circ$  for west. In order to do so, the instrument is placed over the traverse station and after levelling it, the vernier is clamped to read the bearing of the last course. The telescope is next turned on the back picket, and the whole instrument is clamped in that position by clamping the lower plate. The vernier plate is then unclamped, the telescope is transited around its horizontal axis and directed upon the front picket. The bearing of the front course is now read upon the instrument. The compass may be used to advantage as a check on the orientation of the instrument for preventing mistakes.

Traverses made by means of deflection angles or by measuring the angles between successive courses will not be accepted.

145. A traverse of which the object is merely to ascertain an area may be made with a stadia or micrometer of an approved pattern, provided the closing error does not exceed one chain in one hundred chains. The points of the bank or traversed line fixed by the survey shall not be more than ten chains apart on township surveys, or more than five chains apart on other surveys. Offsets shall not be greater than four chains on township surveys and two chains on other surveys. Distances measured by stadia or micrometer must not exceed one-half a mile. Other traverses shall be chained unless permission is obtained to use the stadia or micrometer.

No blazes or permanent marks of any description are made on traverse lines.

146. Every lake or river traversed must be given a name or designation so that it may be referred to in describing parcels of land fronting upon it.

147. As a general rule, subject to exceptions, a quarter section is considered as sufficiently surveyed for disposal when two of its corners are indicated on the ground, either by corner or witness monuments. A quarter section made fractional by water or otherwise must have its area ascertained before it can be dealt with.

It is essential that a surveyor commencing a survey should complete it to such an extent that the land may be thrown open for entry or sale, and no traverse should be omitted which is necessary for that purpose.

## BOUNDARY MONUMENTS.

148. Having ascertained by exact running and measurement the proper point for establishing the township, section or quarter section corner, as the case may be, the surveyor, in marking the same, is to be governed by the following directions:—

149. Only a single row of monuments to indicate the corners of the townships or sections (except as hereinafter provided) is placed on any survey line. These posts and monuments are placed in the west limit of the road allowances on north and south lines, and in the south limit of road allowances on east and west lines, or on the line between the sections where there are no road allowances; and in all cases fix and govern the positions of the boundary corners of the adjoining townships, sections or quarter sections on both sides of the road allowance or line.

150. The township, section or quarter section corners on correction lines, or on lines between different systems of survey, are in all cases indicated by monuments erected and marked independently for the townships on each side; those for the townships north or east of the line, in the north or east limit of the road allowance, and those for the townships south or west, in the south or west limit. Where a road allowance is left, Indian reserve boundaries are also posted on both sides of the road allowance; on one side for the reserve and on the other side for the township.

151. Township and section corners are indicated by pointed iron tubes, marked as hereinafter described, and driven perpendicularly to within ten inches of the top. The iron tube is five feet long and one and three-eighths of an inch in diameter for township corners, and three feet long and three-quarters of an inch in diameter for section corners. The upper end is squared and a crown is stamped on one of the faces.

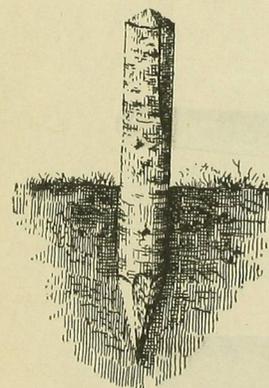


Fig. 8. Post for quarter section corner.

152. A quarter section corner is marked by a wooden post flattened on two sides and marked with the fraction  $\frac{1}{4}$  (fraction-wise) to identify it as a quarter section post. The post (Fig. 8) is two feet six inches long and three inches wide on the flat face. It is driven eighteen inches into the ground, the flat sides facing in the direction of the line. The post is bevelled on top to turn rain. When wood for the post is not to be found within three miles from the site of a quarter section corner, no post need be planted, the corner being indicated simply by the four pits, or mound and pits, as hereinafter provided.

A corner falling in a lake or marsh not over three feet deep is marked by a wooden post as above, but not less than five inches in diameter and long enough to be driven three feet into the ground and to show six inches above the water.

153. The post or tube is in all cases placed exactly at the corner it is meant to indicate. A mound or pits, or both, must also be made, except at quarter section corners in marshes where it is not possible to dig pits.

154. Mounds (Fig. 11) are of the form of square-based pyramids, six feet square at the base and three feet high for township corners, and five feet square by two and one-half feet high for section and quarter section corners.

155. In the formation of mounds, the earth is taken from four several "pits" three feet square and eighteen inches deep, the centre of the pits being four feet six inches

outside and opposite the centres of the respective bases (Fig. 12). These mounds are formed of solid earth, roots and all foreign substances being excluded, and the earth well pressed down with the spade during the process. In order to facilitate the speedy erection of a mound, a rope skeleton may be used. By taking hold of each corner and making a knot of the three lines running to it, the line is carried without becoming tangled; or the spade used may have marked on it the distance from the centre to the corners of the mound and to the sides of the pits, and small pickets may be planted at those distances and in the proper directions. The contents of a pit are 13.5 cubic feet.



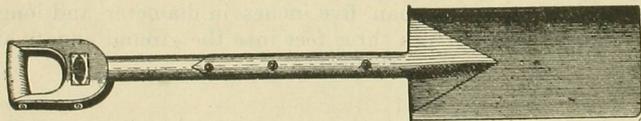
Draining spade, No. 1.



Post-hole spade.



Draining spade, No. 4, with foot tread.



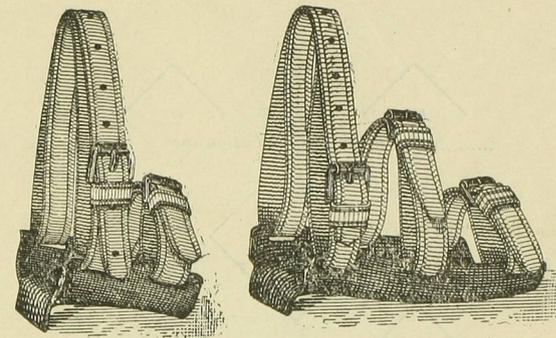
Ditching spade.

Fig. 9—Spades for digging pits.

For digging in hard ground or among brush and roots, a post-hole or a draining spade is used. These spades are made in two grades, heavy and light: the heavy grade is preferable. They have long concave narrow blades rounded at the point and

made of heavy plate. The handles are much stronger than in ordinary spades, so that considerable pressure can be applied without danger of breaking either the handle or the shank.

The blade of the post-hole spade is 15 inches long,  $5\frac{1}{2}$  inches wide at the head and 6 inches wide at the point. There are four sizes of draining spades. The blade of No. 1 is 14 inches long,  $7\frac{1}{2}$  wide at the head and  $5\frac{1}{2}$  at the point; the blade of No. 4 is 18 inches long,  $4\frac{1}{2}$  wide at the head and 3 inches at the point. No. 3 is one inch shorter than No. 4; No. 2 is wider than No. 3. The blades being so narrow, a foot tread is necessary with all draining spades except No. 1.



Short shoe plate. Long shoe plate for left foot.

Fig. 10—Shoe plates for mounders.

The digger should have a shoe plate made of  $\frac{3}{16}$  steel plate cut to the size of his shoe and fastened to the foot by straps or laces. Some men use a plate extending from the heel about half way to the toe, shoving down the spade from the instep: others use a plate extending from the heel to the toe and shove down the spade from the instep or from the ball of the foot. For digging with comfort, rigidity of this plate is desirable. When walking from one point to another, the steel sole is tied to the spade and carried over the shoulder.

It is advisable to have a shovel for throwing out the loose earth. In soil easily dug, the excavation can be carried on rapidly with the shovel when the surface has been broken with the spade.

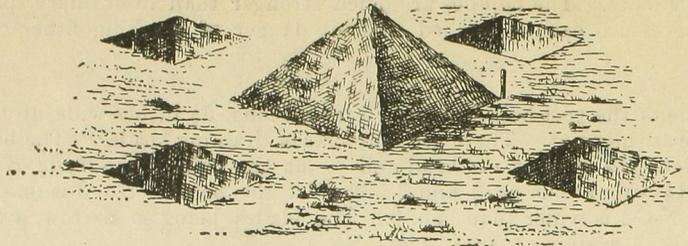


Fig. 11. Post, mound and pits—Perspective.

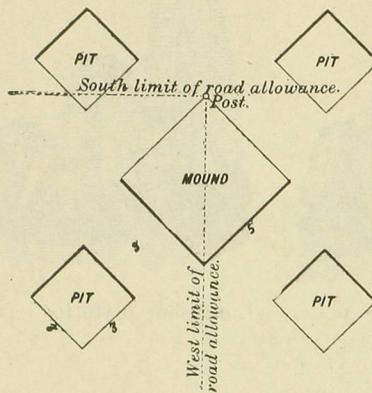


Fig. 12. Post, mound and pits—Plan.

156. Whenever stones can be readily procured, mounds may be built of stones properly piled so as to conform as nearly as possible in size and shape to the earth mounds (Fig. 13). A mound must not be made partly of stone and partly of earth. When a stone mound is built, pits are required as with an earth mound, when it is possible to make them.

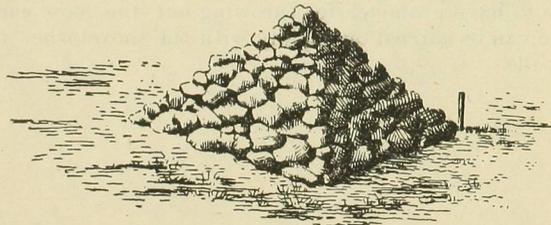


Fig. 13. Stone mound—Perspective.

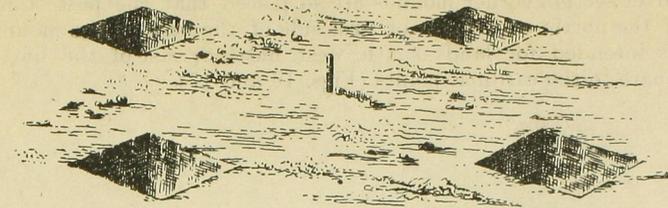


Fig. 14. Post and pits—Perspective.

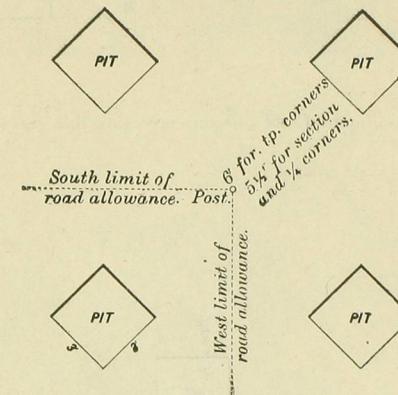


Fig. 15. Post and pits—Plan.

157. When a mound is not built, the pits are placed at the same distances from one another as they would be if the mound were built, and at the same distance from the post as they would be from the centre of the mound (Figs. 14 and 15). In prairie, at township, section and quarter section corners, pits are dug, but no mound is built. The earth from the pits is scattered about, so that they may not be filled again by cattle pawing the earth into the pits.

158. In woods, willows or other scrub a mound and pits are made at all corners.

In wooded spots, the positions of the pits relative to the directions of the lines may, when necessary, be altered to suit circumstances, provided the distances between them and from the centre of the mound are preserved. One of the pits may be omitted, when, on account of large trees or other obstacles, it is found impracticable to dig the four pits.

159. In prairie the rule as to size, depth and position of pits will be rigidly enforced.

160. The mound thrown up at a township, section or quarter section corner is so placed that the post stands at the northerly angle or point thereof, and that the mound stands diagonally to the cardinal points (Fig. 12).

161. Except that on correction lines, the lines between different systems of survey, the outer limits of the roads around Indian reserves, and generally all lines the posts on which mark the boundaries of lands on one side only of the line, the township,

section and quarter section corner mounds are so placed that the post stands precisely in the centre of the north, east, south or west side of the base of the mound, according as the corner is intended for lands south, west, north or east of the line, the mound being placed square to the cardinal points (Figs. 16 and 17).

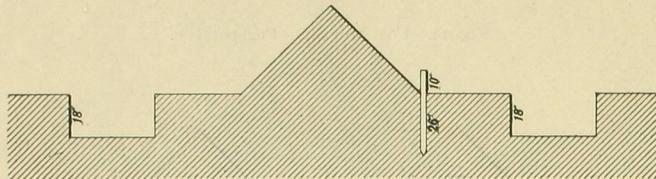


Fig. 16. Post, mound and pits on correction line—Section.

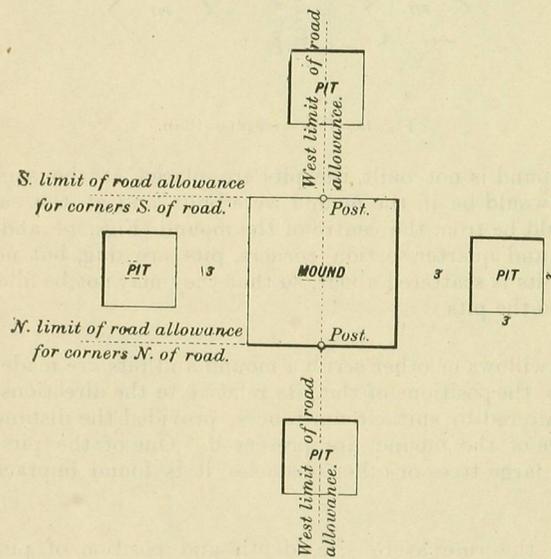


Fig. 17. Post, mound and pits on correction line—Plan.

162. In prairie, where there is no mound, the square formed by the four pits stands square with the cardinal points at corners which govern lands on both sides of the line,

and diagonally to the cardinal points at corners governing one side only. The post stands at the intersection of the diagonals of the square (Figs. 15 and 18).

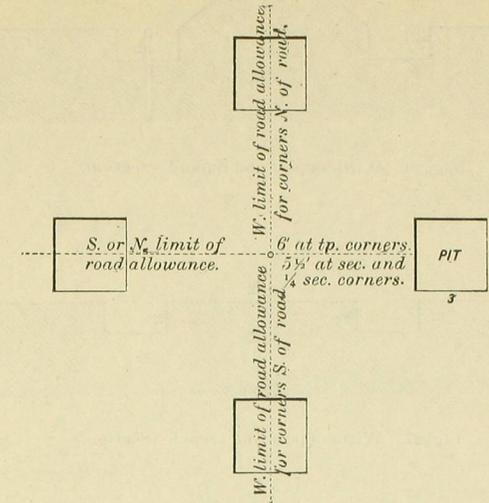


Fig. 18. Post and pits on correction line—Plan.

163. The mound and the pits for a quarter section corner are the same in size and position as those for a section corner.

164. If a township or section corner fall in a lake, or bed of a stream, on an inaccessible mountain or in any other locality unfavourable to the planting of a post, the digging of pits or the erection of a mound, the surveyor perpetuates such corner by a witness iron post with trench, or mound and trench, at the nearest suitable point of the surveyed line, that is either north, south, east, or west of the true corner. The distance in chains and the bearing of the site of the true corner from such witness post are cut on the post, the bearing being indicated by one of the letters N., S., E., or W. By placing the monument at any number of full chains from the corner, the marking of the post is simplified. Care must be taken to indicate the bearing from the witness post to the true corner; thus, a witness post south of the true corner is marked with letter 'N' for north.

A witness monument is not to be placed on a road allowance, public highway, or travelled road.

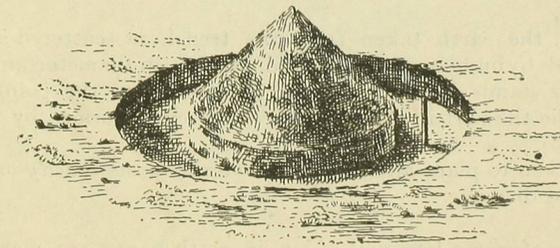


Fig. 19. Witness post and mound—Perspective.

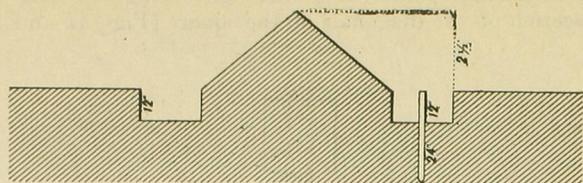


Fig. 20. Witness post and mound—Section.

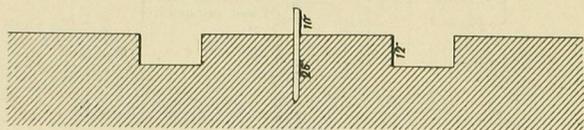


Fig. 21. Witness post and trench—Section.

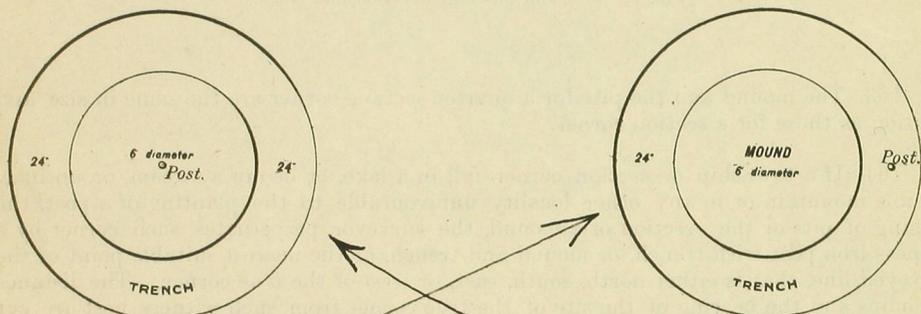


Fig. 22. Witness post and mound—Plan.

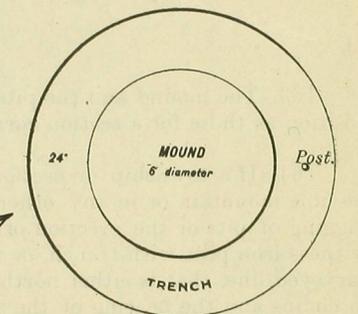


Fig. 23. Witness post and trench—Plan.

165. No witness post, mound or trench is required to mark the position of a quarter section corner.

166. A witness trench is circular, of six feet inside diameter. The trench proper is twenty-four inches wide and twelve inches deep (Fig. 23).

167. In prairie, the earth taken from the trench is scattered about, but in the woods it is employed to build a conical mound, six feet in diameter and two and a half feet high. The post stands in the middle of the trench at the point nearest to the corner while in prairie the post is at the centre of the circle formed by the trench (Figs. 19, 20, 21, 22 and 23).

Care must be taken to plant all corner and witness posts *exactly on line*, as well as at the correct chained distance.

168. The corners of group lots, and of lots in settlements are marked like section corners and indicated by witness posts, mounds and pits. When iron posts are not available, wooden posts may be used.

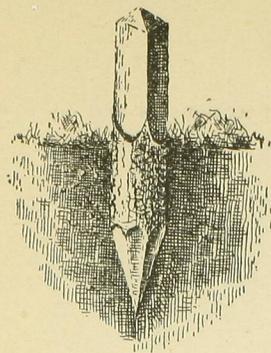


Fig. 24. Wooden post for lot corners and public highways.

170. The monuments erected for marking the limits of highways are the same as at section corners on correction lines. When monuments are erected in both limits, iron posts are used on one side, and wooden posts, like those prescribed for the corners of group or settlement lots, may be used on the other side.

171. No mounds or pits are made for perpetuating the posts of a town site. The iron posts for the corners of blocks are the same as for section corners. The other corners are marked by wooden posts three inches square and twenty-four inches long, sunk fifteen inches in the ground.

172. No monuments are to be erected in positions where they are liable to destruction; they must be placed far enough from rivers to be safe from obliteration by floods. When the site of a corner falls in an exposed position, a witness monument must be erected.

173. Pits must not be made in the middle of a travelled road or trail; a corner falling in such a place is indicated by a witness monument.

174. Surveyors are forbidden to erect a second boundary monument at a corner which they find already marked on the ground unless they are authorized to destroy the monument found. The position of the latter, if destroyed, must be accurately measured and noted. In case of doubt, the surveyor must telegraph for instructions.

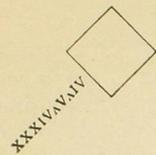
MARKS ON POSTS.

175. The post planted at a township or section corner not on a correction line or on a line between different systems of survey or on an Indian reserve line, is marked on its southwest side with the number of the section the northeast corner of which the post is to indicate, followed by the numbers of the township and range in which that section lies. The number of the section is at the top of the post, then follows the number of the township and the lowest number is the range.



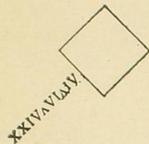
Fig. 25. Township corner.

For the corner between townships 5 and 6, and the 3rd and 4th ranges.



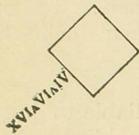
For the northerly corner between sections 34 and 35, township 5, range 4.

Fig. 26. Section corner.



For the easterly corner between sections 24 and 25, township 6, range 4.

Fig. 27. Section corner.

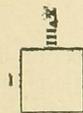


For the corner between sections 15, 16, 21, 22, township 6, range 4.

Fig. 28. Section corner.

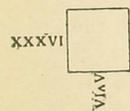
176. Posts at township and section corners on correction lines are marked exclusively for the townships and sections on the respective sides of the road allowance. They have the number of section on the west side, and the number of township and range on the north or south side for posts north or south of the road allowance respectively.

For instance :—



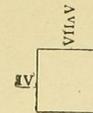
For the southeast corner of township 3, range 10.

Fig. 29. Township corner on correction line.



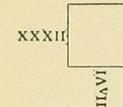
For the northeast corner of township 6, range 5.

Fig. 30. Township corner on correction line.



For the southerly corner between sections 3 and 4, township 7, range 5.

Fig. 31. Section corner on correction line.



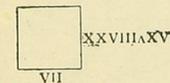
For the northerly corner between sections 32 and 33, township 2, range 6.

Fig. 32. Section corner on correction line.

177. Posts at township and section corners on east and west lines dividing two systems of survey are marked in the same manner as posts on correction lines.

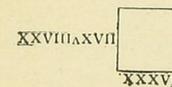
Posts at township and section corners on north and south lines dividing two systems of survey are marked on their south side with the number of the section the north boundary of which they indicate, and with the number of the township and range on their east or west side, according as the posts are on the east or west side of the road allowance respectively.

For instance :—



For the post marking the northwesterly corner of section 7, township 28, range 16, west of second meridian, on the east side of the road allowance dividing the second from the third system of survey.

Fig. 33. Section corner on line between two systems of survey.



For the northeasterly corner of township 28, range 17, west of the second meridian.

Fig. 34. Township corner on line between two systems of survey.

178. Similarly with posts planted on the limits of road allowances adjoining Indian reserves, and on the lines of other reserves, settlements, &c., the general rule being that the sides of mounds, pits, &c., which govern townships and sections on both sides of the road allowance are to be set diagonally, and the posts are to be marked accordingly; but those which govern only townships and sections on one side of the road are set square to the cardinal points.

179. Quarter section posts are always set so that the flat sides face the direction of the line, and they are marked with the fraction  $\frac{1}{4}$ .

180. In ranges numbered from the principal meridian, the letter W. or E. is marked on the post after the number of the range, to denote that it is west or east of the meridian, as for instance :—

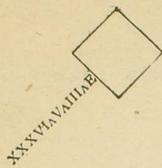


Fig. 35. Township corner east of Principal Meridian.

For the township corner between townships 5 and 6, and the 3rd and 4th ranges east of the principal meridian.



Fig. 36. Section corner west of Principal Meridian.

For the corner between sections 10, 11, 14, 15, township 7, range 4, west of the principal meridian.

The letters W. and E. are not to be marked for any meridian other than the principal meridian. The number of meridian is never to be marked.

181. Witness posts are marked on the side facing the corner with the distance in chains and the bearing thereto, thus :

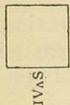


Fig. 37. Witness post.

For witness post standing four chains north of the corner of the section.

182. A post on the line between two lots of a settlement is marked on two opposite faces with the numbers of the adjoining lots.

183. The number of the lot, the number of the group and the number of the corner are marked on the post at a corner of a group lot.

184. A witness post for a settlement lot has cut on two faces the numbers of the adjoining lots. Upon another face are cut or written in red chalk the bearing and distance from the witness post to the corner.

185. A witness post for a group lot is marked with the number of the lot, the number of the group, and the bearing and distance from the witness post to the corner.

186. A post between two town lots is marked on the faces perpendicular to the street or avenue with the numbers of the adjoining lots. In addition thereto, the number of the block preceded by the letter B is inscribed on one of the faces below the number of the lot.

At a block corner, the letter S is inscribed on the face next to the street.

187. The post at a corner of a highway survey is marked on one face with the number of the station and upon another face with the letter R. Intermediate posts are marked with the number of the last station followed by the letter A or B or C, &c., for the first, second, or third post, &c., after the station. The letter R is inscribed upon another face. The posts on opposite sides of the road are marked alike.

188. All marks on posts are to be cut neatly and distinctly.

No mark is to be made on the face of the iron post stamped with the Crown.

## RESURVEYS, RETRACEMENTS AND RESTORATIONS.

189. A *resurvey* is a survey made for the purpose of placing in correct position, corner or witness monuments lost or incorrectly placed by a previous survey.

190. A *retracement* is the survey of a line of a previous survey for the purpose of plotting a plan representing correctly the line as it is on the ground.

191. A *restoration* survey is the survey made for the purpose of restoring the obliterated monuments of a previous survey.

192. A monument is *obliterated* when its position can be ascertained beyond reasonable doubt, either by traces of the original monument or by other evidence, although the monument itself has partly or entirely disappeared.

193. A monument is *lost* when its position cannot be ascertained beyond reasonable doubt.

194. It is the duty of a surveyor to report at once any error which he may discover in previous surveys or any duplicate monument which he may find. A surveyor is expected to restore every monument of a previous survey struck by his lines, when such monument is not in good condition.

Where any section corners have been marked by wooden posts, the surveyor is to substitute iron posts and to build mounds or pits.

In restoring the monument at a section corner originally marked by a wooden post in mound, the surveyor must take care to place the iron post at the exact place formerly occupied by the wooden post, that is to say, in the centre of the old mound. The new mound and pits, if any be built, must be placed as directed in clauses 153-163.

195. Whenever a subdivider finds that a corner on the meridian outline of a township is more than one chain and fifty links from the place where it should be according to the diagram of outlines, he may resurvey or retrace the outline, as provided herein-after. When a resurvey is made, it is desirable that it should be continued to the correction line, if necessary for making the meridian outline right.

196. The outline shall be resurveyed when the sections on both sides are vacant, or when the owners of lands affected by the corrections give in writing their consent to the resurvey.

When the adjoining township has been previously subdivided, the surveyor is to move to correct positions the quarter section marks situated half a mile from the outline and affected by the changes in the corners of the outline.

The positions of the original monuments are to be accurately measured and noted.

No new monument is to be erected before destroying the old one.

197. The defective outline shall be retraced when the owners of lands affected refuse their consent to the correction of the errors, or the re-establishment of the lost corners. A part of the outline may be resurveyed where there is no objection made and another part retraced.

A surveyor who is instructed to restore monuments on a line may retrace the line when it is not possible to locate the position of the monuments otherwise.

198. In retracing a line, all obliterated corners shall be restored and marked as directed for original surveys.

199. Lost monuments shall be re-established when the lands affected are vacant, or when the owners give their consent in writing. Should the owner at a lost corner object to the re-establishment, the surveyor shall not erect a monument, but shall plant a temporary picket at the place shown by his survey to be the location of the corner, and he shall connect to the picket the lines of his subdivision.

200. The field notes must be a faithful, distinct and minute record of everything officially done and observed by the surveyor and his assistants pursuant to instructions in relation to running, measuring and marking lines, establishing monuments, laying off road allowances, &c., and present, as far as possible, a full and complete topographical description of the country surveyed. (See specimens, pages 39 and 40.)

201. The bearings, distances, and other data must be entered in the field notes as actually found on the ground by the surveyor's own measurements, whether the same do or do not agree with previous surveys or with the provisions of the law or of the Manual of Survey. The entry of conventional, theoretic, assumed or supposed data is absolutely forbidden.

202. The field notes of every section line surveyed must be complete in themselves, and be placed on a separate page. Where a corner is marked by a witness post with a mound or trench, the position and character of the witness monument must be shown on each page of the field notes on which the corner appears. Section lines are to be entered in the field book in the order in which they are run. The chaining must, in all cases, commence on the inside of the road allowance, so as to show for the quarter section and section corners the distances from the corner of the section, and the measurements are to be given in all cases exclusive of road allowances.

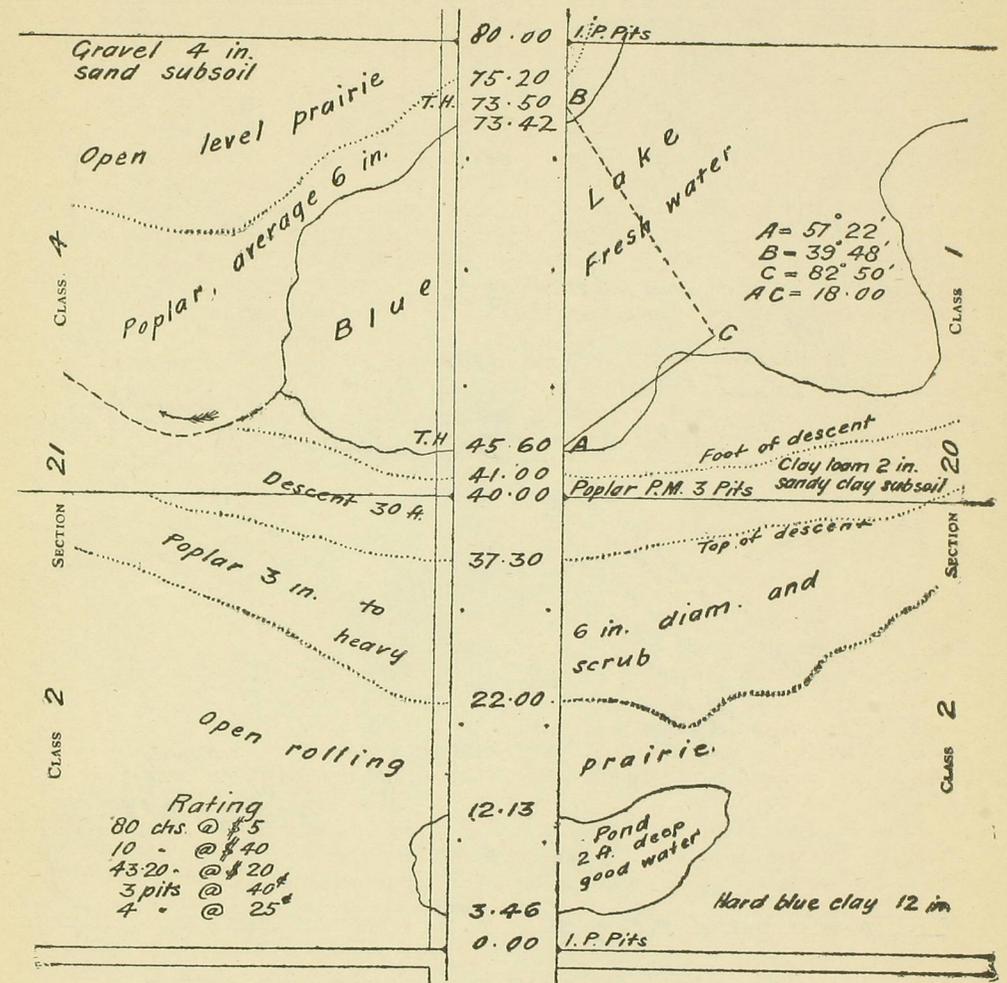
203. Section lines are described as north and east boundaries of sections, not as south or west boundaries, except on the north side of a correction line, where they are properly described as south boundaries of sections 1, 2, 3, &c. On Indian reserve boundaries and on lines between different systems of survey, cases will also occur in which the lines surveyed are to be designated as the south or west boundaries of sections.

204. The following abbreviations of words will be allowed in the notes, that is to say:—

- |                                      |                         |
|--------------------------------------|-------------------------|
| A. for acre.                         | Lks. for links.         |
| A. M. for forenoon.                  | Long. for longitude.    |
| Asc. for ascent.                     | M. for mound.           |
| Astro. for astronomical.             | Mag. for magnetic.      |
| Az. for azimuth.                     | Mer. for meridian.      |
| Bea. for bearing.                    | Mkd. for marked.        |
| Bet. for between.                    | N. for north.           |
| By. for boundary.                    | Obsn. for observation.  |
| Chs. for chains.                     | P. for post.            |
| Cor. for corner.                     | P. M. for afternoon.    |
| Corr. for correction.                | Pol. for Polaris.       |
| Decl. for declination.               | Pr. for principal.      |
| Dep. for departure.                  | R. for range.           |
| Desc. for descent.                   | S. for south.           |
| Diam. for diameter.                  | Sec. for section.       |
| Diff. for difference.                | Sq. for square.         |
| Dist. for distance.                  | Sta. for station.       |
| D. L. S. for Dominion Land Surveyor. | T. for trench.          |
| E. for east.                         | Temp. for temperature.  |
| Elong. for elongation.               | T. H. for traverse hub. |
| Frac. for fractional.                | Tp. for township.       |
| Ft. for feet.                        | Var. for variation.     |
| I. for iron.                         | W. for west.            |
| Ins. for inches.                     | Wit. for witness.       |
| Lat. for latitude.                   | W. P. for wooden post.  |

SPECIMEN OF FIELD NOTES OF SUBDIVISION SURVEY.

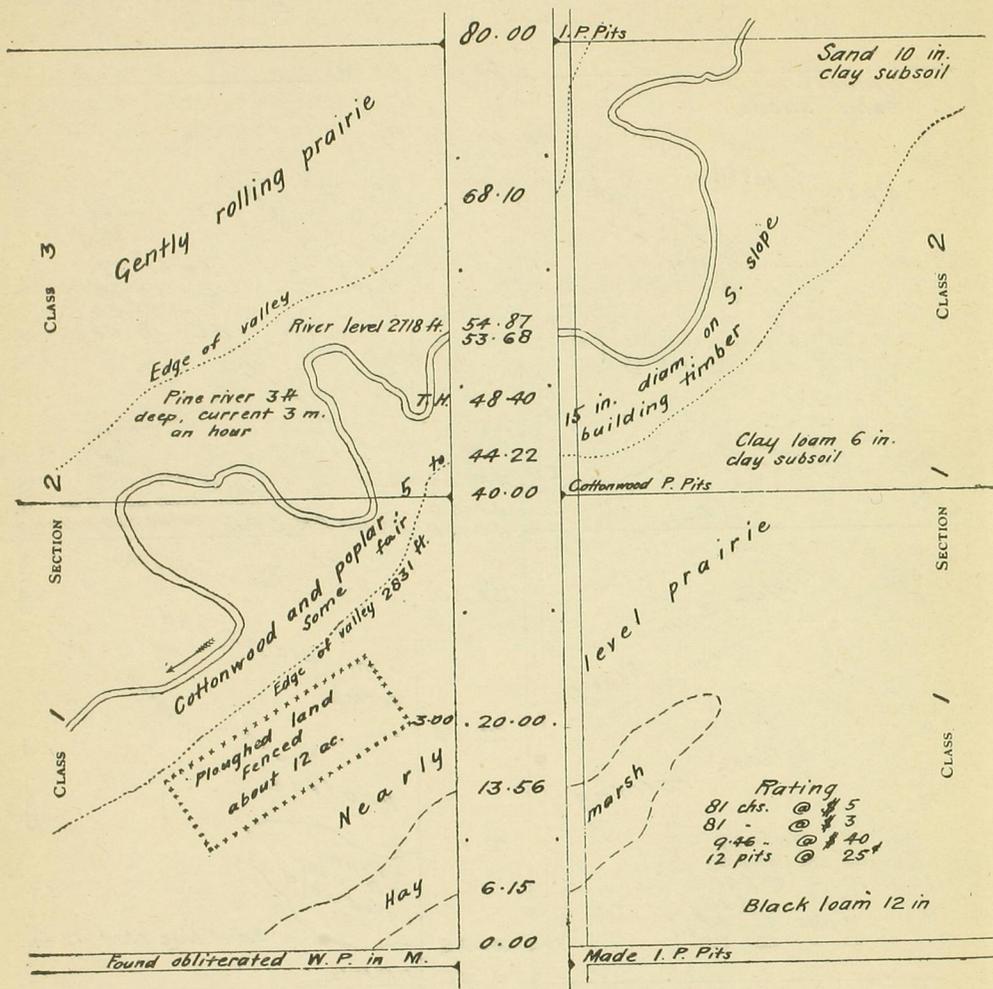
Tp. 34 R. 15 W. Mer. E. By. of Sec. 20 Course 180° 01' produced from bearing 180° 01' of E. By. of Sec. 29



The above line was run on the 31<sup>st</sup> day of October 1902

SPECIMEN OF FIELD NOTES OF SUBDIVISION SURVEY.

Tp. 34 R. 15 W. Mer. E. By. of Sec. 2 Course 359° 58' turned off from bearing 89° 59' of N. By. of Sec. 35.



The above line was run on the 20<sup>th</sup> day of October 1902.

205. The field notes must be always written down on the spot, leaving nothing to be supplied from memory, and are to give the following information in relation to the survey:—

- (a) The length and exact bearing of every line run, noting all necessary offsets therefrom, with the reasons for the same.
- (b) The course and distance for all witness mounds.
- (c) The character of monuments. For wooden posts the kind of wood is stated. 'I.P.M.' is entered for 'iron post and mound,' 'I.P. Pits' for 'iron post and four pits,' 'Stone M.' for 'stone mound,' 'Wit. I.P.T.' for 'witness iron post and trench,' 'T.H.' for 'traverse hub.' The number of pits is stated when less than four. The above information is entered on each page for every corner shown thereon. When the corner was established by a previous survey, or when it was restored, the fact must be stated. The absence of remarks means that the corner was established by the surveyor himself.
- (d) The bearing and distance to every corner of lots, mineral claims, reserves, &c., within the survey.
- (e) Sketches of settlers' improvements in their approximate position and the extent of the same.
- (f) The distances at which the line first intersects, and also where it leaves settlers' claims or improvements, lakes, ponds, rivers, bottom lands, swamps, marshes, brush and woods; also the beginning of ascent, the top and the foot of descent, of all remarkable hills or ridges, with their estimated height in feet above the bottom lands near which they may be situated; also where a stream, lake or pond is crossed, the data used for ascertaining the distance across it.
- (g) The approximate course, direction, average width, depth, and rate of current of all streams, and whether the water is fresh or salt in the lakes which fall within the survey.
- (h) Whether the surface of the country is level, rolling, broken or hilly.
- (i) The nature of the soil, classifying it, according to its fitness for agriculture, as first, second, third, or fourth class—entering the class, at the time of survey, on each quarter section where indicated in the notes.
- (j) Depth of loam and kind of subsoil, where pits are dug.
- (k) If in timber, the kinds, quality and average dimensions thereof.
- (l) Rapids or falls of water affording mill sites, with estimated fall and supply of water in general terms.
- (m) Coal deposits, minerals (transmitting specimens of the same) and salt springs, &c., &c.
- (n) The date of the survey.
- (o) In contract surveys, the rating on every page of the field notes for the lines shown upon the page.

206. The topography of the interior of the sections is to be sketched in the field book as far as it can be seen. The course of the rivers, valleys, trails, etc., must be indicated approximately as well as the outlines of the lakes or ponds, the position of the hills, etc. The draughtsman who plots the plan must have this information for representing the topography in the interior of the sections. It is not sufficient to show the crossings on the line: sketching as shown in the specimen field notes is required for plotting the plan.

207. The surveyor who is making the original survey of a township is to obtain from every settler a statutory declaration on the form supplied, and to see that all the questions on the form are answered, and the answers entered in the form.

All declarations from squatters who reside on the land and have made improvements, are to be accepted, no matter how many there may be on a quarter section. The only case in which a declaration should be refused is when it is clearly untrue or in opposition to the facts.

Declarations are not taken from persons who do not reside on the land or who have no improvements.

A statutory declaration does not give any right or legal status to the declarant ; it is simply for the information of the department.

Surveyors are strictly forbidden to make any charge to squatters for receiving their declarations, and it is no part of their duty to explain the law or to give directions to intending or actual settlers for securing land. Surveyors in the employment of the department are requested to abstain from giving such advice.

Every declaration must be mailed to the department at the first opportunity after it has been taken.

No statutory declarations are to be taken on resurveys, retracements, or restoration surveys.

### CHAPTER III.

#### RETURNS OF SURVEY.

##### PROGRESS REPORTS.

208. Surveyors shall report at least once a month the progress of their work, and forward the report at the first available opportunity.

209. Each progress report shall be accompanied by sketches on the forms supplied showing the work done up to date. The sketches shall give the bearings and lengths of all section lines surveyed and the jogs on correction lines when measured. Traversed lines shall be marked red. A quarter section made fractional by a traversed body of water, shall be designated by the letter "F."

The sketches must also show the main topographical features, that is to say, the rivers, lakes, trails, hills, etc. ; they may be drawn with pencils of different colours. No scale is needed for plotting ; a rough estimate of distances is all that is required. It should be understood that it is not necessary to indicate every little swamp, pond or rise that may be found.

The bearings and distances entered on the sketches may be those recorded in the field : they are subject to any corrections which the surveyor finds necessary when making his final returns.

##### TOWNSHIP PLANS.

210. Plans of townships are made in the department from the surveyor's field notes. They are plotted on a scale of thirty chains to one inch, and reduced for publication to forty chains to one inch. Every fractional township, however small, is shown on a separate plan.

211. The township plans exhibit the astronomical bearings and lengths, as ascertained and measured on the ground, of all surveyed lines, and the main topographical features of the ground.

212. The township plans show the area of all full quarter sections computed to the nearest acre. Fractional quarter sections are divided into quarter quarter sections, and the area of each is computed and shown to the nearest tenth of an acre. A quarter section is fractional when it is broken by lakes or streams which have been traversed or by parcels of land previously laid out.

In a quarter quarter section divided into two or more parts by a traversed lake or stream, the separate area of each part is given.

##### PLANS OTHER THAN TOWNSHIP PLANS.

213. Plans other than township plans shall be made on the following scales :—

Settlements, not less than twenty chains to one inch.

Group lots, not less than five chains to one inch.

Town plots, not less than two hundred feet to one inch.

Highways, not less than ten chains to one inch.

214. The plan of a settlement shall exhibit the bearings and lengths of all boundary lines, the bearings and lengths of all roads surveyed, the corner and witness monuments and their description, the numbers of the lots and their areas, the settlers' improvements, and the main topographical features. The boundaries are marked by solid lines ; the base lines by broken lines.

215. The title of the plan of a settlement shall give the name of the settlement, the district, province or territory, the name of the surveyor, the date of survey and the scale.

216. The plan of a group lot shall exhibit the same information as a settlement plan. It must also show the connection with the nearest survey and with adjoining lots or claims, if any. When the connection is made by a traverse of more than one course, the traverse lines are not shown on the plan; the connection is indicated by its latitude and departure in dotted lines, with distances written on the lines.

When the connection is too long, it is plotted separately on a smaller scale, but on the same sheet of paper. The plan must also show the nearest corners and portions of the boundaries of the adjoining lots or mineral claims, if any. The area is given to the nearest tenth of an acre. The limits of the lot are made more distinct by an edging of colour applied with a brush.

217. The title of the plan of a group lot shall state the number of the lot, the number of the group, the district, province or territory, the name of the surveyor, the date of survey and the scale.

218. The plan of a town site must show the whole of the quarter section or lot in which the site is situated, the connections with the corners thereof and every section, quarter section or lot line passing through or bounding the site. It must exhibit the bearings and lengths of all boundary lines, the posts, the numbers of the blocks, town lots, avenues and streets, the width and depth of the town lots, the width of the streets and avenues, and the houses and improvements. Only the essential topographical features are indicated.

219. The title of the plan of a town site shall state the name of the town site, the number of the section, quarter section or lot in which the town site is situated, the province, district, or territory, the name of the surveyor, the date of survey and the scale.

220. Plans of highways must show the bearings and lengths of the courses, the monuments, their description, and the bearings and lengths thereto, the main topographical features and the area of the highway, computed to the nearest hundredth of an acre, in every separate parcel crossed by it.

221. The title of the plan of a highway must give the name or description of the highway, its beginning and end, the province, district, or territory, the name of the surveyor, the date of survey and the scale.

222. The following rules are applicable to all plans other than township plans, and must appear in the form of a note:—

- (a) Surveyed lines and measured lengths are in vermilion.
- (b) Unsurveyed lines, calculated distances or bearings, and previous surveys are in black.
- (c) Bearings are in degrees and minutes (or degrees and hundredths). Observed bearings are in blue.
- (d) Distances are in chains and links (or in feet and tenths).
- (e) Monuments found on the ground are indicated by square black marks.
- (f) Wooden posts planted are indicated by square vermilion marks.
- (g) Iron posts planted are indicated by square blue marks.

223. The origin of the bearings must be stated on the plan.

224. A retraced or restored line is shown in vermilion, but the boundary marks found upon it are represented by square black marks.

225. An obliterated boundary mark restored by the surveyor is indicated on his plan by a square black mark.

226. A bearing is written in blue, as observed, when the surveyor has measured the course of the line, although his bearings may be derived from the bearing of an adjoining survey.

227. Distances to water boundaries are given only when they are necessary for the description of the parcels.

228. Boundaries are represented by full lines; lines which are not boundaries are shown broken.

229. The description of the monuments is given by means of the same abbreviations as in the field notes.

230. Unless otherwise directed, areas over one hundred acres are given to the nearest acre; under one hundred acres and over ten acres, to the nearest tenth of an acre; under ten acres to the nearest hundredth of an acre.

231. All the bearings of a plan must be referred to a single meridian, so that the angle of any two lines may be given by the difference of their bearings. When the survey is of such an extent in longitude that several meridians have to be used, there shall be a separate plan for each meridian upon which shall be shown all the courses of which the bearings are referred to that meridian.

232. The date of a survey is the date on which measurement was completed on the ground.

233. The surveyor must not lose sight of the fact that the main object of his plan is to identify the boundaries of the parcels laid out; the plan must not be obscured by irrelevant details. Only the main topographical features are to be represented, and in so far only as they may assist in locating the boundaries. Traverse lines of rivers or lakes, generally are of doubtful utility; they are not boundaries, and as the feature which they define is liable to change, any measurements required may, if the traverse has been accurately plotted, be scaled off the plan with sufficient accuracy.

234. Plans must be plotted carefully and accurately, and must be fair specimens of draughtsmanship. If incomplete, faulty, or not up to the standard of professional work, they will not be accepted.

#### FIELD NOTES, REPORTS AND OTHER RETURNS.

235. The field notes sent in to be placed on record in the Dominion Lands Office are to be a fair and exact copy of the original notes taken in the field, after applying to the bearings the corrections deduced from the astronomical observations and the deflections from trial to true lines. The field notes for record must be written in the books furnished for that purpose; the forms supplied for field use are not accepted as office copies.

236. The first page gives the title, the nature of the survey, the name of the surveyor, and the dates of commencement and completion of the work. The second page contains a skeleton diagram, with each section line numbered to correspond with the page of the notes. The third page contains the names and duties of all assistants. Whenever a new assistant is employed or any one changed, an appropriate entry thereof with the reasons therefor is made previous to entering any notes under the changed arrangements.

237. The field notes must be distinctly and neatly made out in language precise and clear, and their figures, letters, words and meaning are always to be unmistakable.

238. The road allowances must be ruled in proper position. The regular width is stated at the beginning of the book; other widths are entered in the notes. Corner boundaries are properly described and marked in true position. When a boundary monument is found, the fact must be stated, also whether it was in good condition or obliterated, and whether it has been restored.

239. Traverses are plotted on a scale of twenty chains to one inch on tracing linen, using one piece of linen for each township if convenient: the lines of the traverse are in red and the shore lines as well as the section lines are in black. Areas are not entered upon these plots: they are calculated at the head office. The plot must not be pasted in the field book. Connecting traverses are dealt with in the same manner. Field notes of the traverses are to be entered in the blank pages in the field book (See specimens, pages 47, 48 and 49).

240. Where islands occur in a stream, or where there are several channels, the traversed line to which areas are calculated is shown on the traverse plot by a fine blue line.

241. The astronomical observations for azimuth together with the calculations thereof, shall be entered in the blank pages at the end of the book.

242. A report, also entered at the end of the field book, shall be made by the surveyor subdividing a township upon the following subjects:—

Route for reaching the place and its condition.

Nature of soil and what it is suitable for.

Description of the surface, whether prairie, timbered or scrubby, with the location and proportions of each kind.

Size, kind, and quantity of timber and where located.

Hay.—Location, quantity, and quality.

Water.—Whether fresh or alkaline. Is supply sufficient and permanent? Description of streams, depth, width, strength of current, and volume of water. Is land liable to be flooded, and, if so, to what depth?

Water powers.—Height of falls, or rapids, and horse power available. Whether such power can be developed by the construction of dams.

Climate.—General indications. Any summer frosts?

Fuel.—What kind of fuel is most readily available, and where can it be procured? Description of any coal or lignite veins in the township.

Stone quarries.—Where located. Kind and quality of stone.

Minerals.—Description and location of any minerals of economic value in the township.

Game.—Kinds of game to be found.

Also any other subject of interest in connection with the township.

243. Every question must be answered: when, for instance, there is no timber, water powers, minerals, &c., the fact must be stated.

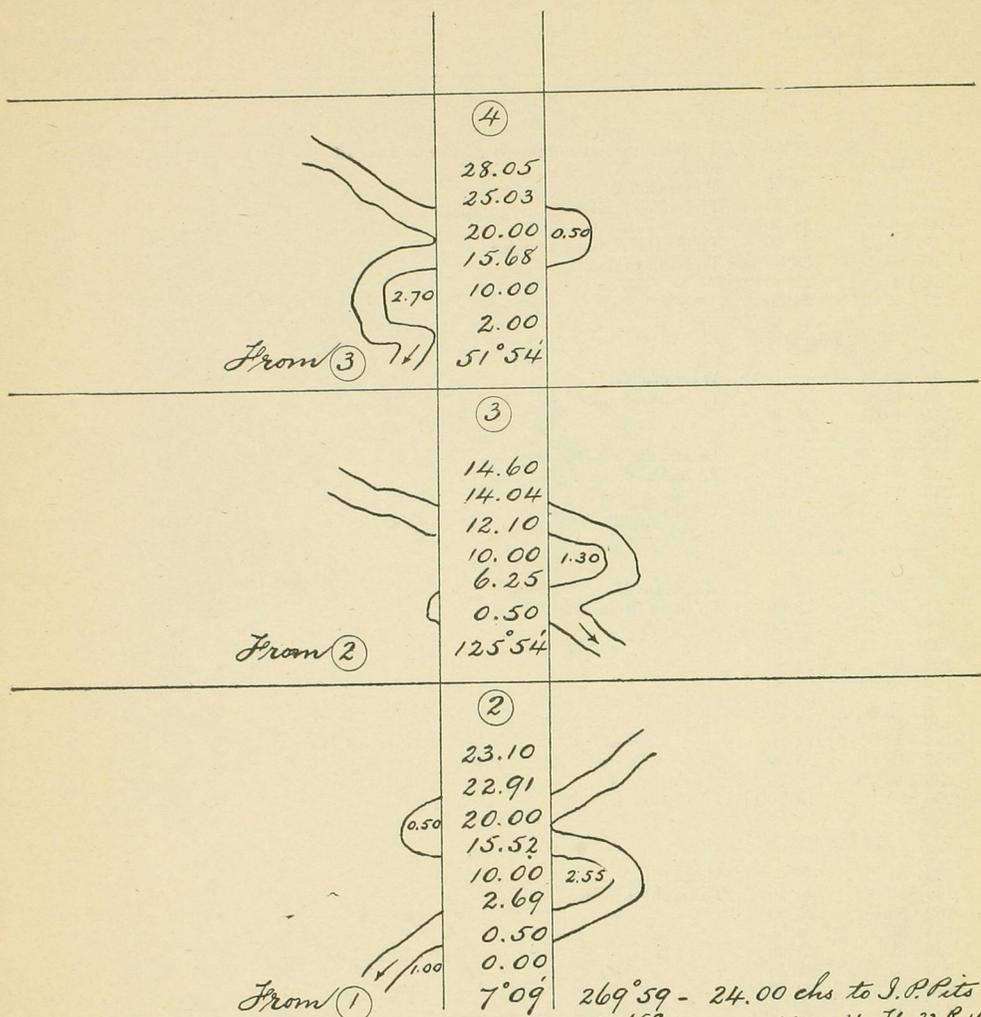
## EXAMPLE OF FIELD NOTES OF MICROMETER TRAVERSE SURVEY.

MICROMETER TRAVERSE OF BLUE LAKE.

Commenced at T.H. (Sta. 1) on E. By. Sec. 20, Tp. 34, R. 15.

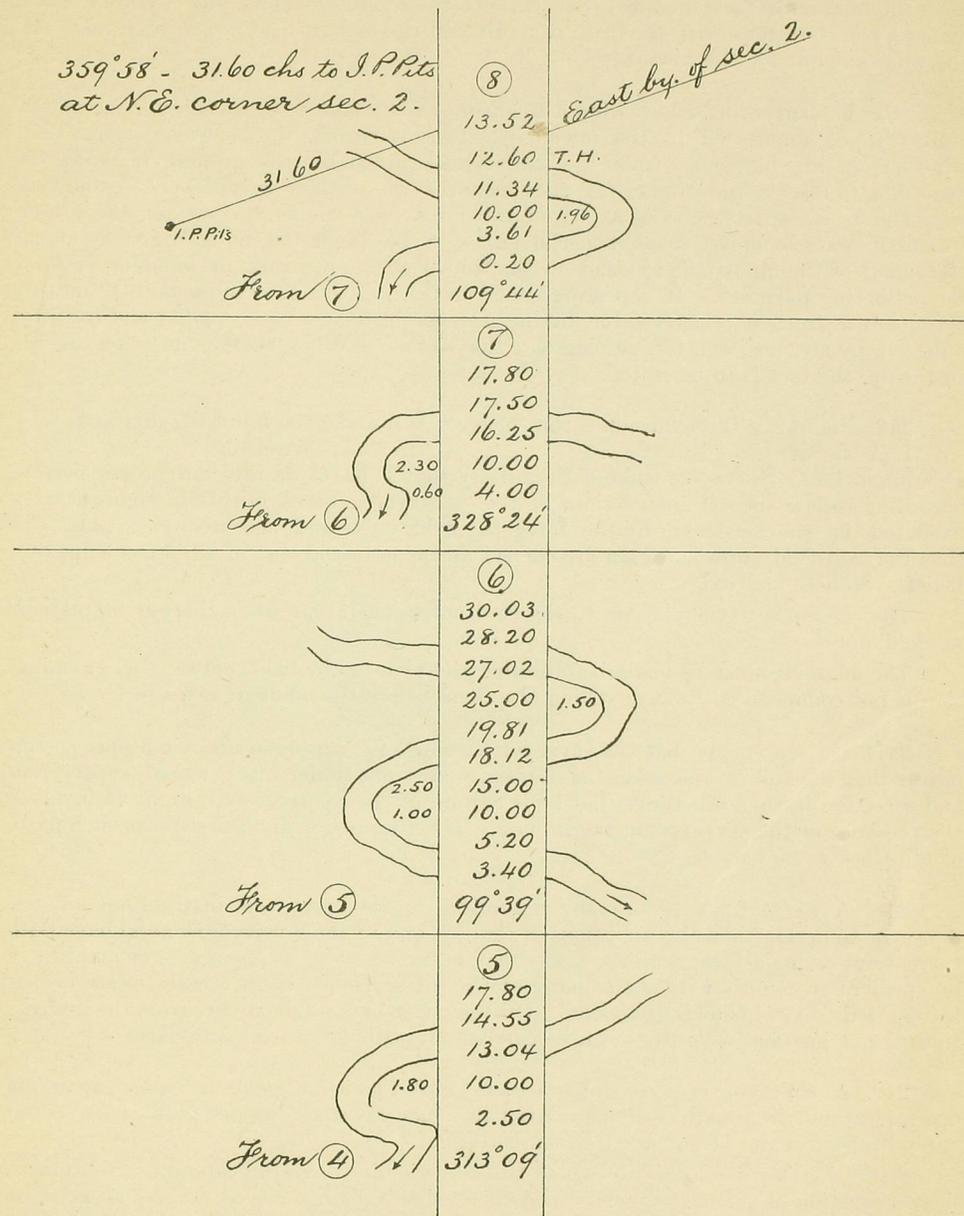
Bearing.	Distance.	
180 01..	6 50	To I. P. pits at northeast corner section 17.
23 30..		Magnetic N.
323 40..	23 90	To station 2.
334 45..	24 35	To bank of lake.
344 42..	28 50	" "
0 01..	27 90	To T. H. on bank of lake.
10 08..	28 80	To bank of lake.
19 25..	27 80	" "
27 40..	26 50	" "
Station 2.		
23 33..		Magnetic N.
96 15..	25 60	To bank of lake.
111 40..	26 40	" "
126 22..	22 60	" "
219 35..	23 20	To station 3.
227 50..	20 10	To bank of lake.
245 43..	20 60	" "
265 05..	21 80	" "
Station 3.		
23 25..		Magnetic N.
351 56..	21 90	To bank of lake.
8 25..	22 50	" "
23 20..	22 40	" "
101 50..	24 80	" "
116 40..	25 80	" "
127 55..	23 80	" "
140 35..	21 70	" "
154 30..	24 80	" "
167 18..	25 50	" "
233 48..	6 70	" "
256 30..	15 10	To station 4.
Station 4.		
23 34..		Magnetic N.
148 10..	26 40	To bank of lake.
162 52..	25 50	" "
175 35..	26 50	" "
191 32..	25 20	" "
209 54..	24 40	" "
225 50..	22 40	" "
244 00..	25 10	" "
256 40..	28 40	" "
270 18..	28 60	" "
283 32..	27 00	" "
296 35..	25 00	" "
312 40..	21 20	" "
325 12..	14 90	" "
325 12..	4 40	" "
322 00..	8 60	" "

SPECIMEN OF FIELD NOTES OF CHAINED TRAVERSE SURVEY.



Nov. 18. 1902. Traverse of Pine river.  
 Commenced at T.H. on north boundary of  
 section 35 Twp. 33, R. 15.  
 Offsets to middle of river.

SPECIMEN OF FIELD NOTES OF CHAINED TRAVERSE SURVEY.—(Continued.)



244. At the end of the field book of a township subdivided under contract, there shall be an account of the cost of the survey. This account must give in miles and decimals of a mile the length of the section and traverse lines surveyed, of the lines opened in the woods, of the lines measured over rough ground, and of the meridian outlines surveyed, together with the rate per mile and the amount claimed in each case, also the number of astronomical observations, the number of pits, and the number of statutory declarations with the rate per unit and the amount claimed in each case, and the total amount for the township.

245. The surveyor subdividing a township shall make a separate report upon the timber to be found within the township. In this report, the surveyor shall state whether, in his judgment from the knowledge gained on the ground, it would be desirable to reserve the timber for the needs of the settlers or whether it would be advisable to set apart the same as a timber berth or as a timber reserve for the conservation of water supply. Should a timber berth be suggested, he is to give a general statement of the quality and extent of the timber over ten inches in diameter suitable for lumbering purposes. If reporting on several timbered townships, he is to make a statement as to their relative value, taking into account the extent, quality and facilities afforded by streams, &c., for getting out the timber. When there is no wood in the township, the fact is to be stated.

246. Following the field notes, the surveyor will make the following affidavit:—

I, A. B., of ..... in the province of .....  
 Dominion Land Surveyor, make oath and say that I have, in my own proper person, according to law and the instructions of the Surveyor-General, faithfully and correctly executed the survey shown by the foregoing field notes and accompanying plan, and that the said field notes and plan are correct and true to the best of my knowledge and belief. So help me God.

The reference to the plan or to the field notes is left out when there is no plan or no field notes.

The affidavit must be made before filing the plan or the field notes: the examination is not commenced nor is anything else done before the affidavit is made.

247. The statement that the surveyor has made the survey in his own proper person means that the survey operations have been carried out under his personal supervision and direction in such a manner that he is certain of their correct execution. It involves the presence of the surveyor on the ground. He may assign to his assistants such parts of the work as he may see fit.

248. A survey has been made according to law and the instructions of the Surveyor-General, when the directions of the law and of the Surveyor-General have been carried out as far as practicable. Cases may occur where it is impossible or manifestly inexpedient to comply with some clause of the instructions; in such cases, the surveyor is expected to use his own discretion. On the other hand, a departure from the instructions is not justified when they can be carried out without causing any harm.

249. A surveyor of township outlines shall furnish a general report upon his operations and the resources of the district in which his work lies, for publication in the annual report of the Department of the Interior.

Attention is particularly drawn to the necessity for devoting care and attention to the preparation of general reports. The object should be not merely to give an account of the surveyor's operations and the quality of the land, but to describe comprehensively the resources of the country visited and its industries, whether farming, stock-raising, lumbering, mining, &c., furnishing such details as may enable the prospective emigrant to choose judiciously the locality in which to settle according to his calling, and to form an idea of the expectations which he may reasonably entertain.

250. The final returns of survey are as follows:—

For a survey of township outlines:

- (a) Field notes.
- (b) General report.
- (c) Oaths of chainmen.
- (d) Accounts in duplicate on the forms supplied.

For the subdivision of townships:

- (a) Field notes.
- (b) Oaths of chainmen.
- (c) Statutory declarations of settlers, if any.
- (d) Timber report.

For other surveys:

- (a) Field notes.
- (b) Plan.
- (c) Oaths of chainmen.
- (d) Statutory declarations of settlers, if any.
- (e) Accounts in duplicate on the forms supplied.

251. Immediate preparation of returns after the surveyor has completed his field work will be insisted upon.

#### INSPECTION AND EXAMINATION OF SURVEYS.

252. The responsibility for the accuracy of a survey and of the plans and field notes of the same, rests with the surveyor. He must not look to the department for assistance in discovering the errors or deficiencies of the survey in the field or for help in completing or correcting the returns.

253. Should the field inspection of a few miles of the survey lines disclose work below the standard required by the instructions, the surveyor will be invited to correct the whole survey, and no further payment will be made until a new inspection has shown the survey to be satisfactory.

254. The field notes and plans must, before being filed, be carefully checked by the surveyor. It is no part of the duties of the office staff to help a surveyor in correcting his returns; that must be done by the surveyor himself. A few errors may escape his attention, and if such as not to require a change to the survey in the field, he will be allowed to file supplementary field notes correcting the previous ones and to be attached to them. Clerical mistakes may, at the request of the surveyor, be corrected in red ink. Should the examination of a few pages of field notes disclose more errors or discrepancies than should exist, had the notes been carefully prepared and checked, the examination will not be continued and the notes will be returned to the surveyor who will be requested to send correct ones.

255. In case the notes show that a part of the survey on the ground is incorrect, deficient or incomplete, the surveyor will have to correct the survey on the ground and to file supplementary returns embodying the correction.

256. After being fully examined by the office staff, neither plans nor field notes will be returned to the surveyor. Any corrections necessary shall be made by supplementary returns, duly sworn to, or shall, at the request of the surveyor, be entered in red ink on the original returns when the mistakes are evidently clerical.

## CHAPTER IV.

## BLOCK SURVEYS.

## GENERAL DIRECTIONS.

257. The first operation in laying out a given portion of country, is the survey of the outlines of the blocks.

The eastern and western exterior boundaries of the blocks in the third system of survey are broken lines each consisting of two meridians separated by the 'jog' at the correction line. The northern and southern limits (base lines) are parts of a polygon described on a parallel of latitude, by laying off, as chords thereto, the successive township sides, forming, as the case may be, the northern or southern outline of the block.

The road allowances along meridians are in all cases of the prescribed theoretic width, one chain. That the distribution of excess or defect is among the sections, and is not applied to the roads, does not materially affect the azimuth of those north and south lines involved; the displacement at the extremes—but two-thirds of a link on each mile—being less than ordinary chaining is at all accurate enough to indicate.

258. Except in the case of the blocks south of the 2nd base, where the meridians are to be surveyed from the 2nd base to the 1st correction line, and then, laying off the theoretical jog, south to the 1st base, leaving all the north and south closing error at the 1st base, the surveyor invariably closes his block on the correction line, projecting first the part on one side of the correction line and then the other half of the block. The north and south error in closing is divided equally between the two quarter sections north and south of and adjoining the correction line. In order to correct for it, and to prevent the accumulation of errors, the surveyor may deviate the two base lines of the next block equally and in opposite directions, so as to effect the required correction at the end of the four ranges. Supposing, for instance, the two quarter sections adjoining the correction line to be each 20 links short, the closing error may be corrected in the next block by deviating each base 21 seconds, the north base to the north and the south one to the south. It does not necessarily follow that the whole amount of the closing error is to be corrected for; the surveyor must take into account the probable cause of the discrepancy and correct only for such part of it as he believes will best ensure the closing of the next block. The jog on the correction line is left such as found, unless it should show an error of more than one chain and fifty links in the lines of the last block, in which case they have to be resurveyed. The limit allowed for the north and south closing error on the correction line is also one chain and fifty links.

The block surveyor marks, on the correction lines, only the township corners; all other posts are planted by the subdivider.

259. When it becomes necessary to deflect a base line to place it in proper latitude, such deflection, unless instructions to the contrary be received from the head office, is not to exceed two minutes, and must be carried to such a distance as to effect the required correction, except in closing on an initial meridian, where the last township corner is connected with the post on the meridian by a trial line, the deviation never extending beyond the range or fraction of a range adjoining the meridian.

260. The method of establishing the lengths and directions of the lines of the survey is the following:—

All lines are measured twice. This is effected by having two sets of chainmen, using the continuous steel band chain. The leading one is of the length of a standard Gunter's chain; by it all topographical and other notes are kept and posts planted. The following band, used solely as a control, is 100 feet in length.

When, at a section or quarter section corner, the distances registered by the respective chainings for the length of the quarter section side, differ, in prairie country, more than two links, or, in woods or brush, more than three links, the two sets of chainmen return to the last post and measure over again, repeating their measurements until accordance within the limit prescribed is attained.

Where the surface is so broken or uneven that it would be unreasonable to expect such accordance, and therefore, in a still greater measure, to look for any proper approximation to the absolute length of the interval chained, the surveyor, while continuing to establish the direction and carry on the production of his line in the usual manner, has recourse to such application of trigonometric methods, for obtaining the distances along it, as his judgment and the necessities of the case may lead him to employ. If using triangles, it is to be remembered that the result obtained is more accurate when angles are measured than when they are laid out with the chain.

261. The field bands are to be frequently compared with the standard measure.

In using the standard for comparison, it should be stretched with a proper tension, measured by means of a spring balance.

As every ten degrees Fahr. more or less heat would give to measurements a corresponding increment or decrement of somewhat more than half a link to the mile, and since in the North-west Territory a season of field work, extending from early spring to beginning of winter, will include variations of temperature covering a range of at least 80 degrees, and sometimes 100 degrees, the side of a block chained in July or August might, from this cause alone, differ from that of an adjacent one measured in November, fully a chain.

262. In ordinary summer weather, however, the corrections for temperature would, compared with the order of precision of the work generally, be inappreciable, yet they must not be entirely neglected. The temperature error might, in any given case, happen to have the same sign as other uncorrected constants, or accidental errors, whose effect it would then go to aggravate. That in another case, further on, it might tend to counteract these, would not lessen the inaccuracy of position of the boundary monument planted under the first condition.

The surveyor will, therefore, apply this correction for all variations of  $10^{\circ}$  and over, from the temperature for which the chains are compared or adjusted to standard. This he can conveniently do, by allowing half a link to the mile for each ten degrees Fahr., not attempting to note or estimate the temperature of his chain to less than ten degrees. This will keep his corrections in the convenient form of multiples of half links, and render tables unnecessary.

A thermometer attached to the end of a chain near the hand, fails to give the temperature of the rest of the chain; fastened to the middle and allowed to drag on the ground, it is liable to derangement and injury, it is therefore extremely difficult for the surveyor to obtain even a rough approximation of the temperature of his chain. By repeating at convenient times, and under varied conditions, the experiment of placing a pocket thermometer on, or in, the grass or brushwood, as nearly as possible, similarly to the average position of the chain during the trial, and comparing the temperature attained by the thermometer so placed with that of the air, or indicated by a thermometer attached to the leading end of the chain, a rough idea may be got of the allowances that should, in practice, be made in taking the indications of the latter, or in rudely estimating the temperature of the chain from that of the air at the time.

Attention is to be paid to the condition of the chain during measurement, whether wet or dry; a wet chain will have its temperature lowered to a great extent, especially in dry weather. The colour of the chain also has some influence; a black or dark blue chain will absorb more heat than a bright one.

Steel bands are very liable to break; this fact cannot be impressed too strongly upon the chainmen. In case such an accident should happen, the surveyor ought to be

SPECIMEN OF PART OF FIELD NOTES OF BLOCK SURVEY.

Sec.	40.140	TRIANGLE NO.	43	b =	9.442
Slope.	3	Observed angles.	Corrected angles.		
	13	A = 64° 43'	64° 44'	log. b =	0.97506
	7	B = 55 56	55 57	cosec. B =	0.08168
	24	C = 59 18	59 19	sin. C =	9.93450
		179 57	180 00	log. c =	0.99124
				c =	9.800
		Distance to near side of obstruction =			0.050
		Distance to far side "			9.850
		TRIANGLE NO.	44	b =	5.287
		Observed angles.	Corrected angles.		
		A = 58° 03'	58° 02'	log. b =	0.72321
		B = 52 51	52 50	cosec. B =	0.09861
		C = 69 09	69 08	sin. C =	9.97054
		180 03	180 00	log. c =	0.79236
				c =	6.200
Th. cor.	-5	Distance to near side of obstruction =			37.000
Sec.	40.182	Distance to far side "			43.200
Sec.	41.140				
Slope	11				
	6				
	18				
	23				
	2				
	1				
	1				
		Temperature 80°			
Th. cor.	-5				
Sec.	81.379				

provided with a small steel punch with sharp edges, a few copper rivets and some brass plates cut to the width of the chain. Holes can be punched through the steel band and the repair effected with two fish plates riveted to the chain.

263. Besides the small plummet line that should be carried by the chainmen to enable them to get correctly past minor irregularities of surface, the assistant should carry an Abney or Locke pocket clinometer, by which he can obtain the inclination and thus permit the chainmen to use the more accurate method of chaining on the inclined surface, instead of the one requiring them to hold their chain level and entailing a continuous repetition of plumbing down from the high end to the pin in the ground.

In using his clinometer, the assistant stands at one end of the slope, one of the chainmen standing at the other end, and he sights through the instrument to some part of the chainman's body, the height of which has been previously ascertained to be the same as the height of his own eye. Such point is easily found by using the clinometer at zero, the assistant and chainman standing close together and on the same level.

264. Table VII gives the correction per chain for given angles of slope. This table printed on cardboard for carrying in the pocket may be had upon application to the head office. The field books supplied to block surveyors contain a form for applying this correction to the chainage. (See specimen, page 54). The first number entered in this form is the length, in links of the chain used, of the quarter section to be laid out. When the chain can be adjusted for length, it is adjusted so as to be standard at some given temperature; the number to be entered is then the theoretic length of the quarter section, forty chains or forty-one chains as the case may be. When it cannot be adjusted the surveyor ascertains its length at the given temperature by comparison with the standard, and computes the number of links of his chain required to give, at the above temperature, the proper length to the quarter section. With a chain too long, the number of links is less than the true length and vice versa. This number being entered in the field book form, the corrections for slope are written underneath; they are in all cases to be added. The correction for temperature, one-quarter of a link to the quarter section for every ten degrees Fahr., is entered next; it is added when the thermometer is below the standard temperature and subtracted when above the same.

At the end of the quarter section, the algebraic sum of the quantities entered shows the number of chains and links to be actually measured on the ground in order to give to the said line its exact length, forty or forty-one chains. The same process is followed to find the distance to be measured for the section corner.

The distance for the topography, being entered as found in the field, is in error by the amount of the correction to the chainage. This quantity being generally small, may be neglected for the topography, but the posts should be entered at their true distances.

The method of chaining along the slopes and correcting for inclination is applied only with the Gunter's chain, by which posts are planted and boundaries ascertained; the 100 foot chain, being solely a control, is used in the ordinary manner, breaking chain when its full length cannot be levelled.

265. When the distance across an obstacle is determined by a triangle, the surveyor must be careful to check it by another independent operation, either another triangle or a micrometer measurement, so as to conform to the principle of double independent chainage.

If a second triangle be adopted, having the side to be calculated common with the first triangle, it is sufficient to set up the instrument at both ends of this side; any error in the angles is shown by the calculation. In all triangles, calling the angle opposite to the base B, the angle opposite to the side to be calculated C and the third one A, the calculation is made according to the form given on page 54. The distance to the nearer side of the obstruction being entered at the proper place, it is only necessary to fill the form to have the distance to the farther side. From this last point the chainmen start with the number of tallies and pins and the fraction of a chain found by the calculation.

Date, 21 July, 1903.

Place, 45 chs. E. of N.E. corner sec 31  
Tp. 28, R. 17, W 2<sup>nd</sup> Mer

Face.		Chronometer Time.	Horizontal circle reading.		
			A.	B.	C.
R.	R. O.	<i>h m. s.</i>	173° 04' 55"	04' 50"	05' 05"
	Polaris.	14 02 22	83 26 40	26 30	26 50
L.	Polaris.	14 05 30	83 28 20	28 25	28 30
	R. O.		173 04 45	04 55	05 05

Chr. Time.	14 02 22	14 05 30	Tan. P.
Chr. Error.	- 02 13	- 02 13	Sec. and tan. L
Sid. Time.	14 00 09	14 03 17	Sin. and cos. t
Polaris R. A.	1 24 40	1 24 40	Sum.
t	12 35 29	12 38 37	Subt. log.

Log. 792.	2.89873.	Tan. Az.
Log. tan. corr.	5.68588	Az.
Log. distance	1.80380	H. C. R. on star.
Log. offset.	0.38811	True North.
Offset in inch.	2.44	H. C. R. on R. O.
		Bearing R. O.

Table of inclination factors.

No. of Town- ship.	Hour angle of Polaris.				
	0 <sup>h</sup> or 24 <sup>h</sup>	3 <sup>h</sup> or 21 <sup>h</sup>	6 <sup>h</sup> or 18 <sup>h</sup>	9 <sup>h</sup> or 15 <sup>h</sup>	12 <sup>h</sup>
0	1.20	1.18	1.15	1.12	1.10
20	1.28	1.25	1.23	1.20	1.17
40	1.37	1.34	1.30	1.28	1.25
60	1.46	1.42	1.39	1.36	1.33
80	1.56	1.52	1.49	1.45	1.42

Mean.  
Bea. by account.  
Correction.

Back course 89° 55' 27" - 63.65 chs.  
One division level = 3".33.

Level		Level Correct.	Mean H. C. R.	Corrected mean H. C. R.
W +	E -			
				173° 04' 57"
10.2	8.5	+5"6	83° 26' 40"	83 26 46
11.3	7.4		83 28 25	83 28 31
				173 04 55
8.32598	8.32598		8.32598	8.32598
0.20533	0.09855		0.20533	0.09855
9.18811	9.99476		9.22454	9.99381
7.71942	8.41929		7.75585	8.41834
	-1125		-1122	
7.70817			7.74463	
00° 17' 34"			00° 19' 06"	
83 26 46			83 28 31	
83 09 12			83 09 25	
173 04 57			173 04 55	
89 55 45			89 55 30	
			89 55 37	
			89 55 27	
			+10"	

266. Should the extension of a block line be hindered by a very large lake or marsh, the surveyor may pass around the same, projecting for the purpose the adjacent township lines. In working around in this way to arrive at and take up the continuation of the block line on the opposite side of the obstruction, the surveyor regularly posts off all township, section and quarter section corners on the several lines, reporting the circumstance fully and sending all the field notes of such additional work forward with the returns of survey.

## INSTRUMENTS.

267. The instrument used for the survey of block outlines is a six-inch reiterating transit theodolite of which the horizontal circle is read by three verniers. A three-inch vertical circle read by two verniers serves as a finder for stars in day time.

The telescope has an objective of one and a half inches diameter, and nine inches focus, supplied with direct eye pieces of power equal to 12, 18 and 32 for terrestrial work, and a diagonal eye piece with powers of 30 and 60 for star work. The instrument is provided with three verniers, because, by reversing the telescope and turning the upper plate  $180^\circ$ , readings are obtained on the same object, at six equidistant points of the circle, thus tending to eliminate periodical errors of graduation to the same extent as an instrument having six verniers.

A small magnetic needle, attached to the instrument, is useful in finding stars in day time, when the surveyor may happen to be elsewhere than on a line of known bearing.

268. The assistant is provided with a repeating transit having a four-inch horizontal circle reading to minutes; it is used for measuring the angles of small triangles, laying out offsets for passing obstacles on the line, placing corner or witness posts on the line, giving to the axemen the direction of the line to be opened out in the bush, and generally doing whatever may be done with sufficient accuracy and more conveniently than with the larger instrument used in the production of the line.

For astronomical work the surveyor must be provided with a sidereal pocket chronometer.

## DIRECTION OF LINES.

269. The reference of lines to an astronomic meridian, in order to obtain their direction, or to check the accuracy of their production, is most readily made by observations on Polaris.

The telescopes used being amply powerful to show stars of the second magnitude within a few hours from noon, and stars of the third magnitude in twilight when it is still clear enough to read the graduation, the observations should be taken in daylight, whenever practicable.

Besides avoiding the errors peculiar to all artificial illumination, and likely to be specially developed in the case of field work in unsheltered positions, and with light from reading lamps held by hand, inconstant in direction and unsteady, daylight observations have the advantage that they are conveniently made with the instrument at one of the stations for the ordinary production of the line, and during its progress, without materially, if at all, interfering therewith. Day observations also give the surveyor more time in evening in camp for their reduction, and for checking his own and his assistant's work generally.

270. In observing for azimuth, the surveyor may adopt the following programme:—

The instrument being in the position which places the vertical circle to the observer's right hand when looking through the telescope, it is directed to the reference object and the verniers read, then to the Pole star, noting the time of pointing and the reading of the verniers. The level of the upper plate is read or the inclination of the horizontal axis measured with the striding level.

Reversing the instrument by revolving the telescope and turning the upper plate  $180^\circ$  in azimuth, so that the vertical circle is now to the left of the observer, the telescope is directed to the Pole star, the level recorded and readings taken on the reference object, as before reversal.

In strong daylight, the surveyor will experience some difficulty in finding Polaris, unless his telescope be in the precise direction of the star. He can readily place it so by help of the Astronomical Field Tables supplied to surveyors. Their use is explained in Appendix B.

271. Other methods which may be employed are, transits of stars across the meridian, observation of Polaris at or near elongation, transits of stars across the same vertical as Polaris, &c.

272. In making these observations, as in angular measurements generally, care should be taken when turning the instrument in azimuth by hand, to use the same forward or backward motion throughout for every pair of pointings in same position, the angle between which is intended to be read on the horizontal circle. This tends to obviate the effect of any yielding in the instrument stand to that part of the impulse of revolution that passes down through the foot screws to the stand head. In some much-used forms of stand this occurs to a notable extent, and as there is no certainty that in springing back, or 'untwisting,' the stand resumes exactly its original position, serious errors are to be apprehended in their use, unless the utmost care is taken. A source of similar error is looseness of foot screws in their nuts. The pinch screws closing these last should always be screwed up so tightly as to have the levelling screw turning stiffly in the nut. Even though this may entail more rapid wear of the screws, and be less convenient to the observer in bringing quickly, and with nicety, his level bubbles to their desired position, the certainty that it ensures warrants it.

273. The tangent screw should always be turned so as to push against its counterpoise spring; because in turning in the opposite direction, the spring might fail to bring back the upper plate at once and do so only during the interval between the observation and the reading of the verniers. Should there be any drag of the verniers, this also prevents it affecting the measure, as the motion is always in the same direction.

274. If a two-vernier instrument be used in observations for azimuth, then, after the two observations as above, the operation should be repeated, shifting for the purpose the lower limb  $90^\circ$  in azimuth, if the instrument be a repeating one;  $120^\circ$  by lifting it off stand, and changing foot screws one interval around, if it be a reiteration instrument, *i.e.*, one which has no motion of lower limb.

275. The reference objects for azimuth work, whether in the daytime a picket on the line, or at night a bulls-eye lantern, should be, if possible, at least half a mile from the observer.

Such a lantern having to slide on over the lens a tin cap, across which there is a vertical slit having an opening in width of about one-quarter of an inch, makes an excellent reference object.

In the case of night observations, the angle between line and reference object is to be determined before observing, and not to be left till morning, thus subjecting the reference object to the risk of accident or removal.

276. Surveyors are expected to observe for azimuth every clear day. With proper care in transporting the instrument, the levels will seldom get much out of adjustment, and then the complete observation for azimuth as above does not require more than ten minutes; generally it can be done without interfering with the work on the line. The reduction takes about fifteen minutes. It is hoped that with the forms and tables supplied to surveyors, the work has been made so short and easy that no objection to the frequency of observation should fairly exist.

277. The chronometer error is required for the reduction of the observations ; it may be found, when on the line, by placing the telescope in the meridian and observing the transit of a star. The time thus deduced is sufficiently accurate for the purpose.

When not on the line, the transit of a star across the vertical of Polaris may be observed, and the time found by following the directions given in the explanation of Table III. The observations for time are entered in the form at the end of the book of record of astronomical observations.

278. The value of one division of the level is required for the reduction of azimuth observations. To obtain this, the level is placed on the upper plate parallel to the plane of revolution of the telescope, and a rod, with two marks upon it, is placed vertically at a certain carefully measured distance from the instrument and in the direction of one of the foot screws. The bubble is brought, by turning the foot screw, close to one end of the tube, and the telescope directed to one of the marks on the rod and firmly clamped. The foot screw is then moved until the telescope be directed to the other mark and the displacement of the bubble noted. The difference between the inclinations of the level in the two positions is deduced from the distance of the rod and the interval between its marks ; dividing it by the number of divisions of displacement gives the value of one division.

279. Surveyors are at liberty to use any formula or process for reducing their observations, but, as forms and tables could not be prepared for every method, the following formula has been adopted ; for convenience, with regard to future reference, it is desirable that all surveyors should adopt it :—

$$\tan Z_2 = \frac{\tan P \sec L \sin t}{1 - \tan P \tan L \cos t}$$

where  $P$ ,  $L$ ,  $t$ , are polar distance, latitude and hour angle respectively.

In the form of record of azimuth observation (see specimen, pages 56 and 57), the letters R and L represent the positions of the instrument, circle right and circle left, H. C. R. is for horizontal circle reading ; R. O. reference object ; R. A. right ascension, and  $Z_2$  azimuth.

Representing by W. and E. the readings of the west and east end of the level, the level correction is equal to the inclination.

$$\left[ \frac{1}{4} (W - E) \times \text{value of one division} \right]$$

multiplied by the inclination factor (cotangent of the zenith distance of Polaris).

It is to be added to or subtracted from the mean H. C. R. according to signs, that is to say, added when the west side is high or when W. is greater than E. and subtracted when smaller.

The logarithms of secant and tangent  $L$  are given in Table II for the north side of every section.

The subtraction logarithm is found in Table V, using as argument  $A$  the logarithm of '  $\tan P \tan L \cos t$ .' The corresponding logarithm,  $B$ , is to be added to the logarithm of '  $\tan P \sec L \sin t$ ' when  $t$  lies between  $0^h$  and  $6^h$ , or  $18^h$  and  $24^h$ ; it is to be subtracted when  $t$  lies between  $6^h$  and  $18^h$ .

280. The following examples, one in each quadrant of a revolution of the Pole star, show how the calculation is to be made :

Ex. Required for the 9th July, 1880, at a point on the 6th base line, or 20 townships north of the 49th parallel, the azimuth of Polaris for hour angles of  $2^h 10^m$ ,  $9^h 32^m$ ,  $16^h 44^m$ , and  $19^h 52^m$ .

	For $t=2^h. 10m.$		For $t=9^h. 32m.$	
Tan $P$ .....	8·36640	8·36640	8·36640	8·36640
Sec $L$ (Table II).....	0·19877	Tan $L$ , 0·08772	0·19877	0·08772
Sin $t$ .....	9·73022	Cos $t$ , 9·92603	9·77946	9·90235
	8·29539	8·38015	8·34463	8·35647
Subt. log (Table V).....	+0·01030		-0·00976	
Tan $Z_2$ .....	8·30569	$Z_2 = -1^{\circ}09'29''\cdot 2$	8·33487	$Z_2 = -1^{\circ}14'19''\cdot 0$

	For $t=16^h. 44m.$		For $t=19^h. 52m.$	
Tan $P$ .....	8·36640	8·36640	8·36640	8·36640
Sec $L$ (Table II).....	0·19877	Tan $L$ , 0·08772	0·19877	0·08772
Sin $t$ .....	9·97567	Cos $t$ , 9·51264	9·94593	9·67161
	8·54084	7·96676	8·51110	8·12573
Subt. log (Table V).....	-0·00400		+0·00576	
Tan $Z_2$ .....	8·53684	$Z_2 = +1^{\circ}58'17''\cdot 4$	8·51686	$Z_2 = +1^{\circ}52'58''\cdot 4$

The bearing by account, when the R. O. is one of the pickets on the line, is the bearing of the line carried over from the last place of observation and corrected for convergence.

The direction of the line is corrected by placing the instrument a certain number of inches from its former position at right angles to the line. This offset is found by multiplying the distance of the back picket by the tangent of the correction.

281. The observations are entered in the note book of astronomical observations at the time they are taken, the calculations made either in pencil or in ink, and the book sent in as part of the returns of survey. No copy is accepted.

PRODUCTION OF LINES.

282. In producing the line the surveyor employs but one flagman, a forward picket-man ; a back flagman is not necessary, as the surveyor, when about to leave an instrument station, can set a picket there himself.

283. Perfectly straight pickets are not indispensable ; a part of the picket, exactly in the line, may be indicated by some visible mark and only this part used in the production of the line.

The flagman carries an ordinary surveying picket, about nine feet long, and terminated at the lower end by an iron point exactly in the axis of the picket. A small bubble, placed at right angles to the axis, is a valuable adjunct to ensure verticality.

284. The following method is recommended to ensure accuracy in the production of the line. When the flagman comes to the place where a new station is to be established, the surveyor gives him roughly the direction of the line. A wooden slab, held to

the ground by two small wooden pins or by stones on the ends, is then placed at right angles to the line at the point determined as above and in all subsequent operations, the picket is held on the slab, and its position marked with a pencil.

In setting a point forward on his line, the surveyor is careful never to do it in one position only of his instrument; in all cases, first making his back and forward sights circle right, then reversing his instrument, repeating them circle left, and having his flagman instructed to make in each case a separate and independent setting of his picket. If there be any difference between the settings, the surveyor carefully marks the middle point. Then the process is once repeated, so that there are two pointings in each position of the instrument on the back and forward pickets respectively, or eight pointings in all.

The same rule as to the reversion and number of pointings is observed in offsetting the line to get past long reaches unfavourable to chaining or triangulation.

The slab ought to be of such a length as to allow play for collimation.

285. The deflection angles at township corners on the base lines can be turned off without any reading of the graduation, by using the 'deflection offset' given in Table I. This deflection offset is the length, at the distance of one chain, of the tangent of the deflection angle, or the angle between the chord forming a township side and the next chord. When the surveyor comes to a township corner, the last picket before the corner is placed south of the line, at a distance equal to the deflection offset, as given by the table, multiplied by the distance from the corner, and the instrument, instead of being set up over the forward point previously ascertained, is placed north of the line, at a distance equal to the deflection offset multiplied by the number of chains between the instrument and the corner. The line is then produced from the back picket in the ordinary manner.

Supposing, for instance, that it should be required to turn off the angle at a township corner on the seventh base line, the back picket being 12 chains behind the corner and the instrument 15 chains beyond the same corner, the back picket will be planted at  $12 \times 1.501$  or 18.01 inches south of the line, and the instrument set up at  $15 \times 1.501$  or 22.51 inches to the north.

286. At the corners of the block, the surveyor turns the required angle approximately, and the flagman holds his picket at the point so determined, while the surveyor measures accurately the angle thus turned off. If the angle is not what it should be, the direction of the line is corrected by offsetting the instrument at the next station.

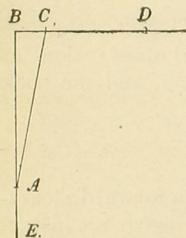


Fig. 38.

Should the corner fall in such a place that the angle cannot be measured correctly, as for instance at *B* (Fig. 38), one of the stations, *C*, being too near the corner, the surveyor has the angle at *B* approximately turned off by his assistant with the small transit, and measures the angle *EAC*. He then sets up his instrument at *C*, determines approximately the next station *D*, and measures *ACD*. The sum of the two angles *EAC* and *ACD*, should be equal to  $180^\circ$  plus the angle to be turned off at *B*. The error, if any, is corrected by offsetting the instrument at *D*.

#### MARKING THE SURVEY.

287. The attention of surveyors is especially directed to the necessity of making sure that the posts planted for township, section and quarter section corners are placed in their correct positions as indicated by the chainage and *exactly on the line*. They are reminded that otherwise all refinement of astronomical observations and of line measurements are absolutely thrown away.

Neglect of precautions in this behalf inevitably leads to serious errors in the subsidiary subdivision work.

## CHAPTER V.

### REGULATIONS FOR THE EMPLOYMENT OF SURVEYORS.

#### SURVEYORS EMPLOYED BY THE DAY.

288. For surveys, other than township subdivision surveys, Dominion land surveyors may be employed at a daily salary.

289. To be eligible for employment, a surveyor must own at least a standard measure, a sixty-six foot steel band and a transit theodolite in good order. The transit theodolite must be not less than four-inch diameter, must read at least to minutes, and be of an approved pattern.

290. A block surveyor must have in addition thereto a six-inch transit of an approved pattern, a pocket chronometer, a clinometer and a one hundred foot steel band.

291. When the services of a surveyor are of a temporary character, his salary is at the rate of six dollars and fifty cents per day for ordinary surveys, but for surveys of block outlines and for services requiring special qualifications, the rate is seven dollars and fifty cents per day.

292. A surveyor is paid for every day of service in the field, including Sundays. The number of days is computed from the day on which he leaves his home until the day of his return, both days inclusive.

293. For office work, preparing his returns, a surveyor is allowed the actual time spent on their preparation, but not in excess of the number of days declared sufficient by the Surveyor-General.

294. If a surveyor employed at a daily salary or a member of his party meets with an accident while engaged on the work of the survey, the Minister may pay to the injured surveyor or member such portion of his salary while incapacitated from work, and of his reasonable surgical expenses, as he may see fit.

295. The surveyor is allowed the actual cost of hire of men, provided their number and rate of pay is not in excess of what is permitted by his instructions.

296. For the transport of himself and party, and miscellaneous expenditure, (not including meals, board, hotel expenses, camp equipage and stationery), the surveyor is allowed actual expenses supported by vouchers, provided they do not exceed what is allowed by his instructions. Requisitions for railway tickets are furnished to him, and he is expected to obtain transportation at the lowest rate after inquiry from the ticket agents. Return tickets or excursion tickets must be used whenever practicable, or limited tickets when they answer the purpose as well as unlimited tickets.

297. The items chargeable to transport account are: Horses, horseshoes, horse-shoe nails, horseshoeing tools, horse medicines, oil for flies, buckboard, buckboard cover, castor oil, carts or wagons, covers, cart wrench, bolts, screws, nails, wire, sets of harness, saddles, bridle cloth, nose bags, hobbles, tethering ropes or chains, logging chain, horse bells, pail for watering horses, oats and horse keeping, leather, rivets and burrs, buckles, snaps, hemp and wax for harness repairs, harness oil, axle grease, pack saddles, with sling ropes and binding ropes (when required), pack straps (when required), also all material and charges for repairing transport. Horse-shoeing tools include hammer, rasp and crooked knife.

298. The surveyor, while in the field, is allowed for himself and every man of his party, a ration allowance of fifty cents per day.

299. For meals, board and hotel expenses of himself and party while in the field, the surveyor is allowed in addition to the ration allowance a sum of twenty-eight cents per day for himself, and four cents per day for every other member of the party.

300. Camp equipage is owned and furnished by the surveyor. For its use he is allowed, while in the field, twenty-two cents per day for himself, and six cents per day for every other member of the party.

301. Camp equipage comprises the following articles:—tents, cooking utensils, dishes, plates, forks, knives, candles, lanterns, lamp oil, soap, bags, towelling, stoves, blankets, robes, axes, brush hooks, spades, picks, scribing irons, grindstones, whetstones, scythes, chain pins, surveying pickets, boxes for instruments and other purposes, and all tools required to keep the outfit in repair, excepting horseshoeing tools.

Medicines and medical expenses, otherwise than provided by clause 294, are not allowed.

302. The assistant, when a licensed surveyor or when a graduate of a recognized university serving as a pupil under articles, is granted the same ration, board and camp equipage allowances as the surveyor in charge.

303. A sum of ten dollars is allowed for stationery.

304. While engaged at office work preparing returns, the surveyor is allowed one dollar per day for living expenses, in addition to his daily salary.

305. In special cases, when it is considered that any of the regulations respecting rations, board, camp equipage or stationery is not suitable, the surveyor may be allowed actual expenses supported by vouchers.

306. The surveyor receives with his instructions such an advance on account of his survey as appears necessary for procuring his outfit and supplies. Subsequent advances are made on receipt of a certified statement on form G, exhibiting in detail the payments made out of former advances and those which are to be made out of the amount applied for. Twenty per cent of his salary is retained until his accounts are finally closed.

307. On the completion of the survey, the outfit is to be sold by auction unless otherwise directed. When so instructed, the surveyor shall store such part of the outfit and winter such of the horses as are in good condition for another season's work. A surveyor must, under no circumstances, winter a horse which is not in fairly good condition.

308. The accounts are in duplicate. The original and duplicate must be exactly alike in all respects and made up in separate bundles. Each consists of:

Form A.—Account of personal services.

Form B.—Pay-list of party showing the date of engagement and discharge of each man, his occupation and rate of pay, and the number of rations for the party. It must be signed by each of the men.

Form C.—Transport account with vouchers duly numbered, accompanied by a separate and detailed statement of travelling expenses.

Form D.—Account of miscellaneous expenses.

Form E.—Statement of disposal of outfit showing the articles received and the disposal made thereof.

Form F.—Balance sheet showing on the credit side the gross amounts of personal services, pay list, transport and miscellaneous accounts and stationery allowance, and on the debit side the payments received on account of the survey.

Each account must have its vouchers attached and statements of sales, if any, attested by the auctioneer or purchasers.

The vouchers must give the details of the articles purchased with the price of each.

The item of stationery, for which a specific amount is allowed, is charged in one lump sum, without details or vouchers.

309. The following statutory declaration is to be made to the accounts:—

I, A. B., Dominion Land Surveyor, do solemnly declare that this account is correct, and I make this solemn declaration conscientiously believing it to be true, and knowing that it is of the same force and effect as if made under oath, and by virtue of the Canada Evidence Act, 1893.

310. A diary showing the employment of every day in the field, is to be furnished.

#### CONTRACT SURVEYS.

311. The subdivision of townships is made according to law at certain rates per mile.

312. Section lines are paid at the rate of five dollars per mile of line surveyed.

313. A further payment at the rate of fifty cents per chain (\$40 per mile) up to ten chains in a section side, is made for opening, cutting and blazing the line through woods, windfalls, underbrush or heavy scrub.

314. Any opening, cutting and blazing of the line in excess of ten chains in a section side is paid at the rate of twenty-five cents per chain (\$20 per mile).

315. No payment is made under the provisions of clauses 313 and 314 where the line could have been measured without opening and cutting.

316. The part of a section line chained across a marsh or measured across water by means of a triangulation is, up to half a mile, paid as opening through woods when the body of water is surrounded by continuous woods.

317. For the interpretation of clauses 313 and 314, a section line means the distance between two monuments at section corners or the places assigned to such corners, and this distance may include a road allowance.

318. When the side of a section, exclusive of the road allowance, is greater than ninety chains or smaller than seventy chains, the number of chains of opening which may be paid at the rate of fifty cents per chain is increased or reduced in proportion to the length of the section side.

319. Only the lines actually run and marked in the field are paid for. Nothing is allowed for random and trial lines, bases of triangles and offsets.

320. A further payment at the rate of three dollars per mile is made for section lines surveyed over rough or hilly country. A section side is classified as rough or hilly when the field notes show that it crosses a ravine not less than one hundred feet deep, or two ravines each not less than fifty feet deep, or that the difference of level between two points of the line not more than half a mile apart exceeds two hundred feet, the depths or heights being measured by aneroid barometer. In case the corner of the section falls in the ravine or on the side of the hill, payment is made for either of the adjoining sections but not for both.

321. A further payment at the rate of four dollars per mile may be made upon a report of the Examiner of Surveys, concurred in by the Surveyor-General, stating that

the survey presented unusual difficulties on account of large rivers or of marshes too deep to be waded across. Payment, if made, is for the number of miles recommended in the report.

322. A further payment at the rate of four dollars per mile is made for surveying the meridian outlines of a township when such outlines are included in a subdivision survey contract, but such payment is not made for resurveying or retracing lines previously surveyed.

323. Section lines resurveyed or retraced are paid at the same rate as original section lines when such lines are resurveyed or retraced in compliance with the directions of the Manual of Survey or the instructions of the Surveyor-General, but nothing is paid for the measurement of a portion of the outlines which the Manual of Survey directs to be made for testing the chaining before commencing the subdivision of a township.

324. A further payment at the rate of twenty-five cents per pit in prairie, and forty cents per pit in the woods, is made for erecting a boundary monument, such payment covering the cost of planting and marking the post, building the mound and otherwise completing the monument. A witness trench is paid as four pits. A long quarter section post planted in a marsh is reckoned as two prairie pits (fifty cents).

325. Traverses of lakes and rivers and connecting traverses are paid at the rate of eleven dollars per mile. For traverses of lakes and rivers, the distance to be paid for is measured along the bank of the lake or river from every point fixed by the survey in a straight line to the next point. Nothing is paid for offsets.

326. A payment may be made for ascertaining the astronomical bearings of the lines of the survey when the said bearings have been ascertained in a manner approved of and satisfactory to the Surveyor-General. Payment is at such rate as the Surveyor-General authorizes, but not exceeding fifteen dollars per township.

One dollar is paid for every statutory declaration of a settler.

327. The above allowances cover the cost of preparing the returns of survey.

328. Iron posts used on the survey are supplied free of cost at Winnipeg. Posts not used, if not returned to stores, are charged to the surveyor at forty cents each.

329. A deduction at such rate as the Examiner of Surveys recommends is made from the payments to survey contractors for deficiency in the survey monuments, whether the deficiency be in the size of the pits, the marking or driving of the posts, or the scattering of the earth from the pits. The deduction recommended by the examiner is at the rate of six cents per cubic foot of deficiency in the pits in excess of a foot and a half per pit, and five cents per pit for not scattering the earth away from the pits. The deficiency is averaged on the pits examined and applied to the whole contract.

In paying for traverses, one dollar is deducted for every offset less than the number required by the Manual. Distances measured by means of improper triangles are not paid for.

330. The lines embraced in any survey under contract must be surveyed by the surveyor in person; no payment will be made on such contract work if otherwise performed.

331. To be eligible as a survey contractor, a Dominion land surveyor must own at least a standard measure, a sixty-six foot steel band and a transit theodolite of an approved pattern, not less than four-inch in diameter and reading at least to minutes.

332. Upon receiving a contract, a surveyor is required to enter into a bond jointly with two sureties each in a sum equal to the estimated amount of the contract, for the due and faithful fulfilment thereof.

333. On receipt of the bond properly executed, an advance not exceeding fifteen hundred dollars on account of the contract is made to the surveyor, and the advance is made in such a manner as the Surveyor-General considers advisable.

334. Seventy-five per cent on account of the work performed is, after deducting advances, paid to the contractor or placed to his credit as he may direct. Such payments are made on receipt of progress accounts accompanied by sketches of the work. Credits may be telegraphed through banks having agencies in Ottawa, but only after receipt of the sketches.

335. All payments are made by cheques issued in favour of the payee or in favour of a bank to be placed to his credit. It is useless to ask bank bills or post office orders; they cannot be sent.

A payment may be divided into several cheques, if desired.

An application for a payment on account must contain explicit directions as to whether a credit or a cheque is wanted, and where it is to be sent.

336. A rigid inspection of the work is made. On receipt of a report from the Inspector of Surveys, that the survey is being improperly executed, payments on account of the contract are stopped and steps are taken to recover the advances from the contractor and from his sureties, but when the deficiencies are of such a nature that they can be remedied by the contractor, he may be warned to correct them and payments on account may be continued for a reasonable time.

#### GENERAL DIRECTIONS.

337. It is of the utmost importance that the department should be kept well informed of the surveyor's address. Particular attention is called to the matter as the most vexatious delays, due to this cause, are continually occurring, and the surveyor is the first to suffer therefrom. The file number should always be quoted in communications to the department.

338. No draft on the department is accepted. Powers of attorney must be made on the official forms, supplied on application, and must conform to the regulations of the Treasury Board.

339. Iron posts are supplied on requisition, stating the number and kind wanted, where they are to be sent, and whether by express or by freight.

340. The following forms are supplied free of cost upon a requisition stating the number of each kind wanted:—

Township form for progress report, 80 chains to one inch, 1st and 2nd systems of survey.

Township form for progress report, 80 chains to one inch, 3rd system of survey.

Field book for field use, 56 section lines.

Field book for field use, 72 section lines.

Field book for final returns, 54 section lines.

Field book for final returns, 72 section lines.

Field book for miscellaneous surveys.

Field book for block surveys.

Record of chronometer errors and rates.

Statutory declaration of occupation.

Oath of chainman.

5½

Articles of agreement for the engagement of labourers.

Letter pad with official letter head.

Letter pad without official letter head.

Progress account for subdivision survey contract.

Astronomical Field Tables.

✓ Azimuth observation forms.

Table VII, printed on cardboard for the pocket.

Table VIII, printed on cardboard for the pocket.

Accounts for surveys paid by the day :

- 3 - Form A—Personal service. 4
- 3 - Form B—Pay-list. x
- 6 - Form C—Transport. 6
- 6 - Form D—Miscellaneous. 3
- Form E—Statement of disposal of outfit. 3 -
- 3 - Form F—Balance sheet. 3
- Form G—Estimate of cost of survey. x
- Official diary. x

341. In his requisition the surveyor must state what forms he wants and how many. Giving this information entails no work on his part beyond writing it, while the office staff cannot find it without a long search through the records. A surveyor cannot reasonably expect that the officers of the department will undertake this unnecessary work for no other purpose than to save him the trouble of writing a few lines. Any surveyor making a requisition in indefinite terms, such as 'the forms which I require for preparing my returns,' or some such expression will receive no other reply than a reference to this paragraph of the Manual of Survey. The same remarks apply to requisitions for iron posts and to other requests addressed to officers of the department. Every request should always state fully and explicitly what is wanted.

## APPENDICES.

## APPENDIX A.

Extracts from the Dominion Lands Act—Chap. 54, R. S. C., as amended to date.

### CLAUSES RELATING TO SURVEYS.

#### SURVEYORS AND SURVEYS.

99. No person shall act as surveyor of Dominion lands unless he was, before the fourteenth day of April, one thousand eight hundred and seventy-two, duly qualified by certificate, diploma or commission, to survey the Crown lands in some one of the Provinces of Canada, or has become qualified under the provisions hereinafter set forth. 46 V., c. 17, s. 87, *part.*

100. Persons qualified under the provisions of this Act shall be styled 'Dominion Land Surveyors,' or 'Dominion Topographical Surveyors,' as the case may be. 46 V., c. 17, s. 87, *part.*

#### *Board of Examiners.*

101. There shall be a Board of Examiners for the examination of candidates for commissions as Dominion land surveyors, or as articled pupils, which shall consist of the Surveyor-General and two Dominion topographical surveyors appointed from time to time by Order in Council; and the meetings of the Board shall commence on the second Monday in the month of February in each year or at such other times as the Minister directs,—due notice thereof being given in the *Canada Gazette*, and the place of meeting shall be at the city of Ottawa, or at such other place as is from time to time fixed by the Minister. 62-63 V., c. 16, s. 5.

2. Every member of the Board shall take an oath of office, according to the form M, in the schedule to this Act, which shall be administered by a judge of any one of the superior courts in any Province of Canada, or a judge of the Supreme Court of Canada, and such judge is hereby authorized and required to administer such oath:

3. Three members of the Board shall form a quorum.

4. The Board shall, from time to time, appoint a fit and proper person to be secretary thereof, who shall keep a record of its proceedings.

5. The Minister may cause examinations of candidates for commissions as Dominion land surveyors, or as articled pupils, to be held at such times and places as he directs, by one of the members of the Board, or by a special examiner who shall be a Dominion land surveyor, or Dominion topographical surveyor, and shall be appointed by Order in Council; but such examination shall be subject to the rules and regulations made by the Board in that behalf, and shall have no effect unless they are conducted in accordance with such rules and regulations, and are subsequently approved by the Board. 49 V., c. 27, s. 12, *part.* 62-63 V., c. 16, s. 6.

6. In the event of any member of the Board being unable, through illness or other cause, to attend any meeting of the Board, his place may be temporarily filled by another Dominion topographical surveyor appointed by Order in Council as occasion requires. 62-63 V., c. 16, s. 7.

102. No person shall be admitted as an articled pupil with any Dominion land surveyor, unless he has previously passed an examination before the Board of Examiners, or before one of the members thereof, as to his penmanship and orthography, and also as to his knowledge of arithmetic, algebra, including quadratic equations, plane

geometry, plane trigonometry, spherical trigonometry as far as the solution of triangles, the mensuration of superficies, and the use of logarithms, and has obtained a certificate of such examination, and of his proficiency, from such Board. 49 V., c. 27, s. 12, *part*.

103. Applicants for such examination, previously to being articed, shall give notice to the secretary of the Board of their desire to present themselves for examination; whereupon that officer shall instruct them as to the manner in which they must proceed. 46 V., c. 17, s. 90.

104. No pupil shall be entitled to be examined before the Board or before one of the members thereof, for admission as a Dominion land surveyor, unless he has previously served regularly and faithfully for and during the period of three successive years, under articles in writing, in the form N, in the schedule to this Act, duly executed before two witnesses, as pupil of a Dominion land surveyor, and unless he produces an affidavit from such surveyor in the form O, in the schedule to this Act, together with his own affidavit in the form P in the schedule to this Act, that he has so served; or if for some good and valid reason such affidavits cannot be produced, unless he produces such evidence of service as the Board requires; and such three years' service shall include at least twelve months' actual practice in the field. 49 V., c. 27, s. 13.

105. Whenever the pupil of a Dominion land surveyor is, at the time of his entering into articles in writing, in compliance with the provisions of the next preceding clause, a person of twenty-one years of age, the said form N may be altered to suit the case, by leaving out so much as relates to the father or other person, by whose consent and approbation the pupil enters into articles, by making the pupil take upon himself the obligation in the said form imposed on such father or other person, by stating that the consideration money has been paid by the pupil, and by otherwise so varying the form as to suit the circumstances of the case. 46 V., c. 17, s. 91, *part*.

106. Any Dominion land surveyor may, by an instrument in writing, transfer a pupil, with his own consent, to any other Dominion land surveyor, with whom such pupil may serve the remainder of his term; but such pupil shall not be entitled to examination unless he produces the affidavits of both surveyors in the form O in the schedule to this Act, or, in default thereof, such evidence as is required by clause one hundred and four of this Act. 49 V., c. 27, s. 14.

107. If any Dominion land surveyor dies, or leaves Canada, or is suspended or dismissed, his pupil may complete his term under articles, as aforesaid, with any other Dominion land surveyor. 46 V., c. 17, s. 93.

108. Articed pupils shall transmit to the secretary of the Board, within three months of the date of their articles, a duplicate thereof, together with a fee of two dollars for receiving and filing the same; and the secretary shall acknowledge the receipt of such papers and shall carefully file and keep the same with the records of the Board. 46 V., c. 17, s. 94.

109. Every person who, subsequently to the fourteenth day of April, one thousand eight hundred and seventy-two, was or becomes duly qualified by certificate, diploma or commission, to survey lands in any province of Canada, and who, in order to become so qualified, has served a term under articles to a surveyor, similar to the term prescribed by this Act, and has passed an examination in the subjects prescribed by clauses 102 and 113 of this Act, before the board of examiners of such province, shall be entitled to obtain a commission as Dominion land surveyor without further service and without being subjected to any examination other than with respect to the system of survey of Dominion lands; but it shall rest with the Board of Examiners to decide

whether the service of such person is equivalent to that prescribed in this Act for the pupils of Dominion land surveyors, and whether the subjects of examination for the certificate, diploma or commission of a surveyor of Crown lands in such province are sufficiently similar to those set forth in the said clauses to entitle him, under the foregoing provisions, to such commission; and if such service or subjects of examination are, in the opinion of the Board, not sufficiently similar to those required by this Act, the Board may, in its discretion require any candidate for admission as a Dominion land surveyor under the provisions of this clause to complete such further term of service or practice in surveying, and may examine him in such of the subjects set forth in clauses 102 and 113 of this Act, as may appear necessary. 61 V., c. 31, s. 8.

110. Every person who shows, to the satisfaction of the Board of Examiners that he has been duly admitted as a surveyor of lands in any part of His Majesty's dominions other than the Provinces of Canada to which the provisions of the next preceding clause relate, and that he has had at least two years' practice either as a surveyor or as a pupil to a surveyor (of which practice at least six months has been in the field), shall be entitled to a commission on passing an examination in the subjects set forth in clauses one hundred and two and one hundred and thirteen of this Act, and on his producing an affidavit from a Dominion land surveyor in the form O, in the schedule to this Act, that such person has, in addition to the service aforesaid, served for one year with him, including at least six months' actual practice with him in the field. 49 V., c. 27, s. 15, *part*.

111. Every graduate in surveying of the Royal Military College of Canada, and every person who has followed a regular course of study in all the branches of education required by this Act for admission as a Dominion land surveyor, through the regular sessions, for at least two years in any college or university where a complete course of theoretical and practical instruction in surveying is organized, and who has thereupon received from such college or university a diploma as civil engineer, shall be exempt from serving three years as aforesaid, and shall be entitled to examination after one year's service under articles with a Dominion land surveyor, (at least six months of which service has been in the field), on producing the affidavit required by the next preceding clause as to such service; but it shall rest with the Board to decide whether the course of instruction in such college or university is that required by this clause. 49 V., c. 27, s. 15, *part*.

112. Every person who desires to be examined before the Board shall give due notice thereof in writing to the secretary at least one month previous to the meeting of the Board, and shall, with such notice, transmit the fee hereinafter prescribed. 46 V., c. 17, s. 98.

113. No person shall, unless he is thereto entitled under any other clause of this Act, receive a commission from the Board authorizing him to practise as a Dominion land surveyor, unless he has complied with the foregoing provisions of this Act, nor until he has attained the full age of twenty-one years and has passed a satisfactory examination before the Board or before a member thereof as hereinbefore provided on the following subjects, that is to say: plane and solid geometry; spherical trigonometry, so far as it includes solution of triangles; the use of logarithms; measurement of areas, including their calculation by latitude and departure, and the dividing or laying off land; a knowledge of the elements of practical astronomy and the solution of the following elementary problems:—

(a.) To ascertain the latitude of a place from an observation of a meridian altitude of the sun or of a star;

(b.) To obtain the local time and the azimuth from an observed altitude of the sun or a star;

(c.) From an observed azimuth of a circumpolar star, when at its greatest elongation from the meridian, to ascertain the direction of the latter:

He shall be practically familiar with surveying operations and capable of intelligently reporting thereon, and be conversant with the keeping of field notes, their plotting and representation on plans of survey, in a style of draughtsmanship satisfactory to the Board, the describing of lands by metes and bounds by title, and with the adjustments and methods of use of ordinary surveying instruments; and shall also be perfectly conversant with the system of survey as embodied in this Act, and with the manual of standing instructions and regulations published by the authority of the Minister from time to time for the guidance of Dominion land surveyors. 49 V., c. 37, s. 16.

114. The Board may examine any candidate on oath,—which oath may be administered by any one of the examiners,—as to his actual practice in the field, and with regard to his instruments. 46 V., c. 17, s. 100.

115. Every person who passes the examination prescribed by this Act, and every person who is entitled to receive a commission under clause one hundred and nine of this Act, shall receive a commission from the Board in accordance with the form Q in the schedule to this Act, constituting him a Dominion land surveyor, and shall, jointly and severally with two sufficient sureties to the satisfaction of the Board, enter into a bond in the sum of one thousand dollars to His Majesty, His heirs and successors, conditioned for the due and faithful performance of the duties of his office, and shall take and subscribe before a judge of any one of the superior courts in any Province of Canada—who is hereby authorized and required to administer such oaths—or before the Board—any member of which may administer the same—the oath of allegiance, and an oath in the form following:—

'I, \_\_\_\_\_, do solemnly swear (or affirm as the case may be) that I will faithfully discharge the duties of a Dominion land surveyor according to law, without favour, affection or partiality. So help me God.'

2. Until the above formalities have been complied with the said commission of Dominion land surveyor shall have no effect:

3. The said oaths of allegiance and of office shall be deposited in the Dominion lands office:

4. The said bond shall be deposited and kept in the manner prescribed by law with regard to the bonds given for the like purposes by other public officers of Canada, and shall be subject to the same provisions, and shall inure to the benefit of any person who sustains damage by breach of any condition thereof:

5. The commission shall be registered in the office of the Registrar General of Canada. 46 V., c. 17, s. 101;—49 V., c. 27, s. 17.

116. Every Dominion land surveyor who has previously given the notice prescribed in clause one hundred and twelve of this Act, may be examined as to his knowledge of the following subjects relating to the higher branches of surveying, qualifying him, (in addition to the performance of the duties declared by this Act to be within the competence of Dominion land surveyors), for the prosecution of extensive governing or topographic surveys or those of geographic exploration, that is to say:—

- (a.) Algebra;
- (b.) Plane and spherical trigonometry;
- (c.) The plane co-ordinate geometry of the point, straight line, circle and ellipse, and the transformation of co-ordinates;
- (d.) The geometrical theory of limits, and the determination of the form, magnitude and radius of curvature of any plane section of a spheroid of revolution;
- (e.) Differential calculus as far as Taylor's and McLaurin's theorems, with its practical application;
- (f.) Methods of trigonometrical surveying, of observing the angles and calculating the sides of large triangles on the earth's surface, and of obtaining the differences

of latitude and longitude of points in a series of such triangles, regard being had to the effect of the figure of the earth;

(g.) The theory of the projections and developments used in the delineation of spherical surfaces;

(h.) The portion of the theory of practical astronomy which relates to the determination of the geographic position of points on the earth's surface and the directions of lines on the same;

(i.) The use of the method of least squares in combining direct and indirect observations, the solution of simple equations of condition and the determination of the probable and the mean error;

(j.) The theory of the Dominion lands system of survey, the methods of surveying blocks and township outlines and of making track, micrometer and exploratory surveys;

(k.) The theory and use of the instruments used in connection with the foregoing, and also of the ordinary meteorological instruments;

(l.) Elementary mineralogy and geology, so far as respects a knowledge of the more common characters by which the mineral bodies that enter largely into the composition of rocks are distinguished, with their general properties and conditions of occurrence; the ores of the common metals and the classification of rocks; and the geology of North America, so far as to be able to give an intelligent outline of the leading geological features of Canada;

(m.) Methods of trigonometrical levelling, of measurement of heights by barometer or by the temperature of boiling water, and the use of the pendulum in determining the compression of the earth;

(n.) The instruments and methods used in determining the magnetic declination, inclination and intensity. 49 V., c. 27, s. 18.

117. Persons who pass the above mentioned examination in the higher branches of surveying, shall receive a certificate to that effect from the Board, and shall be designated Dominion topographical surveyors. 46 V., c. 17, s. 103.

118. The following fees shall be paid under the provisions of this Act:—

(a.) To the secretary of the Board, by each pupil, on giving notice of his desire for examination preliminary to being articulated, one dollar;

(b.) To the secretary of the Board, as the fee due on such examination, ten dollars, and a further sum of two dollars for the certificate;

(c.) To the secretary of the Board, by each pupil, at the time of transmitting to such secretary the indentures or articles of such pupil, two dollars;

(d.) To the secretary of the Board, by each candidate for either the ordinary or the higher examination for a commission, with his notice thereof, two dollars;

(e.) To the secretary of the Board, by each applicant obtaining a commission, as his fee thereon, two dollars;

(f.) To the secretary of the Board as an admission fee by any candidate receiving a commission, twenty dollars,—but such amount, as also the ten dollars required to be paid under sub-clause (b) of this clause, shall be paid to the Minister of Finance and Receiver General to the credit of Dominion lands;

(g.) To the secretary of the Board by each applicant who obtains a commission as Dominion topographical surveyor, as his fee thereon, two dollars;

(h.) To the secretary of the Board for testing a surveyor's standard of length, two dollars. 46 V., c. 17, s. 104;—49 V., c. 27, s. 19.

119. Every member of the Board who attends at the meetings thereof, and the secretary and every member who holds an examination as provided by clause 101, shall receive five dollars for each day's sitting, and the actual travelling and living expenses incurred by such member and consequent upon such attendance,—and the Minister shall pay such sums; but no member or temporary member of the Board shall be entitled to any payment under the provisions of this clause, unless he was previously

notified by the secretary to attend the meeting of the Board because of which he claims payment for his services or for travelling and living expenses, and unless the secretary reports to the Minister that he was in regular attendance at such meeting, as a member or temporary member of the Board, and was duly notified to attend such meeting. 62-63 V., c. 16, s. 8.

120. The Board may, in its discretion, suspend or dismiss from the practice of his profession, any Dominion land or topographical surveyor whom it finds guilty of gross negligence or corruption in the execution of the duties of his office; but the Board shall not suspend or dismiss such surveyor without having previously summoned him to appear in order to be heard in his defence, nor without having heard the evidence offered both in support of the complaint and on behalf of such surveyor; and, if, after being summoned as aforesaid, the surveyor does not appear, the Board may appoint a fit and proper person to present the evidence on behalf of the surveyor. 49 V., c. 27, s. 20, *part*.

121. The Surveyor-General shall require every Dominion land or topographical surveyor, in addition to the oath by this Act required to be administered to him on receiving his commission as such, to take and subscribe on oath, or make and subscribe an affirmation, on the return of his surveys of Dominion lands, that the same have been faithfully and correctly executed according to law and the instructions of the Surveyor-General; and if it is proved, on satisfactory evidence, before any court of competent jurisdiction, that such surveys, or any part thereof, have not been so executed, the Attorney General of Canada shall, upon the application of the Surveyor-General, immediately institute a suit upon the bond of such surveyor; and the institution of such suit shall operate as a lien on any property owned or held by such surveyor, or his sureties, at the time the suit is instituted. 46 V., c. 17, s. 107, *part*.

122. Every Dominion land surveyor shall keep exact and regular journals and field notes of all his surveys of Dominion lands, and shall file them in the order of time in which the surveys have been performed, and he shall give copies thereof to all persons concerned, when required so to do; and for so doing he shall be paid the sum of one dollar for each copy, if the number of words therein does not exceed four hundred—but if the number of words therein exceeds four hundred, he shall be paid ten cents additional for every hundred words over and above four hundred words. 46 V., c. 17, s. 123.

123. Every Dominion land surveyor summoned to attend any court, civil or criminal, for the purpose of giving evidence in his professional capacity as a surveyor, shall be allowed five dollars for each day he so attends, in addition to his reasonable travelling and living expenses, to be taxed and paid in the manner by law provided, with regard to the payment of witnesses attending such court. 46 V., c. 17, s. 124.

#### *Chain Bearers.*

124. Every chain bearer employed in the survey of Dominion lands shall, before he commences his chaining or measuring, take an oath or affirmation that he will discharge such duty with exactness, according to the best of his judgment and ability, and render a true account of his chaining or measuring to the surveyor by whom he has been appointed to such duty; and any Dominion land surveyor may administer such oath or affirmation. 46 V., c. 17, s. 108.

#### *Standard of Measure.*

125. The measure of length used in the surveys of Dominion lands shall be the English measure of length; and every Dominion land surveyor shall be in possession of a subsidiary standard thereof—which subsidiary standard, tested and stamped as

correct by the Department of Inland Revenue, shall be furnished to him by the secretary of the Board on payment of a fee of eight dollars therefor; and all Dominion land surveyors shall, from time to time, regulate and verify, by such standard, the length of their chains and other instruments for measuring; and the said standard measure shall be returned to the secretary of the Board as often as it requires to be tested again:

2. Every surveyor who is found performing his duties without being in possession of the standard measure which, by this clause, he is required to have, shall be liable to be suspended for a period not exceeding twelve months. 49 V., c. 27, s. 21.

#### *Renewal of Lost Corners and Obliterated Lines.*

126. Whenever a Dominion land surveyor is employed to run any dividing line or limit between sections or other legal subdivisions, and the mound, post or monument erected, marked or planted in the original survey, to define the corner of such section or other legal subdivision, cannot be found, he shall obtain the best evidence that the nature of the case admits of, respecting such corner mound, post or monument; but if the position of the same cannot be satisfactorily so ascertained, he shall proceed as follows:—

(a.) If the lost corner mound, post or monument is that of a township corner, he shall report the circumstances of the case to the Surveyor-General, who shall instruct him how to proceed;

(b.) If the lost corner mound, post or monument is on one of the outlines of a township, he shall join, by a straight line, the nearest undisputed section or quarter section corners on such outline, and divide such straight line into such number of sections or quarter sections or other legal subdivisions as the same contained in the original survey,—giving to each an equal breadth;

(c.) If, in re-establishing the east or west boundary of a township, one of the nearest undisputed corners is on a correction line, every quarter section shall be made exactly forty chains, and the deficiency or surplus, as the case may be, shall be left in the quarter section adjoining the correction line;

(d.) If, in re-establishing the north or south boundary of a township surveyed under the first system of survey, one of the nearest undisputed corners is the western corner of the township, every quarter section shall be made exactly forty chains, and the deficiency or surplus, as the case may be, shall be left in the western quarter section;

(e.) When the position of the township corner is also lost, it shall be re-established as aforesaid, previously to re-establishing the outline of the township;

(f.) When the lost corner is in the interior of a township, on the limit of a meridian road allowance, the surveyor shall connect the two nearest undisputed corners on such limit by a straight line, and divide the distance into such number of sections or other legal subdivisions as the same contained in the original survey, giving to each an equal breadth;

(g.) If one of the nearest undisputed corners is on a correction line, he shall make each quarter section exactly forty chains and leave the deficiency or surplus, as the case may be, in the quarter section adjoining the correction line;

(h.) When the nearest undisputed corners on the said limit of a meridian road allowance are in different townships, the outline between such townships shall be re-established previous to re-establishing the meridian;

(i.) When the lost corner is that of a quarter section on a line running east and west, the surveyor shall join, by a straight line, the opposite section corners on the meridians on each side, and give to each quarter section an equal breadth;

(j.) If, in townships surveyed under the first system of survey, the lost corner is in the western row of sections of a township, the first quarter section shall be made exactly forty chains, and the deficiency or surplus, as the case may be, shall be left in the western quarter section;

(k.) When the position of one of the corners on the meridians is also lost, such meridian shall be re-established previously to re-establishing the east and west line ;

(l.) Whenever a surveyor erects, plants or places a mound, post or monument as aforesaid, to renew a lost or obliterated corner, he shall duly take into account any allowance for road or roads ; and the corner, or division or limit so established, shall be the true corner, or division or limit of such section or other legal subdivision. 46 V., c. 17, s. 110.

*Survey of Legal Subdivisions.*

127. When, in the survey of legal subdivisions, it is necessary for a Dominion land surveyor to establish the division line between two sections, he shall effect this by connecting, by a straight line, the opposite original section corners, if they exist, and if not, by similarly connecting the points established in renewal thereof, in accordance with the next preceding clause, giving, in either case, the quarter sections involved an equal breadth :

2. In laying out a half section or a quarter section he shall connect the opposite quarter section posts by straight lines :

3. In laying out other and minor legal subdivisions he shall give to every such subdivision its proportionate share of frontage and interior breadth, and connect the resulting terminal points by a straight line :

4. The lines or limits so drawn on the ground in the manner above prescribed shall, in the respective cases, be the true lines or limits of such section, half section or other legal subdivision, whether the same correspond or do not correspond with the area expressed in the respective patents for such lands. 46 V., c. 17, s. 111.

*Division Lines in Fractional Sections.*

128. The dividing lines or limits between legal subdivisions, in fractional sections, shall be drawn from the original corners (or the points representing such corners, as defined on the ground, in accordance with the provisions of this Act), in the section line intended as the front of the lot :

2. Northerly or southerly lines shall be drawn due north or due south :

3. Easterly or westerly lines shall be drawn at an angle with the meridian equal to the mean of the angles formed with the same meridian by the lines which are the northern and the southern boundaries respectively of the section. 46 V., c. 17, s. 112.

*Original Boundary Lines.*

129. All boundary lines of townships, sections or legal subdivisions, towns or villages, and all boundary lines of blocks, gores and commons, all section lines and governing points, all limits of lots surveyed, as defined by mounds, posts or monuments, erected, placed or planted at the angles of any townships, towns, villages, sections or other legal subdivisions, blocks, gores, commons and lots or parcels of land under the authority of this Act or of the Governor in Council, shall, subject to the provisions hereinafter in this clause contained, be the true and unalterable boundaries of such townships, towns and villages, sections or other legal subdivisions, blocks, gores, commons and lots or parcels of land respectively, whether the same, upon admeasurement, are or are not found to contain the exact area or dimensions mentioned or expressed in any patent, grant or other instrument in respect of any such township, town, village, section or other legal subdivision, block, gore, common, lot or parcel of land :

2. Whenever the Minister of the Interior has reason to believe that any gross irregularity or error has been made in the survey of any township surveyed under the authority of this Act, the Governor in Council, upon the recommendation of the Minister of the Interior, may direct that such survey shall be cancelled and a new survey made, and the said new survey shall be made accordingly :

3. In effecting any new survey as provided by the preceding subclause, all posts, mounds, or other marks placed to mark the original survey which is to be corrected, may be removed, and the new posts, mounds or other marks placed to mark and define the new survey, shall become the original marks of such survey :

4. The plan of any survey performed under the provisions of this Act, and of record in the Department of the Interior, or any tracing or lithographed copy of the same, may be altered and amended so as to show any and all alterations made by a new survey effected as provided by this Act. 52 V., c. 27, s. 7.

130. Every township, section or other legal subdivision, town, village, block, gore, common, lot or parcel of land, shall consist of the whole width included between the several mounds, posts, monuments or boundaries respectively, so erected, marked, placed or planted as aforesaid, at the several angles thereof, and no more or less—any quantity or measure expressed in the original grant or patent thereof notwithstanding. 46 V., c. 17, s. 114.

131. Every patent, grant or instrument purporting to be for any aliquot part of any section, or other legal subdivision, block, gore, common, lot or parcel of land, shall be construed to be a grant of such aliquot part of the quantity the same contains on the ground, whether such quantity is more or less than that expressed in such patent, grant or instrument. 46 V., c. 17, s. 115.

132. In every town and village in Manitoba or the North-west Territories, surveyed and laid out under the provisions of this Act, all allowances for any road, street, lane, lot or common, laid out in the original survey of such town or village, shall be public highways and commons ; and all mounds, posts or monuments, placed or planted in the original survey of such town or village, to designate or define any allowance for a road, street, lane, lot or common, shall be the true and unalterable boundaries of such road, street, lane, lot or common ; and all Dominion land surveyors employed to make surveys in such town or village, shall follow and pursue the same rules and regulations in respect of such surveys as are, by law, required of them when employed to make surveys in townships. 46 V., c. 17, s. 116.

*Evidence before Surveyors.*

133. Every Dominion land surveyor acting in that capacity, may examine witnesses on oath, with respect to all matters relating to the settlement, occupation or possession of Dominion lands, and to the survey of lands, and for better ascertaining the original corner or limits of any township, section or other legal subdivision, lot or tract of land, and may administer such oath or oaths to every person whom he examines in relation to such matters. 46 V., c. 17, s. 117.

134. Whenever any Dominion land surveyor is in doubt as to the true corner, boundary or limit of any township, section, lot or tract of land which he is employed to survey, and has reason to believe that any person is possessed of any important information touching such corner, boundary or limit, or of any writing, plan or document tending to establish the true position of such corner, boundary or limit, and if such person does not willingly appear before, and be examined by such surveyor, or does not willingly produce to him such writing, plan or document, such surveyor may apply to any justice of the peace for an ordinary subpoena *ad testificandum* or a subpoena *duces tecum*, as the case requires, accompanying such application by an affidavit or solemn declaration made before such justice of the peace, of the facts on which the application is founded ; and such justice may issue a subpoena accordingly, commanding such person to appear before the surveyor at a time and place mentioned in the subpoena, and, if the case requires it, to bring with him any writing, plan or document mentioned or referred to therein :

2. Such subpoena shall be served on the person named therein by delivering a copy thereof to him, or by leaving the same for him with some adult person of his family at his residence, exhibiting to him or such adult person the original:

3. If the person required in such subpoena to appear, after being paid his reasonable expenses, or having the same tendered to him, refuses or neglects to appear before the surveyor at the place and time appointed in the subpoena, or to produce the writing, plan or document, if any, therein mentioned or referred to, or to give such evidence and information as he possesses touching the boundary or limit in question, a warrant by the justice for the arrest of such person may be issued, and he shall be liable to a penalty not exceeding one hundred dollars, or to imprisonment for a term not exceeding ninety days, or to both, in the discretion of such justice. 46 V., c. 17, s. 118.

135. All evidence taken by a Dominion land surveyor, as aforesaid, shall be reduced to writing and shall be read over to the person giving the same, and shall be signed by such person; or if he cannot write, he shall acknowledge the same as correct before two witnesses, who shall sign the same, as shall also the Dominion land surveyor; and such evidence shall, and any document or plan prepared and sworn to as correct before a justice of the peace, by any Dominion land surveyor, with reference to any survey by him performed, may be filed and kept at the registry office of the place in which the lands to which the same relate are situate, subject to be produced thereafter in evidence in court. 46 V., c. 17, s. 119.

136. Any Dominion land surveyor, when engaged in the performance of his duties as such, may pass over, measure along and ascertain the bearings of any township or section line, or other governing line, and for such purposes may pass over the lands of any person whomsoever, doing no actual damage to the property of such person. 46 V., c. 17, s. 120.

*Offences.*

137. Every person who, in any part of the Dominion lands, interrupts, molests or hinders any Dominion land surveyor while in the discharge of his duty as a surveyor, is guilty of a misdemeanor, and liable to a penalty not exceeding twenty dollars, or to imprisonment for a term not exceeding two months, or to both, in the discretion of the court. 46 V., c. 17, s. 121.

138. Every person who, knowingly and wilfully, pulls down, defaces, alters or removes any mound, post or monument erected, planted or placed in any original survey under the provisions of this Act, or under the authority of the Governor in Council, is guilty of felony, and shall be liable to imprisonment for any term not exceeding seven years:

2. Every person who, knowingly and wilfully, defaces, alters or removes any other mound or land mark, post or monument placed by any Dominion land surveyor to mark any limit, boundary or angle of any township, section or other legal subdivision, lot or parcel of land in Manitoba or the North-west Territories, is guilty of a misdemeanor, and liable to a penalty not exceeding one hundred dollars, or to imprisonment for a term not exceeding three months, or to both, in the discretion of the court. 46 V., c. 17, s. 122, *part.*

3. Every person who, not being a Dominion land surveyor, knowingly and wilfully has in his custody and possession, and not for any lawful purpose in connection with a survey of Dominion lands, any such post or monument, or any post or monument intended, or apparently intended to be used for the purposes of any such survey, or to mark any such limit, boundary or angle, is guilty of an offence and is liable on summary conviction to imprisonment for a term not exceeding six months, or to a penalty not exceeding one hundred dollars, or to both such fine and imprisonment. 61 V., c. 31, s. 9.

139. Nothing in this Act shall extend to prevent Dominion land surveyors, in their operations, from taking up posts or other boundary marks when necessary, after which they shall carefully replace them as they were before. 46 V., c. 17, s. 122, *part.*

FORM M.

OATH OF MEMBER OF BOARD OF EXAMINERS.

I, A.B., do solemnly swear (*or affirm, as the case may be*), that I will faithfully discharge the duty of an examiner of candidates for commissions as Dominion land or topographical surveyors according to law, without favour, affection or partiality. So help me God.  
46 V., c. 17, sch. form N.

FORM N.

ARTICLES OF PUPIL TO DOMINION LAND SURVEYOR.

THESE ARTICLES OF AGREEMENT, made the \_\_\_\_\_ day of \_\_\_\_\_ one thousand nine hundred and \_\_\_\_\_, between A.B., of \_\_\_\_\_ of \_\_\_\_\_ Dominion land surveyor, of the one part, and C.D., of \_\_\_\_\_ and E. F., son of the said C.D., of the other part, witness:—

That the said E.F., of his own free will, and by and with the consent and approbation of the said C.D., doth, by these presents, place and bind himself pupil to the said A.B., to serve him as such from the day of the date hereof, for and during and until the full end and term of three years from hence next ensuing, and fully to be completed and ended:

And the said C.D. doth hereby, for himself, his heirs, executors and administrators, covenant with the said A.B., his executors, administrators and assigns, that the said E.F. shall well and faithfully, and diligently, according to the best and utmost of his power, serve the said A.B. as his pupil in the practice or profession of a Dominion land surveyor, which he, the said A.B., now followeth, and shall abide and continue with him from the day of the date hereof, for and during and unto the full end of the said term of three years:

And that he, the said E.F., shall not, at any time during such term, cancel, obliterate, injure, spoil, destroy, waste, embezzle, spend or make away with any of the books, papers, writings, documents, maps, plans, drawings, field notes, moneys, chattels or other property of the said A.B., his executors, administrators or assigns, or of any of his employers; and that in case the said E.F. shall act contrary to the last mentioned covenant, or if the said A.B., his executors, administrators or assigns, shall sustain or suffer any loss or damage by the misbehaviour, neglect or improper conduct of the said E.F., the said C.D., his heirs, executors, or administrators, will indemnify the said A.B., his executors, administrators or assigns, and make good and reimburse him or them the amount or value thereof:

And further, that the said E.F. shall, at all times, keep the secrets of the said A.B., in all matters relating to the said business and profession, and will, at all times during the said term, be just, true and faithful to the said A.B., in all matters and things, and, from time to time, pay all moneys which he shall receive of or belonging to or by order of the said A.B. into his hands, and make and give true and fair accounts of all his acts, and doings whatsoever in the said business and profession, without fraud or delay, when and so often as he shall thereto be required; and will readily and cheerfully obey and execute his lawful and reasonable commands, and shall not depart or absent himself from the service or employ of the said A.B. at any time during the said term, without his consent first had and obtained, and shall, from time to time, and at all times during the said term, conduct himself with all due diligence and with honesty and sobriety:

And the said E. F. doth hereby, for himself, covenant with the said A. B., his executors, administrators and assigns, that he, the said E.F., will truly, honestly and diligently serve the said A.B. at all times, for and during the said term, as a faithful pupil ought to do, in all things whatsoever in the manner above specified :

In consideration whereof, and of \_\_\_\_\_ of lawful money by the said C.D. to the said A.B. paid at or before the sealing and delivery of these presents (the receipt whereof is hereby acknowledged), the said A.B., for himself, his heirs, executors and administrators, doth covenant with the said C.D., his heirs, executors and administrators, that the said A.B. will accept and take the said E.F. as his pupil, and that he, the said A.B., will, by the best ways and means he may or can, and to the utmost of his skill and knowledge, teach and instruct, or cause to be taught and instructed, the said E.F. in the course of study prescribed by clause one hundred and thirteen of 'The Dominion Lands Act,' in practical surveying operations, and in the use of instruments, and generally in the art, practice and profession of a Dominion land surveyor, which he, the said A. B., now doth, and shall, at all times during the said term, use and practice, and also will provide the said E.F. with all the necessary and reasonable expenses incurred in transacting or performing the business of the said A.B., and also will, at the expiration of the said term, make the affidavit of service required by section one hundred and four of 'The Dominion Lands Act,' and use his best means and endeavours, at the request, cost and charges of the said C.D. and E.F., or either of them, to cause and procure him, the said E.F., to be examined before the Board of Examiners of candidates for commissions as Dominion land surveyors: Provided the said E.F. shall have well, faithfully and diligently served his said intended pupilage :

And for the true performance of all and every the covenants and agreements aforesaid, according to the true intent and meaning thereof, each of them, the said A. B. and C.D., doth bind himself, his heirs, executors and administrators, unto the other, his heirs, executors, administrators and assigns, in the penal sum of five hundred dollars, firmly by these presents :

IN WITNESS WHEREOF, the parties aforesaid have hereunto set their hands and seals, the day and year first above written.

A. B. (Seal.)  
C. D. (Seal.)  
E. F. (Seal.)

Signed, sealed and delivered  
in the presence of

G. H.,  
J. K.

46 V., c. 17, sch. form O.

FORM O.

AFFIDAVIT BY THE SURVEYOR.

I, A. B., of \_\_\_\_\_, Dominion land surveyor, do solemnly swear that E. F. has served regularly and faithfully as my pupil from the \_\_\_\_\_ day of \_\_\_\_\_, 19\_\_\_\_, to the \_\_\_\_\_ day of \_\_\_\_\_, 19\_\_\_\_. That he has been engaged with me in the field on the following surveys, that is to say :

From the \_\_\_\_\_ day of \_\_\_\_\_ to the \_\_\_\_\_ day of \_\_\_\_\_, on the survey of \_\_\_\_\_ at \_\_\_\_\_ ;

From the \_\_\_\_\_ day of \_\_\_\_\_ to the \_\_\_\_\_ day of \_\_\_\_\_, on the survey of \_\_\_\_\_ at \_\_\_\_\_

and that the said E.F. has always conducted himself with all due diligence, honesty and sobriety on the said service.

SWORN before me

49 V., c. 27, s. 22, part.

FORM P.

AFFIDAVIT BY THE PUPIL.

I, E. F., of \_\_\_\_\_, do solemnly swear that I have attained the full age of twenty-one years; that I have served regularly and faithfully with A. B., Dominion land surveyor, as his pupil, from the \_\_\_\_\_ day of \_\_\_\_\_, 19\_\_\_\_, to the \_\_\_\_\_ day of \_\_\_\_\_, 19\_\_\_\_; that I have been engaged with him in the field between the following dates on the following surveys, that is to say :

From the \_\_\_\_\_ day of \_\_\_\_\_ to the \_\_\_\_\_ day of \_\_\_\_\_, on the survey of \_\_\_\_\_ at \_\_\_\_\_ ;

From the \_\_\_\_\_ day of \_\_\_\_\_ to the \_\_\_\_\_ day of \_\_\_\_\_, on the survey of \_\_\_\_\_ at \_\_\_\_\_

SWORN before me

49 V., c. 27, s. 22, part.

FORM Q.

COMMISSION AS DOMINION LAND SURVEYOR.

This is to certify to all whom it may concern, that A. B., of \_\_\_\_\_ hath duly passed his examination before the Board of Examiners, and hath been found duly qualified to fill the office and perform the duties of Dominion land surveyor, he having complied with all the requirements of the law in that behalf: Wherefore he, the said A. B., is hereby duly admitted to the said office, and commissioned for the discharge of the duties thereof, and is by law authorized to practice as a surveyor of Dominion lands.

IN WITNESS WHEREOF, WE, the President and Secretary of the said Board, have signed this commission, at \_\_\_\_\_ on this \_\_\_\_\_ day of \_\_\_\_\_, one thousand nine hundred and \_\_\_\_\_

C. D.,  
Surveyor-General.  
E. F.,  
Secretary.

46 V., c. 17, sch. form P.

## APPENDIX B.

## THE DETERMINATION OF THE ASTRONOMICAL MERIDIAN.

The plan of a land survey is the record of the boundaries of the parcels of land laid out. With an accurate survey and a plan properly made, the precise location of the boundaries, if lost, may be defined on the ground by means of the data furnished by the plan, provided some of the monuments are found. It is not contended that boundaries re-established in this way will, in every case, hold good in law, but they are material evidence and the kind of evidence which it is the purpose of the plan to furnish. When the plan gives angles only, but no astronomical bearings, two at least of the original monuments must be found in order that the lines may be located; with a plan giving the bearings of the boundaries a single monument is sufficient. The reference of the lines to the astronomical meridian thus adds one element to the value of the plan as a record.

It is an error to consider a survey as worthless when the direction of its meridian is incorrect. Should the survey be otherwise accurate, the angle of any two lines is correctly given by the difference of their bearings, provided all the bearings are, as they should always be, referred to the same meridian. The survey has, therefore, the same value as an angular survey. The above considerations, and the fact that the lines of the system of Dominion land surveys have to be run north and south or east and west, make the determination of the astronomical meridian an operation of paramount importance for the surveyor of Dominion lands.

On block surveys, where great precision is required, the azimuth is ascertained as explained in Chapter IV. The following remarks apply to subdivision surveys:—

What seems to be the most convenient method is the observation of Polaris: it should be made in daytime. With modern instruments, there is no longer any necessity for night observations with all the discomforts attending the use of lanterns. After the day's work in the field, the night is best devoted to rest.

By means of the "Astronomical Field Tables," now supplied to surveyors, the observation has become very easy and simple: the tables are not absolutely accurate, but they are good enough for subdivision purposes. On contract surveys, azimuth observations made otherwise than by means of these tables are not paid for.

## INSTRUMENTS REQUIRED.

The instruments necessary are a watch keeping sidereal time, that is to say gaining 3 m. 56 s. a day, and a four-inch transit theodolite of the so-called "Canadian pattern" now listed by several of the English manufacturers, or an instrument provided with a telescope of equal power.

A common watch of a reputable manufacture is good enough: the movement should be in a strong open face dust proof screw case. The best grade in a nickel case, costs about \$32.75, or in a silver case \$36.50. Such a watch keeps the time for weeks with sufficient accuracy for subdivision purposes: its error is ascertained from time to time by a meridian observation of the sun or of a star. Inferior grades are equally serviceable, but they require more frequent observations of the error. These watches regulated to sidereal time may be obtained at cost from the office of the Surveyor-General.

No time piece will give good service without reasonable care. Great changes of temperature must be avoided; this is accomplished by carrying it constantly in an inner pocket where it is maintained at an even temperature by the heat of the body. The pocket must be clean and reserved exclusively for the watch which is placed in it always in the same position. It is a good plan, as a protection against dust, to keep it in a tight fitting case of chamois skin. If exposed to a very low temperature in winter, it may not only stop but be injured permanently. It must be kept away from electric

motors or dynamos, which might magnetize the balance. Winding every day as nearly as possible at the same hour is essential; this is to be done by turning the crown or the key and not by turning the watch. At least once in eighteen months it must be placed in the hands of a competent watchmaker for cleaning and oiling. A watch, particularly if of a higher grade, may easily be ruined by an incompetent workman; too much care cannot be exercised in selecting the man to whom it is intrusted.

The telescope of the transit theodolite has a Steinheil object glass with a clear aperture of  $1\frac{1}{2}$  inches. The diaphragm has platino-iridium points; a spare diaphragm ruled on glass is provided. The trough compass may be set either under the lower plate or on one of the standards.

Some prejudice still exists against the points diaphragm although experience has shown it to be superior in every respect to spider webs, platinum wires or lines ruled on glass. The alloy of which the points are made has the hardness of steel and is perfectly non-corrosive in air or moisture. The points are sufficiently stiff to be dusted with a camel hair brush without the slightest fear of disturbance. They form a perfectly permanent index of sufficient stability to last in perfect adjustment as long as the instrument lasts in wear. Upon first impression, the point may not appear so fine as a web, but it will be found by experiment that the point reading is much more exact, as irradiation due to edge reading of the web is entirely avoided, also the covering of the object when it is intersected by the web. For star observations in daylight, the glass diaphragm is to be avoided, as it absorbs considerable light and the stars are less easily seen than with webs or points.

Besides the ordinary eye pieces supplied with instruments of this class, a special prismatic eye piece is provided for daylight observations. A small ring between the eye piece and its sleeve just prevents bringing the diaphragm to focus: the surveyor must grind or file down this ring to proper thickness, to suit his eye sight, before the diaphragm can be brought to focus. When that has been done, the ring always keeps the eye piece accurately adjusted to focus, and the eye piece may be turned around as needed without fear of disturbing the adjustment.

## STAR OBSERVATIONS IN DAYLIGHT.

In Manitoba and the North-west Territories the air is in general exceedingly transparent, and a very bright star, like Sirius, may be seen at almost any time of the day; for smaller stars, it is necessary to wait till the sun is low. In the Eastern Provinces, the stars cannot be seen as easily as in the West. The pole star is best seen about half an hour or an hour before dark, while there is still ample light for reading the graduation: it may also be observed in the morning.

It is essential that the telescope be very accurately focussed, which may be done as follows:—The prismatic eye piece is first focussed upon the diaphragm and kept permanently in focus by means of the small ring which has already been mentioned. The telescope is now directed upon a star not too bright, the pole star for instance, and the tube of the telescope is racked in or out until the star appears as a fine point. A mark is made on the tube with a sharp knife to indicate this position. This must be done very accurately: for any other position the image of the star is more or less spread out and therefore not so bright.

For observing time stars close to the zenith, the prismatic eye piece is inconvenient and it is necessary to use the long diagonal eye piece. A mark must therefore be made with a sharp knife on this eye piece for placing it in focus.

To discover a star in the field in day time requires a little patience and some practice, but once discovered, it is easy to follow or to find it again. The telescope must be so directed as to bring the star within the field: how this is to be done will be explained later. After clamping the telescope in the proper direction, the field is carefully scanned: it may be a minute or more before the star is perceived as a little speck of light in some corner of the field. A quick moving star is more easily found than one which moves slowly. The motion of the pole star being almost imperceptible, a little movement to and fro given to the telescope by means of the tangent screw of

the vernier plate helps in perceiving it. Once found, it appears so plain that it is always a subject of surprise that it was not seen before.

## OBSERVATION OF THE POLE STAR FOR AZIMUTH.

For all astronomical observations, whether for time or azimuth, the instrument must be very carefully levelled. In subdividing a township, an observation for azimuth is made on a section line or at a station of a traverse. The section line or the course of the traverse is taken as reference line: in either case, the bearing of the reference line is known with sufficient approximation for setting the instrument in the meridian. This is done as follows:—

Set the vernier of the horizontal circle to read the bearing of the reference line, loosen the lower clamp and turn the instrument until the telescope is directed on the reference line: fasten the lower clamp and release the upper clamp. The instrument is now set to read astronomical bearings. By setting the vernier at  $360^\circ$ , the telescope is in the meridian.

In example No. 1, the vernier is set to read  $180^\circ 05'$ , the lower clamp released and the telescope directed on the east boundary of section 18. In example No. 2, the vernier is set at  $269^\circ 56'$  and the telescope directed on the north boundary of section 24.

The telescope must now be set for the altitude of the pole star. Take the latitude of the place from the diagram in the Astronomical Field Tables. For example No. 1, the diagram shows a latitude of  $51^\circ 20'$  corresponding to township 27: for example No. 2, the latitude opposite township 35 is  $52^\circ 03'$ . Add or subtract the number of minutes in the first column of the "Table for finding the Pole Star, etc." (A. F. T.): the result is the altitude of the star. For example No. 1, the number in the first column is 33' which subtracted from the latitude  $51^\circ 20'$  gives  $50^\circ 47'$  for the altitude. In example No. 2, the number in the first column is 12' which added to the latitude  $52^\circ 03'$  gives  $52^\circ 15'$  for the altitude of the star. The telescope is set at the altitude found.

The vernier is now set to read the bearing of the star taken from the table for the time shown by the watch. For example No. 1, it is set at  $358^\circ 19'$ , and for example No. 2 at  $1^\circ 53'$ . With the instrument so set, the star is in the field and will be seen provided the telescope is accurately focussed and the light not too strong. When found, it is brought under the vertical thread or point by means of the slow motion screws of the vernier plate and vertical circle. The time by the watch is noted as well as the horizontal circle reading.

This is only one half of the observation. For all azimuth work, it is essential that the observation be made in two positions of the instrument, circle right and circle left. The position of the instrument is reversed by transiting the telescope and turning the vernier plate  $180^\circ$ . The first part of the observation is now repeated. The H.C.R. on the reference line is recorded, the telescope is set at the altitude of the star, the vernier at the bearing, and the field is scanned for the star. When found, the time by the watch and horizontal circle reading are again recorded.

The examples and appended explanations show clearly how the observation is worked out.

It may be desired to observe at a place where no line of known bearing exists. For instance, the surveyor may wish while in camp to ascertain the time by the meridian transit of a star: for doing so, he has to set his instrument in the meridian by means of the pole star. The method is the same as before, except that use is made of the compass for turning the instrument in the direction of the star. The compass box is set on the standard (not under the lower plate).

Having fixed the telescope at the proper altitude, as explained above, set the vernier of the horizontal plate to read the astronomical bearing of magnetic north, taken from the small map in the Astronomical Field Tables. Release the lower clamp and turn the instrument until the point of the needle is opposite the zero mark of its box. Fasten the lower clamp and release the upper one: the instrument is now set to read approximately astronomical bearings. Set the vernier of the horizontal plate to read the bearing of the pole star taken from the table: if the magnetic declination and setting

of the compass box were correct, the star should now be in the field of the telescope. The needle being subject to large variations, the star may be out of the field. If not found after looking carefully, the instrument is turned slowly, a degree or two on each side, by means of the lower slow motion screw. After finding the star, the vernier is again set to the bearing from the Astronomical Field Tables for the time of the watch, and the star is brought under the vertical thread or point by means of the lower slow motion screw. Setting now the vernier at  $360^\circ$ , the telescope is in position for observing meridian transits of stars.

The pole star is more readily found with the compass if the instrumental error of the needle has been ascertained before hand. With the compass set on the standard, this error is sometimes considerable. It is readily ascertained by observing the magnetic bearing of a section line.

## EXAMPLE NO 1

## ASTRONOMICAL OBSERVATION.

Date *October 7, 1904. 8.25 A.M. Mountain Time*

Place *N.E. corner Sec. 18, Tp. 27, R. 20, W. 3 Mer.*

Reference line *East boundary Sec. 18*

Face.	H.C.R. on Reference line.	H.C.R. on Polaris.	Watch Time.
1 Right	<i>180° 05'</i>	<i>358° 23'</i>	<i>9<sup>h</sup> 13<sup>m</sup> 22<sup>s</sup></i>
2 Left	<i>180 03</i>	<i>358 24</i>	<i>9 16 14</i>
Mean	<i>180 04</i>	<i>358 23.5</i>	<i>9 14 48</i>
3 Watch correction			<i>- 41</i>
Sidereal time			<i>9 14 07</i>
4 Tabular bearing for <i>9 h. 10 m. and Tp. 20</i>			<i>358° 19'</i>
5 Difference for <i>4 m. 7 s.</i>			<i>+ 1.0</i>
6 Difference for <i>7 townships</i>			<i>- 1.3</i>
7 Convergence for <i>2 sections</i>			<i>+ 2.2</i>
8 Bearing of Polaris			<i>358 21.0</i>
9 H.C.R. on Polaris			<i>358 23.5</i>
10 Correction to H.C.R.			<i>- 2.5</i>
11 H.C.R. on Reference line			<i>180 04.0</i>
12 Bearing of Reference line			<i>180 01.5</i>

NOTE.—The Reference line must be a section line or a line between two stations of a lake or river traverse.

(1) The figures on this line are for the position of the instrument in which the vertical circle is at the right of the telescope. "H. C. R. on Reference line" is the reading of the horizontal circle when the telescope is pointed on the reference line. "H. C. R. on Polaris" is the reading of the horizontal circle when the telescope is pointed on the star. "Watch time" is the time shown by the watch when the star was under the middle thread or point of the diaphragm.

(2) The explanation of these figures is the same as above, but they are for the second position of the instrument, in which the vertical circle is at the left. The instrument is brought to this position by transiting the telescope and turning it 180° in azimuth.

(3) The watch correction is obtained as shown in the examples of observations for time.

(4) The tabular bearing is taken from the table for finding the pole star and the astronomical meridian (A.F.T.). The sidereal time being 9h. 14m. 07s. and the number of the township 27, the bearing is taken for 9h. 10m. and township 20.

(5) This is the proportional part, taken from the table, for the difference, 4m. 07s., between the time of observation and the time of the table.

(6) This is the proportional part, taken from the table, for the difference 7, between 27, the number of the township in which the observation was made, and 20, the number of the township in the table.

(7) The convergence of the meridians is taken from the diagram in the Astronomical Field Tables. For township 27, the diagram shows a convergence of about 1'11 per section. The point of observation being two sections away from the central meridian, the convergence is 2'22, say 2'2.

The sign of the convergence is + in the western half of the township.

(8) This is the astronomical bearing of the star at the time of observation: it is the algebraic sum of the four numbers above it.

(9) This is the mean of the observed readings on Polaris.

(10) The correction to the horizontal circle readings is the difference between the bearing of Polaris and the H. C. R. on Polaris. Its sign is - when the bearing is less than the H. C. R. on Polaris. If the instrument was set in what was believed to be the meridian, this correction represents the error of orientation.

(11) This is the mean of the horizontal circle readings on the reference line.

(12) The correct bearing of the reference line is the algebraic sum of the H. C. R. on reference line and of the correction to H. C. R.

This bearing is generally found to differ from the bearing by account which was 180° 05' in this example. The difference represents the accumulated errors of the survey. It is distributed among the previous courses of the survey according to the judgment of the surveyor.

## EXAMPLE No 2

## ASTRONOMICAL OBSERVATION.

Date *November 2, 1904. 5.30 P.M. Mountain Time*

Place *N.E. corner sec. 24. Tp. 35, R. 13. W. 3 Mer.*

Reference line *North boundary sec. 24*

Face.	H.C.R. on Reference line.	H.C.R. on Polaris.	Watch Time.
1 Right	<i>269° 56'</i>	<i>1° 51'</i>	<i>20<sup>h</sup> 01<sup>m</sup> 32<sup>s</sup></i>
2 Left	<i>269 57</i>	<i>1 49</i>	<i>20 05 18</i>
Mean	<i>269 56.5</i>	<i>1 50</i>	<i>20 03 25</i>
			<i>+ 39</i>
3 Watch correction.....			<i>20 04 04</i>
Sidereal time.....			
4 Tabular bearing for <i>20 h. 0 m. and Tp. 20</i>			<i>1° 52.9</i>
5 Difference for <i>4 m. 4 s.</i>			<i>- .3</i>
6 Difference for <i>15 townships</i>			<i>+ 3.3</i>
7 Convergence for <i>3</i> sections.....			<i>- 3.4</i>
8 Bearing of Polaris.....			<i>1 52.5</i>
9 H.C.R. on Polaris.....			<i>1 50.0</i>
10 Correction to H.C.R.....			<i>+ 2.5</i>
11 H.C.R. on Reference line.....			<i>269 56.5</i>
12 Bearing of Reference line.....			<i>269 59.0</i>

NOTE.—The Reference line must be a section line or a line between two stations of a lake or river traverse.

(1) The figures on this line are for the position of the instrument in which the vertical circle is at the right of the telescope. "H. C. R. on Reference line" is the reading of the horizontal circle when the telescope is pointed on the reference line. "H. C. R. on Polaris" is the reading of the horizontal circle when the telescope is pointed on the star. "Watch time" is the time shown by the watch when the star was under the middle thread or point of the diaphragm.

(2) The explanation of these figures is the same as above, but they are for the second position of the instrument, in which the vertical circle is at the left. The instrument is brought to this position by transiting the telescope and turning it 180° in azimuth.

(3) The watch correction is obtained as shown in the examples of observations for time.

(4) The tabular bearing is taken from the table for finding the pole star and the astronomical meridian (A. F. T.). The sidereal time being 20h. 04m. 04s. and the number of the township 35, the bearing is taken for 20h. and township 20.

(5) This is the proportional part, taken from the table, for the difference 04m. 04s., between the time of observation and the time of the table.

(6) This is the proportional part, taken from the table, for the difference, 15, between 35, the number of the township in which the observation was made, and 20, the number of the township in the table.

(7) The convergence of the meridians is taken from the diagram in the Astronomical Field Tables. For township 35, the diagram shows a convergence of about 1'·135 per section and the point of observation being three sections away from the central meridian, the convergence is 3'·4.

The sign of the convergence is—in the eastern half of the township.

(8) This is the astronomical bearing of the star at the time of observation: it is the algebraic sum of the four numbers above it.

(9) This is the mean of the observed readings on Polaris.

(10) The correction to the horizontal circle readings is the difference between the bearing of Polaris and the H. C. R. on Polaris. Its sign is + when the bearing is greater than the H. C. R. on Polaris. If the instrument was set in what was believed to be the meridian, this correction represents the error of orientation.

(11) This is the mean of the horizontal circle readings on the reference line.

(12) The correct bearing of the reference line is the algebraic sum of the H. C. R. on reference line and of the correction to H. C. R.

This bearing is generally found to differ from the bearing by account which was 269° 56' in this example. The difference represents the accumulated errors of the survey. It is distributed among the previous courses of the survey, according to the judgment of the surveyor.

#### DETERMINATION OF THE ERROR OF THE WATCH.

In the observation for azimuth, the watch correction was assumed to be known within a minute. This correction has to be ascertained from time to time, more or less frequently according as the watch is of a better or an inferior grade.

The watch may first be set by means of the "sidereal time at noon, mountain time," given in the Astronomical Field Tables for the fifteenth of each month. For other dates, the time is calculated by interpolation, the variation being approximately four minutes per day. Mountain time is the time of the meridian of 105° west: in that longitude, the watch is set to the sidereal time of the table when it is noon, mountain time. Further west, four minutes must be subtracted from the sidereal time at noon for every degree of longitude from the meridian of 105° west.

The watch having been set approximately to sidereal time, its correction is ascertained by observing the meridian transit of a star or of the sun.

#### DETERMINATION OF THE TIME BY THE MERIDIAN TRANSIT OF A STAR.

The observation of the meridian transit of a star is best made while surveying section or traverse lines, because the telescope is readily placed in the meridian by turning the requisite angle from a line of known bearing. At other places, the instrument is placed in position by means of the compass and the pole star, as previously explained.

After placing the instrument in the meridian, the telescope is set at the altitude of the star, which is obtained by subtracting the polar distance from the supplement of the latitude. The stars in the Astronomical Field Tables pass the meridian south of the zenith. The telescope being in position, the field is examined for the star a little before the time of transit. With a long diagonal eye piece, the star enters the field on the left: with the prismatic or an inverting eye piece, it enters on the right. The star moves through the field and when it crosses the vertical thread or point, the time of the watch is noted.

In example No. 3, the latitude of the place from the diagram in the Astronomical Field Tables is 52° and its supplement 128°: subtracting the polar distance of Pollux, 61° 45', gives for the altitude 66° 15', at which the telescope is set.

In example No. 4, the latitude of the place is 51° 21' and its supplement 128° 39': subtracting the polar distance of Regulus, 77° 34', gives for the altitude 51° 05'. The calculation of the altitude is made roughly: a few minutes more or less do not matter.

The examples and explanations appended show how the watch correction is deduced.

#### EXAMPLE No. 3.

##### TIME BY MERIDIAN TRANSIT OF A STAR.

DATE—October 7, 1904,—6.45 A.M., Mountain time.

PLACE—Sec. 12, Tp. 35, R. 13, W. 3 Mer.

(1) Watch time of meridian transit of Pollux . . . . .	7 <sup>h</sup> 38 <sup>m</sup> 31 <sup>s</sup>
(2) Sidereal time " " " . . . . .	7 <sup>h</sup> 39 <sup>m</sup> 30 <sup>s</sup>
(3) Watch correction (slow) . . . . .	+ 39 <sup>s</sup>

(1) This is the time shown by the watch when the star crosses the vertical thread or point of the diaphragm, the telescope having previously been set in the meridian.

(2) The sidereal time of meridian transit is taken from the table of time stars (A. F. T.).

(3) The watch correction is + when the watch is slow and - when it is fast.

#### EXAMPLE No. 4.

##### TIME BY MERIDIAN TRANSIT OF A STAR.

DATE—November 2, 1904,—7.30 A.M., Mountain time.

PLACE—Sec. 30, Tp. 27, R. 20, W. 3 Mer.

(1) Watch time of meridian transit of Regulus . . . . .	10 <sup>h</sup> 03 <sup>m</sup> 59 <sup>s</sup>
(2) Sidereal time " " " . . . . .	10 <sup>h</sup> 03 <sup>m</sup> 18 <sup>s</sup>
(3) Watch correction (fast) . . . . .	- 41 <sup>s</sup>

(1) This is the time shown by the watch when the star crosses the vertical thread or point of the diaphragm, the telescope having previously been set in the meridian.

(2) The sidereal time of meridian transit is taken from the table of time stars (A.F.T.).

(3) The watch correction is + when the watch is slow and - when it is fast.

#### DETERMINATION OF THE TIME BY THE MERIDIAN TRANSIT OF THE SUN.

The determination of the watch correction by means of the meridian transit of the sun is a very convenient method. The observation is made at a time of the day when the instrument is on the survey and therefore can readily be set in the meridian, there is no difficulty in finding the sun, and moreover it can be observed through light clouds or haze when stars are invisible.

The observation is exceedingly simple. The telescope is set in the meridian as explained for a star transit, and a note is made of the times shown by the watch when the first limb and the second limb cross the vertical thread or point of the diaphragm. The observation is, of course, made with the coloured glass. The Apparent Right Ascension of the sun at the time of observation must now be calculated: it is found by adding the variation for the longitude to the Right Ascension at Greenwich Apparent Noon given in the Astronomical Field Tables.

The longitude of the place of observation, which is required for calculating the variation of the Right Ascension, is taken from the diagram in the Astronomical Field Tables where it is given in hours and tenths. The variation in one hour is given in the table in the column next to the Right Ascension: the variation for the longitude is the product of the longitude expressed in hours and decimals by the variation in one hour.

The details of the calculation are shown in examples Nos. 5 and 6 and in the notes appended.

EXAMPLE No. 5.

TIME BY MERIDIAN TRANSIT OF THE SUN.

DATE—March 18th, 1905.

PLACE—Tp. 28, R. 19, W. 2 Mer.

(1) Transit of first limb . . . . .	23 <sup>h</sup> 49 <sup>m</sup> 12.8 <sup>s</sup>
(2) " second limb . . . . .	23 <sup>h</sup> 51 <sup>m</sup> 20.8 <sup>s</sup>
Mean . . . . .	23 <sup>h</sup> 50 <sup>m</sup> 16.8 <sup>s</sup>
(3) Sun's R. A. at App. Noon, Green. . . . .	23 <sup>h</sup> 49 <sup>m</sup> 51.3 <sup>s</sup>
(4) Var. in 6 <sup>h</sup> .98 = 9 <sup>s</sup> .1 × 6.98 . . . . .	1 <sup>m</sup> 03.5 <sup>s</sup>
(5) Sun's R.A. at observation . . . . .	23 <sup>h</sup> 50 <sup>m</sup> 54.8 <sup>s</sup>
(6) Watch correction (slow) . . . . .	+ 38 <sup>s</sup>

(1) This is the time shown by the watch when the first limb of the sun crosses the vertical thread or point of the diaphragm, the telescope having been previously set in the meridian.

(2) This is the time of the watch at the crossing of the other limb.

(3) The Apparent Right Ascension of the Sun at Apparent Noon is taken from the Astronomical Field Tables.

(4) The longitude 6<sup>h</sup>.98 is obtained from the diagram in the Astronomical Field Tables. The variation in one hour is given in the column next to the Apparent Right Ascension.

(5) The Sun's Right Ascension at the time of observation is the sum of the Right Ascension at Greenwich noon and the variation in 6<sup>h</sup>.98.

(6) The watch correction is obtained by subtracting the watch time from the Sun's Right Ascension at observation.

EXAMPLE No. 6.

TIME BY MERIDIAN TRANSIT OF THE SUN.

DATE—October 25th, 1904.

PLACE—Tp. 65, R. 15, W. 5 Mer.

(1) Transit of first limb . . . . .	13 <sup>h</sup> 58 <sup>m</sup> 27 <sup>s</sup>
(2) " second limb . . . . .	14 <sup>h</sup> 00 <sup>m</sup> 39 <sup>s</sup>
Mean . . . . .	13 <sup>h</sup> 59 <sup>m</sup> 33 <sup>s</sup>
(3) Sun's R. A. at App. Noon, Green. . . . .	13 <sup>h</sup> 57 <sup>m</sup> 54 <sup>s</sup>
(4) Var. in 7 <sup>h</sup> .75 = 9 <sup>s</sup> .56 × 7.75 . . . . .	1 <sup>m</sup> 14 <sup>s</sup>
(5) Sun's Right Ascension at observation . . . . .	13 <sup>h</sup> 59 <sup>m</sup> 08 <sup>s</sup>
(6) Watch correction (fast) . . . . .	- 25 <sup>s</sup>

(1) This is the time shown by the watch when the first limb of the sun crosses the vertical thread or point of the diaphragm, the telescope having previously been set in the meridian.

(2) This is the watch time of crossing of the other limb.

(3) The Apparent Right Ascension of the Sun at Apparent Noon is taken from the Astronomical Field Tables.

(4) The longitude 7<sup>h</sup>.75 is obtained from the diagram in the Astronomical Field Tables. The variation in one hour is given in the column next to the Apparent Right Ascension.

(5) The Sun's Right Ascension at the time of observation is the sum of the Right Ascension at Greenwich Noon and the variation in 7<sup>h</sup>.75.

(6) The watch correction is obtained by subtracting the watch time from the Sun's Right Ascension at observation.

OBSERVATION OF THE SUN FOR AZIMUTH.

Star observations require a clear sky: they may be prevented by smoke, haze or light clouds, while the sun is quite visible. It may therefore happen that the observation of the sun will be the only method available for the determination of the azimuth.

The method is not as accurate as with Polaris and as it involves considerable calculation it is more liable to errors. It is not recommended when Polaris can be observed.

The instrument must be provided with a dark coloured glass for looking at the sun through the telescope.

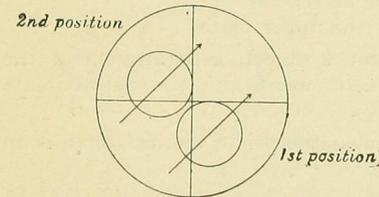


Fig. 39. Observation of the sun in the forenoon with an erecting eye piece.

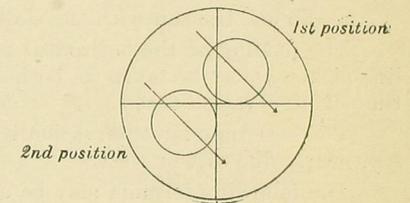


Fig. 40. Observation of the sun in the afternoon with an erecting eye piece.

The observation is made first with the vertical circle in one position, to the right of the observer for instance, and next with the circle to the left, after reversing the telescope and turning the upper plate 180°. In the first position of the instrument, the image of the sun is brought in the angle formed by two of the threads in the telescope so as to be tangent to both at the same time. The same process is repeated with the instrument in the second position, but with the sun's image in the opposite angle (Figs. 39 and 40). In order to bring both threads tangent to the sun's limb at the same time, the sun's image must be so placed as to move towards one thread while going away from the other. The former thread is kept tangent to the limb by the proper slow motion screw until both threads are tangent together. In the opposite angle of the threads, the same process is repeated with the other slow motion screw. Fig. 39 shows how the sun's image appears in the forenoon with an erecting eye piece. In the upper left angle of the threads, the sun's image moves away from the horizontal thread and towards the vertical thread; the latter is kept tangent by the slow motion screw of the upper plate. In the lower right angle of the threads, the sun's image moves away from the vertical thread and towards the horizontal thread, the latter being kept tangent by the slow motion screw of the vertical circle. Fig. 40 shows how the discs would be placed in the afternoon.

An erecting eye piece is not suitable for observing the sun; a diagonal eye piece is more convenient. The explanations which follow are for the use of the long diagonal.

Figs. 41 and 42 show how the images of the sun appear in the forenoon, and in the afternoon, with this eye piece.

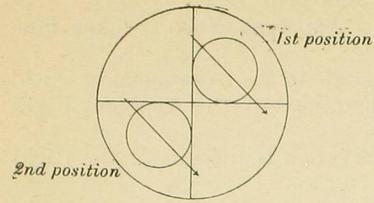


Fig. 41. Observation of the sun in the forenoon with a long diagonal eye piece.

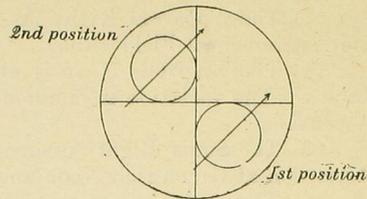


Fig. 42. Observation of the sun in the afternoon with a long diagonal eye piece.

The observation is easy enough if made methodically, otherwise there is a risk of not placing the images in opposite angles which would entirely vitiate the result. The rules which follow, if learned by heart so as to be carried out without any hesitation, will prevent mistakes :—

1. Always commence with the sun on the right of the vertical thread and impinging upon it, above the horizontal thread in the forenoon and below in the afternoon.
2. Always commence by following the sun with the slow motion screw of the vertical circle.

In the second position of the instrument, the rules are reversed.

3. Place the sun on the left of the vertical thread and impinging upon the horizontal thread, below it in the forenoon and above it in the afternoon.
4. Follow the sun with the slow motion screw of the upper plate.

The reading of the horizontal circle on the reference object, generally one of the line pickets, must be taken in both positions of the instrument, and the approximate time of observation noted.

The best time for observation is when the sun is near the prime vertical, that is to say, nearly due east or west.

The following formula may be used for the calculation :—

$$\cos \frac{Az}{2} = \sqrt{\cos S \cos (S-P) \sec L \sec h}$$

$$\text{where } S = \frac{h + L + P}{2}$$

$h$  being the true altitude of the sun,  $L$  the latitude,  $P$  the sun's polar distance, and  $Az$  the azimuth of the sun. Reckoning the bearing from  $0^\circ$  to  $360^\circ$  from the north point through east, south and west,  $Az$  is the bearing in the forenoon and  $360^\circ$  minus the bearing in the afternoon.

The latitude and its secant are given in Table II for the north side of every section.

On page 95 two examples are given, one in the afternoon and the other in the forenoon. H. C. R. is for horizontal circle reading.

DATE—21st November, 1881—3.18 P.M.

PLACE—50 chs. W. of N.E. corner section 31, Tp. 4, R. 14, W. of 3rd meridian.

FACE.	SUN'S ALTITUDE.	H. C. R. ON SUN.	H. C. R. ON LINE.
Right.	6° 25'	227° 35' 00''	90° 00' 00''
Left.	7 09	228 43 00	90 01 00
Mean.	6 47	228 09 00	90 00 30

GREENWICH TIME.		$h = 6^\circ 39' 31''$	sec. $h = 0.00294$
Local time=November 21	3h. 18m.	$L = 49 20 58$	sec. $L = 0.18612$
Longitude	+7 12	$P = 110 07 17$	cos. $S = 9.08188$
Greenwich time=November 21	10 30	$2S = 166 07 46$	cos. $(S-P) = 9.94966$
		$S = 83 03 53$	$\cos^2 \frac{Az}{2} = 19.22060$
		$S-P = 27 03 24$	cos. $\frac{Az}{2} = 9.61030$
			$\frac{Az}{2} = 65^\circ 56' 30''$
			$Az = 131 53 00$
			Bearing = 228 07 00
			Convergence, $2\frac{5}{8}$ sec. (§ 68 & 69) = + 2 40
			Bea. referred to central mer. = 228 09 40
			H. C. R. on sun = 228 09 00
			Correction = + 40
			H. C. R. on line = 90 00 30
			Bearing of line = 90 01 10

DATE—June 15th, 1881—7.20 A.M.

PLACE—25 chs. W. of N.E. corner section 36, Tp. 28, R. 17, W. of 2nd meridian.

FACE.	SUN'S ALTITUDE.	H. C. R. ON SUN.	H. C. R. ON LINE.
Right.	30° 09'	175° 43' 00''	176° 39' 00''
Left.	30 15	176 51 00	176 40 00
Mean.	30 12	176 17 00	176 39 30

GREENWICH TIME.		$h = 30^\circ 10' 28''$	sec. $h = 0.06324$
Local time=June 14	19h. 20m.	$L = 51 26 45$	sec. $L = 0.20533$
Longitude	+6 57	$P = 66 39 30$	cos. $S = 9.43664$
Greenwich time=June 15	2 17	$2S = 148 16 43$	cos. $(S-P) = 9.99629$
		$S = 74 08 21$	$\cos^2 \frac{Az}{2} = 19.70150$
		$S-P = 7 28 51$	cos. $\frac{Az}{2} = 9.85075$
			$\frac{Az}{2} = 44^\circ 50' 00''$
			$Az$ or Bearing = 89 40 00
			Convergence, $2\frac{5}{8}$ sec. (§ 68 & 69) = -3 00
			Bea. referred to central mer. = 89 37 00
			H. C. R. on sun = 176 17 00
			Correction = -86 40 00
			H. C. R. on line = 176 39 30
			Bearing of line = 89 59 30

## APPENDIX C.

## AN ORDINANCE RESPECTING MASTERS AND SERVANTS.

(Chapter 50, Consolidated Statutes of the Northwest Territories of Canada.)

The Lieutenant-Governor by and with the advice and consent of the Legislative Assembly of the Territories enacts as follows:—

1. Every contract or hire of personal service shall be subject to the provisions of this Ordinance, and if such contract is for any period more than one year it shall be in writing and signed by the contracting parties. No. 26 of 1895, s. 2.

2. Any person engaged, bound or hired whether as clerk, journeyman, apprentice, servant, labourer or otherwise howsoever, guilty of drunkenness or of absenting himself by day or night without leave from his proper service or employment, or of refusing or neglecting to perform his just duties or to obey the lawful commands of his master, or of dissipating his employer's property or effects shall be deemed guilty of a violation of his contract, and upon summary conviction of one or more of the said violations, forfeit and pay such sum of money not exceeding \$30, as to the justice or magistrate seems meet together with costs of prosecution, and in default of payment thereof, forthwith shall be imprisoned for any period not exceeding one month, unless the fine imposed and costs together with the costs of commitment and conveying such person convicted to the place of imprisonment be sooner paid. No. 26 of 1895, s. 3.

3. Any justice, upon oath of any employee, servant or labourer complaining against his or her master or employer concerning any non-payment of wages (not exceeding two months' wages, the same having been first demanded) illusage or improper dismissal by such master or employer, may summon the master or employer to appear before him at a reasonable time to be stated in the summons, and the justice shall upon proof on oath of the personal service of the summons examine into the matter of the complaint, whether the master or employer appears or not, and upon due proof of the cause of complaint the justice may discharge the servant or labourer from the service or employment of the master and may direct the payment to him or her of any wages found to be due (not exceeding two months' wages as aforesaid), and the justice shall make such order for payment of the said wages as to him seems just and reasonable with costs. No. 26 of 1895, s. 4; No. 38 of 1897, s. 53 (1).

4. Proceedings may be taken under this Ordinance within three months after the engagement or employment has ceased, or within three months after the last instalment of wages under the agreement of hiring has become due whichever shall last happen. No. 26 of 1895, s. 5.

5. The provisions of this Ordinance shall be held to apply in the Territories to contracts and agreements made at any place outside the same. No. 26 of 1895, s. 6.

6. Nothing in this Ordinance shall in any wise curtail, abridge or defeat any civil or other remedy for the recovery of wages or damages which employers or masters may have against servants or employees, or which servants or employees may have against their masters or employers. No. 26 of 1895, s. 8; No. 38 of 1897, s. 53 (2).

## APPENDIX D.

## FORM OF ENGAGEMENT FOR EMPLOYEES

ARTICLES OF AGREEMENT made and entered into at the City of Hamilton in the Province of Ontario this sixteenth day of March, A.D. 1903.

BETWEEN *John Brown*, of the said City of Hamilton, Dominion Land Surveyor, hereinafter called the employer, and *William Smith*, of the same place, labourer, hereinafter called the employee.

Witness that the said employee hereby agrees to enter into the service and employment of the said employer and to faithfully and diligently serve him and his assistant or assistants or any person under whose charge the said employee may for the time being be placed by order and direction of the said employer in the capacity of *labourer* for the period of *eight months* from the date of this agreement in connection with surveys to be performed in the *North-west Territories*, or until the completion of the said surveys.

And also to execute, do and perform with all due despatch and punctuality and according to his skill and ability all such work as the said employer or such assistant or assistants or other person as aforesaid shall require him to do in the said capacity.

And also at all times to conduct himself honestly, faithfully and properly in the course of such services; and also not to leave the service of the said employer or enter into the service or employment of any other person during the said period without the written consent of the said employer.

And the said employer in consideration of such service agrees to pay to the said employee the wages of *seventy-five cents* per day for the first *half* of such service, and *one dollar and fifty cents* per day for the other *half* of the said service, and to board him so long as the said employee continues to serve under this agreement.

The said employer also agrees to advance the actual travelling expenses of the said employee from the *City of Hamilton to the North-west Territories*, the said advance to be retained by the said employer from the wages of the said employee.

And provided that if the said employee shall be guilty of any misconduct in his service or shall commit any breach of this agreement he shall forfeit all wages which may then be due him, without prejudice to the said employer's other remedies.

In witness whereof the parties hereto have hereunto set their hands the day and year first above written.

*John Brown,*  
*William Smith.*

Signed in the presence of  
*Robert Jones.*

APPENDIX E.

CONSTRUCTION AND USE OF TABLES.

TABLE I.

This table gives for the third system of survey the latitudes of base and correction lines, and other data for these lines.

The latitudes given are those of the line of posts on the north boundary of the township and on the south side of the road allowance.

The 'chord azimuth' is the angle of the base or correction line with the meridian of the township corner; it is equal to the complement of half the convergence for one range. The 'chord azimuth' is given for the south side of correction lines.

The 'deflection' is the angle through which a base or correction line has to be deflected upon arriving at a township corner; it is equal to the convergence of meridians for one range.

This deflection angle may be turned with the instrument, but more readily by the use of the 'deflection offsets' in the table. The tabulated offset is the linear distance in inches between one of the chords and the prolongation of the other, at one chain from the township corner.

Their distance apart at any point is found by multiplying the tabulated offset by the distance, expressed in chains, of the point from the township corner.

For example, if the instrument is standing on the prolongation of the first chord at five chains past the corner, and the back picket be fifteen chains on the other side of, that is, behind the corner, then the instrument must be moved north five times, and the back picket south fifteen times, the 'deflection offset for one chain.' The line of the instrument and picket is now in the correct bearing for the prolongation of the base line.

The angle is thus turned as accurately as a straight line can be produced with the instrument, and much more accurately than the angle can be measured with the graduated arc, while the setting of the instrument at the corner (which may be in low ground, unsuitable for accurate line production) is rendered unnecessary.

The 'longitude covered by one range' is given both in arc and in time.

Owing to the convergence of meridians, a range is wider than four hundred and eighty-six chains south of the base line and narrower on the north side. The table gives the width of the range on both sides of the correction line.

The 'jog' is the excess in width on the correction line of the range on the north side of the road allowance over the range on the south side.

Clarke's elements of the figure of the earth were used for the computation of this table.

TABLE II.

This table gives for the north side of every section, up to township eighty-two, the latitude with the logarithms of its tangent and secant, and the width of the quarter sections.

The logarithms of the tangent and secant are used in the computation of time and azimuth observations.

TABLE III.

This table is for determining the watch error by the observation at any time of the transits of Polaris and another star across the same vertical plane.

Let  $L$  be the latitude of the place,  $R.A.$  and  $D$  the right ascension and declination of Polaris,  $R.A.'$  and  $D'$  the same quantities for the other star,  $T$  and  $T'$  the watch times

at which each of the stars crossed the same vertical, and  $p$  the distance from the pole to the vertical of the pole star. The hour angle of the time star, at the instant it was observed, is:

$$t = p (\tan L - \tan D')$$

This value, when  $p$  is known, is readily calculated by taking  $(\tan L - \tan D')$  from a table of natural tangents. The logarithmic form of the formula may also be employed:

$$t = p \frac{\sin(L - D')}{\cos L \cos D'}$$

In using either formula it must be remembered that a south declination is negative. Table III gives the value of  $\log p$  expressed in seconds of time.

The arguments are the declination of the time star  $D'$ , and the time interval  $A$ , of which the value is:

$$A = (R.A.' - R.A.) - (T' - T)$$

$A$  is taken in the column at the left of the table for time stars of north declination, and at the right of the table for stars of south declination.

The table was calculated for a value of  $D$  equal to  $88^\circ 51'$ . For other values, a correction must be added to  $\log p$ ; it is given in Table IV.

The time obtained by means of this table is sufficiently accurate for all practical purposes, except the determination of longitudes.

The table may also be employed for calculating the azimuth of Polaris when the sidereal time is known. The hour angle of Polaris is used as argument ' $A$ ' and the latitude of the place instead of 'Declination North.' The azimuth in minutes of arc is

$$\frac{p \sec L}{4}$$

The result is accurate within a few seconds of arc.

Table III was computed by the following formula:—

$$p = P \sin A + \frac{P^2}{2} \sin 2A \tan D'$$

where  $P$  is the polar distance of Polaris.

Example. On the 15th April, 1903, on the north boundary of township twenty, range two, west of the fifth meridian, the following transits were observed across the same vertical:—

Polaris	6 <sup>h</sup> 33 <sup>m</sup> 27 <sup>s</sup>
Alpha Canis Majoris	6 36 42

Chronometer keeping sidereal time—Required the chronometer error.

R. A.' = 6h 40m 52.9s	T' = 6h 36m 42s	L (Table II) = 50° 45'	
R. A. = 1 23 24.7	T = 6 33 27	D' = -16 35	D 88° 47' 25"
R. A.' - R. A. = 5 17 28.2	T' - T = + 3 15	L - D' = 67 20	
T' - T = + 3 15.0			
A = 5 14 13.2			

CALCULATION BY LOGARITHMS.

Log. $p$ for 5h 10m (Table III).....	=	2.4300
Difference for 4m 13s.....	= +	.0017
Correction for 88°47'25" (Table IV).....	= +	.0220
Log. sin (L-D').....	=	9.9651
Log. sec L (Table II).....	=	0.1988
Log. sec D'.....	=	0.0185
<hr/>		
Log. $t$ .....	=	2.6361
$t$ .....	=	432.6
R. A.'.....	=	0h 7m 12.6s
	=	6 40 52.9
<hr/>		
Sidereal time of transit.....	=	6 33 40.3
T'.....	=	6 36 42.0
<hr/>		
Chronometer error.....	= -	3 1.7

CALCULATION BY NATURAL TANGENTS.

Nat. tan L = 1.2239	Log. $p$ for 5h 10m (Table III).....	=	2.4300
Nat. tan D' = 0.2978	Difference for 4m 13s.....	= +	.0017
Tan L - tan D' = 1.5217	Correction for 88° 47' 25" (Table IV).....	= +	.0220
	Log. (tan L - tan D').....	=	.1823
<hr/>			
	Log. $t$ .....	=	2.6360
	$t$ .....	=	432.5s
		=	0h 7m 12.5s
	R. A.'.....	=	6 40 52.9
<hr/>			
	Sidereal time of transit.....	=	6 33 40.4
	T'.....	=	6 36 42.0
<hr/>			
	Chronometer error.....	= -	3 1.6

TABLE IV.

This table gives the correction to be added to the value of log  $p$  in Table III when the declination of Polaris is less than 88° 51'; the correction is merely the difference between the logarithm of the polar distance of Polaris, expressed in seconds of arc and the logarithm of 276.

TABLE V.

This is the part of the table of addition and subtraction logarithms, useful in reducing time azimuth observations with Polaris. Suppose two numbers  $a$  and  $b$ , and  $a > b$ ; then we have, as long as  $A$  is less than 10:

FOR SUMS.

Take 10 + log.  $b$  - log.  $a = A$   
and then  
Log. ( $a + b$ ) = log.  $a + B$ .

FOR DIFFERENCES.

Take log.  $a$  - log.  $b = B$   
and then  
Log. ( $a - b$ ) = log.  $b + A - 10$ .

TABLE VI.

This is useful in deflecting trial lines. It gives the angular deflection of a line for deviations of 1 to 149 links at the end of eighty-one chains.

TABLE VII.

The correction in links to slope measurements is given for one and for eight chains, tapes of these lengths being those in general use on Dominion Land Surveys. The table is used in connection with a clinometer. See clauses 263-264.

TABLE VIII.

This table is intended for laying out roads: it gives for roads one chain wide the distance to the opposite limit at road corners when the survey is made along one of the limits. For wider or narrower roads, the tabular distance is proportionally increased or decreased. When the survey is made along the middle of the road, the distance of the corners on each side is one half of the tabular distance. See clauses 129-130.

ASTRONOMICAL FIELD TABLES.

These tables are a specimen of those issued every six months for the use of surveyors in the field. Their object is to facilitate the determination of the astronomical meridian. Their use is fully explained in Appendix B.

*Table for finding the Pole Star and the Astronomical Meridian.*—A double purpose is served by this table. It may be employed for finding the pole star in daylight by setting the telescope in the direction of the star. The first column gives the number of minutes to be added to or subtracted from the latitude for obtaining the altitude of the star. In the second column is the argument, the local sidereal time for every ten minutes. In the other columns are the bearings of the star for every twentieth township up to township 80.

The other purpose of the table is to determine the direction of the astronomical meridian in subdividing townships: it is not absolutely accurate, but the precision is ample for subdivision surveys.

*Time Stars.*—For the determination of the local sidereal time by the observation of the meridian transit of stars. The brightest stars crossing the meridian south of the zenith and visible in the North-west Territories are given in the table. The "Polar Distance" serves to calculate the altitude.

*Sidereal Time at Noon, Mountain Time.*—For setting the watch approximately to local sidereal time.

*The Sun's Apparent Right Ascension and Variation for One Hour at Greenwich Apparent Noon.*—Copied from the British Nautical Almanac. This table is for the determination of the local sidereal time by the observation of the meridian transit of the sun.

*Longitude in Hours and Tenths.*—From this diagram, the longitude in hours and tenths for every township up to township 80 and for every range as far as the seventh meridian, is obtained at a glance. This longitude is used for calculating the Sun's Apparent Right Ascension at the time of observation.

*Latitude and Convergence per Section.*—The diagram shows at a glance for every township up to township 80, the convergence of the meridians for one section in minutes and hundredths, and the latitude. The convergence serves to refer an observed bearing to the meridian of the centre of the township or to any other meridian. See clauses 68 and 69. The latitude is used for calculating the altitude of stars for daylight observations.

*Astronomical Bearings of Magnetic North in Western Canada.*—This diagram is intended for setting the transit theodolite to read astronomical bearings by means of the compass attached to the standard. The method is fully explained in Appendix B.

TABLES

TABLE I.

Latitude, Chord Azimuth, Deflection, &c., for Base and Correction lines.

Third System of Survey

Township Number.	Latitude.	Chord Azimuth.	Deflection.	Deflection Offset for one Chain Distance.	LENGTH OF ONE RANGE ON CORRECTION LINE.		Jog.	LONGITUDE COVERED BY 486 CHAINS.		Township Number.
					North Side of Road.	South Side of Road.		Arc.	Time.	
					Chains.	Chains.		Chains.	s	
0	49 00 00.00	89 56 58.5	6 03.0	1.394				8 00.990	32.1	0
2	10 29.05	57.4	05.2	1.403	487.719	484.297	3.422			2
4	20 58.07	56.3	07.5	1.411				04.388	32.3	4
6	31 27.08	55.1	09.8	1.420	740	276	464			6
8	41 56.08	54.0	12.0	1.429				07.852	32.5	8
10	52 25.05	52.9	14.3	1.438	762	255	507			10
12	50 02 54.01	51.7	16.6	1.447				11.385	32.8	12
14	13 22.96	50.5	19.0	1.456	784	233	551			14
16	23 51.88	49.4	21.3	1.465				14.988	33.0	16
18	34 20.77	48.2	23.7	1.474	806	212	594			18
20	44 49.65	47.0	26.1	1.483				18.662	33.2	20
22	55 18.51	45.8	28.5	1.492	829	188	641			22
24	51 05 47.35	44.6	30.9	1.501				22.411	33.5	24
26	16 16.17	43.3	33.4	1.510	852	167	685			26
28	26 44.98	42.1	35.8	1.520				26.235	33.7	28
30	37 13.76	40.9	38.3	1.529	875	144	731			30
32	47 42.53	39.6	40.8	1.539				30.136	34.0	32
34	58 11.26	38.3	43.4	1.548	899	120	779			34
36	52 08 39.98	37.1	45.9	1.558				34.118	34.3	36
38	19 08.69	35.8	48.4	1.568	923	097	826			38
40	29 37.37	34.5	51.0	1.578				38.181	34.5	40
42	40 06.04	33.2	53.6	1.588	947	072	875			42
44	50 34.69	34.9	56.2	1.598				42.329	34.8	44
46	53 01 03.31	30.6	58.8	1.608	972	047	925			46
48	11 31.92	29.3	7 01.5	1.619				46.564	35.1	48
50	22 00.52	27.9	04.2	1.629	997	024	973			50
52	52 29.09	26.6	06.9	1.639				50.887	35.4	52
54	42 57.65	25.2	09.6	1.650	488.023	483.998	4.025			54
56	53 26.19	23.8	12.4	1.660				55.302	35.7	56
58	54 03 54.71	22.4	15.2	1.671	049	972	077			58
60	14 23.21	21.0	18.0	1.682				59.811	36.0	60
62	24 51.69	19.6	20.8	1.693	075	946	129			62
64	35 20.15	18.2	23.7	1.704				9 04.417	36.3	64
66	45 48.59	16.7	26.6	1.715	102	919	183			66
68	56 17.01	15.3	29.4	1.726				09.123	36.6	68
70	55 06 45.42	13.8	32.4	1.737	130	892	238			70

TABLE I.—Concluded.

Latitude, Chord Azimuth, Deflection, &c., for Base and Correction lines.—Concluded.

Third System of Survey.

Township Number.	Latitude.	Chord Azimuth.	Deflection.	Deflection Offset for one Chain Distance.	LENGTH OF ONE RANGE ON CORRECTION LINE.			LONGITUDE COVERED BY 486 CHAINS.		Township Number.
					North Side of Road.	South Side of Road.	Jog.	Arc.	Time.	
	° ' "	° ' "	' "	inches				' "	s	
72	55 17 13.82	89 56 12.4	7 35.3	1.749				9 13.932	36.9	72
74	27 42 20	10.9	38.3	1.760	488.158	483.855	4.293			74
76	38 10 55	09.4	41.3	1.772				18.847	37.3	76
78	48 38 89	07.8	44.4	1.783	187	837	350			78
80	59 07 20	06.3	47.4	1.795				23.871	37.6	80
82	56 09 35.49	04.8	50.5	1.807	215	809	406			82
84	20 03 77	03.2	53.6	1.819				29.006	37.9	84
86	30 32 03	01.7	56.7	1.831	245	779	466			86
88	41 00 28	00.1	59.8	1.843				34.258	38.3	88
90	51 28 51	89 55 58.5	8 03.0	1.855	275	750	525			90
92	57 01 56.70	56.9	06.3	1.867				39.630	38.6	92
94	12 24 89	55.2	09.6	1.879	306	720	586			94
96	22 53 07	53.6	12.8	1.892				45.125	39.0	96
98	33 21 22	51.9	16.2	1.905	338	690	648			98
100	43 49 36	50.3	19.5	1.918				50.747	39.4	100
102	54 17 48	48.6	22.9	1.931	369	658	711			102
104	58 04 45.57	46.8	26.3	1.944				56.500	39.8	104
106	15 13 66	45.1	29.8	1.957	402	627	775			106
108	25 41 73	43.4	33.3	1.971				10.02.389	40.2	108
110	36 09 78	41.6	36.8	1.984	434	594	840			110
112	46 37 81	39.9	40.3	1.998				08.418	40.6	112
114	57 05 83	38.0	44.0	2.012	469	561	908			114
116	59 07 33.83	36.2	47.6	2.026				14.593	41.0	116
118	18 01 81	34.4	51.2	2.040	503	528	975			118
120	28 29 77	32.6	54.9	2.054				20.917	41.4	120
122	38 57 71	30.7	58.6	2.068	538	493	5.045			122
124	49 25 64	28.8	9 02.4	2.083				27.396	41.8	124
126	59 53 55	26.9	06.2	2.097	574	458	116			126

TABLE II.—Latitude, &c., for the North Boundary of each Section.

Township.	Section.	Latitude.	Secant L.	Tangent L.	¼ Section.
		° ' "			
	36	49 00 00.00	0.183 06	0.060 84	40.000
1	1	00 52.75	19	0.061 06	39.988
	12	01 44.84	31	28	976
	13	02 37.59	44	51	964
	24	03 29.68	57	73	953
	25	04 22.43	69	95	941
	36	05 14.53	82	0.062 17	929
2	1	06 07.28	95	40	917
	12	06 59.36	0.184 08	62	905
	13	07 52.11	20	85	893
	24	08 44.21	33	0.063 07	882
	25	09 36.96	46	29	870
	36	10 29.05	59	51	858
					40.143
	1	11 21.89	71	74	131
	12	12 13.89	84	96	119
	13	13 06.63	97	0.064 18	107
	24	13 58.72	0.185 10	41	095
	25	14 51.46	23	63	084
	36	15 43.56	35	85	072
4	1	16 36.30	48	0.065 08	060
	12	17 28.40	61	30	048
	13	18 21.14	74	52	036
	24	19 13.24	87	74	024
	25	20 05.98	0.186 00	97	012
	36	20 58.07	12	0.066 19	40.000
5	1	21 50.81	25	42	39.988
	12	22 42.91	38	64	976
	13	23 35.65	51	86	964
	24	24 27.74	64	0.067 08	952
	25	25 20.48	77	31	940
	36	26 12.58	90	53	928
6	1	27 05.32	0.187 03	76	916
	12	27 57.41	15	98	904
	13	28 50.15	28	0.068 20	892
	24	29 42.25	41	43	880
	25	30 34.99	54	65	868
	36	31 27.08	67	87	858
					40.145
7	1	32 19.82	80	0.069 10	133
	12	33 11.91	93	32	121
	13	34 04.65	0.188 06	54	109
	24	34 56.75	19	77	097
	25	35 49.49	32	99	085
	36	36 41.58	45	0.070 21	073
8	1	37 34.32	58	44	060
	12	38 26.41	71	66	048
	13	39 19.15	84	89	036
	24	40 11.25	97	0.071 11	024
	25	41 03.99	0.189 10	33	012
	36	41 56.08	23	56	40.000
9	1	42 48.82	36	78	39.988
	12	43 40.91	49	0.072 00	976
	13	44 33.65	62	23	964
	24	45 25.74	75	45	951
	25	46 18.48	88	68	939
	36	47 10.56	0.190 01	90	927

TABLE II.—Latitude, &c.—Continued.

Township.	Section.	Latitude.	Secant L.	Tangent L.	$\frac{1}{4}$ Section.
		° ' "			
10	1	49 48 03 30	0 190 14	0 073 12	39 915
	12	48 55 41	27	35	903
	13	49 48 15	40	57	891
	24	50 40 23	53	79	879
	25	51 32 97	66	0 074 02	867
	36	52 25 05	79	24	{ 39 855 40 147
11	1	53 17 79	93	47	135
	12	54 09 88	0 191 06	69	122
	13	55 02 62	19	92	110
	24	55 54 70	32	0 075 14	098
	25	56 47 44	45	36	086
	36	57 39 53	58	59	073
12	1	58 32 27	71	81	061
	12	59 24 36	84	0 076 03	050
	13	50 00 17 10	98	26	037
	24	01 09 18	0 192 11	48	024
	25	02 01 92	24	71	012
	36	02 54 01	37	93	40 000
13	1	03 46 75	50	0 077 16	39 988
	12	04 38 84	63	38	975
	13	05 31 58	77	60	963
	24	06 23 66	90	83	951
	25	07 16 40	0 193 03	0 078 05	939
	36	08 08 49	16	28	926
14	1	09 01 23	29	50	914
	12	09 53 31	43	72	902
	13	10 46 05	56	95	890
	24	11 38 14	69	0 079 17	877
	25	12 30 88	82	40	865
	36	13 22 96	96	62	{ 39 853 40 149
15	1	14 15 70	0 194 09	85	137
	12	15 07 78	22	0 080 07	124
	13	16 00 52	35	30	112
	24	16 52 60	49	52	099
	25	17 45 34	62	75	087
	36	18 37 42	75	97	074
16	1	19 30 16	89	0 081 20	062
	12	20 22 24	0 195 02	42	050
	13	21 14 98	15	64	037
	24	22 07 06	28	87	025
	25	22 59 80	42	0 082 09	012
	36	23 51 88	55	32	40 000
17	1	24 44 61	69	54	39 988
	12	25 36 70	82	77	975
	13	26 29 43	95	99	963
	24	27 21 51	0 196 09	0 083 22	950
	25	28 14 24	22	44	940
	36	29 06 33	35	67	925
18	1	29 59 06	49	89	913
	12	30 51 14	62	0 084 12	901
	13	31 43 87	76	34	888
	24	32 35 96	89	56	876
	25	33 28 69	0 197 02	79	863
	36	34 20 77	16	0 085 01	{ 39 851 40 150

TABLE II.—Latitude, &c.—Continued.

Township.	Section.	Latitude.	Secant L.	Tangent L.	$\frac{1}{4}$ Section.
		° ' "			
19	1	50 35 13 50	0 197 29	0 085 24	40 138
	12	36 05 58	43	46	125
	13	36 58 31	56	69	113
	24	37 50 40	69	91	100
	25	38 43 13	83	0 086 14	088
	36	39 35 21	96	36	075
20	1	40 27 94	0 198 10	59	063
	12	41 20 02	23	81	050
	13	42 12 75	37	0 087 04	038
	24	43 04 84	50	27	025
	25	43 57 57	64	49	013
	36	44 49 65	77	72	40 000
21	1	45 42 38	91	94	39 987
	12	46 34 46	0 199 04	0 088 17	975
	13	47 27 19	18	39	962
	24	48 19 27	31	62	950
	25	49 12 00	45	84	937
	36	50 04 08	58	0 089 07	925
22	1	50 56 81	72	29	912
	12	51 48 89	85	52	899
	13	52 41 62	99	74	887
	24	53 33 70	0 200 13	97	874
	25	54 26 43	26	0 090 20	862
	36	55 18 51	40	42	{ 39 849 40 152
23	1	56 11 24	53	65	140
	12	57 03 32	67	87	127
	13	57 56 05	81	0 091 10	114
	24	58 48 12	94	32	102
	25	59 40 85	0 201 08	55	089
	36	51 00 32 93	21	77	076
24	1	01 25 66	35	0 092 00	064
	12	02 17 74	49	22	051
	13	03 10 47	62	45	038
	24	04 02 54	76	68	025
	25	04 55 27	90	90	013
	36	05 47 35	0 202 03	0 093 13	40 000
25	1	06 40 08	17	35	39 987
	12	07 32 15	31	58	975
	13	08 24 88	44	81	962
	24	09 16 96	58	0 094 03	949
	25	10 09 69	72	26	936
	36	11 01 76	85	48	924
26	1	11 54 49	99	71	911
	12	12 46 56	0 203 13	93	898
	13	13 39 29	27	0 095 16	885
	24	14 31 36	40	39	873
	25	15 24 09	54	61	860
	36	16 16 17	68	84	{ 39 847 40 154
27	1	17 08 90	82	0 096 07	141
	12	18 00 97	95	29	129
	13	18 53 70	0 204 09	52	116
	24	19 45 77	23	74	103
	25	20 38 50	37	97	090
	36	21 30 58	51	0 097 19	077

TABLE II.—Latitude, &c.—Continued.

Township.	Section.	Latitude.	Secant L.	Tangent L.	$\frac{1}{4}$ Section.
		° ' "			
28	1	51 22 23 31	0 204 64	0 097 42	40 064
	12	23 15 38	78	65	051
	13	24 88 11	92	87	039
	24	25 00 18	0 205 06	0 098 10	026
	25	25 52 91	20	33	013
	36	26 44 98	33	55	40 000
29	1	27 37 71	47	78	39 987
	12	28 29 78	61	0 099 00	974
	13	29 22 50	75	23	962
	24	30 12 57	89	46	949
	25	31 05 29	0 206 03	69	936
	36	31 59 37	17	91	923
30	1	32 52 09	31	0 100 14	910
	12	33 44 17	44	36	897
	13	34 36 89	58	59	884
	24	35 28 96	72	82	871
	25	36 21 68	86	0 101 05	858
	36	37 13 76	0 207 00	27	{ 39 846 40 156
31	1	38 06 48	14	50	143
	12	38 58 56	28	72	130
	13	39 51 28	42	95	117
	24	40 43 35	56	0 102 18	104
	25	41 36 07	70	41	091
	36	42 28 15	84	63	078
32	1	43 20 87	99	86	065
	12	44 12 94	0 208 12	0 103 08	052
	13	45 05 66	26	31	039
	24	45 57 74	40	54	026
	25	46 50 46	54	77	013
	36	47 42 53	68	99	40 000
33	1	48 35 25	82	0 104 22	39 987
	12	49 27 32	96	45	974
	13	50 20 04	0 209 10	68	961
	24	51 12 11	24	90	948
	25	52 04 83	38	0 105 13	935
	36	52 56 90	52	35	922
34	1	53 49 62	66	58	909
	12	54 41 68	80	81	896
	13	55 34 40	94	0 106 04	883
	24	56 26 47	0 210 08	26	869
	25	57 19 19	22	49	856
	36	58 11 26	36	72	{ 39 843 40 158
35	1	59 08 98	51	95	145
	12	59 56 05	65	0 107 17	132
	13	00 48 77	79	40	119
	24	01 40 83	93	63	106
	25	02 33 55	0 211 07	86	092
	36	03 25 62	21	0 108 08	079
36	1	04 18 34	36	31	066
	12	05 10 41	50	54	053
	13	06 03 13	64	77	040
	24	06 55 19	78	99	026
	25	07 47 91	92	0 109 22	013
	36	08 39 98	0 212 06	45	40 000

24' 08" 11

TABLE II.—Latitude, &c.—Continued.

Township.	Section.	Latitude.	Secant L.	Tangent L.	$\frac{1}{4}$ Section.
		° ' "			
37	1	52 09 32 70	0 212 21	0 109 68	39 987
	12	10 24 77	35	90	974
	13	11 17 49	49	0 110 13	960
	24	12 09 55	63	36	947
	25	13 02 27	77	59	934
	36	13 54 34	92	81	921
38	1	14 47 06	0 213 06	0 111 04	907
	12	15 39 12	20	27	894
	13	16 31 84	34	50	881
	24	17 23 91	49	73	868
	25	18 16 63	63	96	855
	36	19 08 69	77	0 112 18	{ 39 841 40 160
39	1	20 01 41	92	41	147
	12	20 53 47	0 214 06	64	134
	13	21 46 19	20	87	120
	24	22 38 25	34	0 113 09	107
	25	23 30 97	49	32	093
	36	24 23 03	63	55	080
40	1	25 15 75	77	78	067
	12	26 07 81	92	0 114 01	053
	13	27 00 53	0 215 06	24	040
	24	27 52 59	20	46	027
	25	28 45 31	35	69	013
	36	29 37 37	49	92	40 000
41	1	30 30 08	64	0 115 15	39 987
	12	31 22 15	78	38	973
	13	32 14 86	92	61	960
	24	33 06 93	0 216 07	83	946
	25	33 59 64	21	0 116 06	933
	36	34 51 71	35	29	920
42	1	35 44 42	50	52	906
	12	36 36 48	64	75	893
	13	37 29 19	79	98	879
	24	38 21 26	93	0 117 21	866
	25	39 13 97	0 217 08	44	853
	36	40 06 04	22	66	{ 39 839 40 162
43	1	40 58 75	37	89	149
	12	41 50 82	51	0 118 12	135
	13	42 43 53	66	35	122
	24	43 35 59	80	58	108
	25	44 28 30	95	81	095
	36	45 20 37	0 218 09	0 119 04	081
44	1	46 13 08	24	27	068
	12	47 05 14	38	49	054
	13	47 57 85	53	73	041
	24	48 49 92	67	95	027
	25	49 42 63	82	0 120 18	014
	36	50 34 69	96	41	40 000
45	1	51 27 40	0 219 11	64	39 986
	12	52 19 46	25	87	973
	13	53 12 17	40	0 121 10	950
	24	54 04 23	55	33	946
	25	54 56 94	69	56	932
	36	55 49 00	84	79	919

TABLE II.—Latitude, &c.—Continued.

Township.	Section.	Latitude.	Secant L.	Tangent L.	$\frac{1}{4}$ Section.
46	1	52 56 41.71	0.219 98	0.122 02	39.905
	12	57 33.77	0.220 13	25	.891
	13	58 26.48	28	48	.878
	24	59 18.54	42	70	.864
	25	53 00 11.25	57	93	.851
	36	01 03.31	71	0.123 16	{ 39.837 40.164
47	1	01 56.02	86	39	.151
	12	02 48.08	0.221 01	62	.137
	13	03 40.79	15	85	.123
	24	04 32.85	30	0.124 08	.110
	25	05 25.56	45	31	.096
	36	06 17.62	59	54	.082
48	1	07 10.33	74	77	.068
	12	08 02.38	89	0.125 00	.055
	13	08 55.09	0.222 04	23	.041
	24	09 47.15	18	46	.027
	25	10 39.86	33	69	.014
	36	11 31.92	48	92	40.000
49	1	12 24.63	63	0.126 15	39.986
	12	13 16.69	77	38	.972
	13	14 09.40	92	61	.958
	24	15 01.45	0.223 07	84	.945
	25	15 54.16	22	0.127 07	.931
	36	16 46.22	36	30	.917
50	1	17 38.93	51	53	.903
	12	18 30.99	66	76	.889
	13	19 23.70	81	99	.875
	24	20 15.75	96	0.128 22	.861
	25	21 08.46	0.224 10	45	.848
	36	22 00.52	25	68	{ 39.834 40.166
51	1	22 53.23	40	91	.153
	12	23 45.28	55	0.129 14	.139
	13	24 37.99	70	37	.125
	24	25 30.04	85	60	.111
	25	26 22.75	0.225 00	83	.097
	36	27 14.81	14	0.130 06	.083
52	1	28 07.52	29	30	.069
	12	28 59.57	44	53	.055
	13	29 52.28	59	76	.042
	24	30 44.33	74	99	.028
	25	31 37.04	89	0.131 23	.014
	36	32 29.09	0.226 04	45	40.000
53	1	33 21.80	19	68	39.986
	12	34 13.85	34	91	.972
	13	35 06.56	49	0.132 14	.958
	24	35 58.61	63	37	.944
	25	36 51.32	79	60	.930
	36	37 43.37	93	83	.917
54	1	38 36.08	0.227 08	0.133 07	.903
	12	39 28.13	23	30	.890
	13	40 20.84	38	53	.875
	24	41 12.89	53	76	.861
	25	42 05.60	68	99	.847
	36	42 57.65	83	0.134 22	{ 39.833 40.169

TABLE II.—Latitude, &c.—Continued.

Township.	Section.	Latitude.	Secant L.	Tangent L.	$\frac{1}{4}$ Section.
55	1	53 43 50.36	0.227 99	0.134 45	40.155
	12	44 42.41	0.228 13	68	.140
	13	45 35.11	29	91	.126
	24	46 27.16	44	0.135 14	.112
	25	47 19.86	59	38	.098
	36	48 11.92	74	61	.084
56	1	49 04.62	89	84	.070
	12	49 56.68	0.229 04	0.136 07	.056
	13	50 49.38	19	30	.042
	24	51 41.43	34	53	.028
	25	52 34.13	49	77	.014
	36	53 26.19	64	0.137 00	40.000
57	1	54 18.89	79	23	39.986
	12	55 10.94	95	46	.972
	13	56 03.64	0.230 10	69	.958
	24	56 55.70	25	92	.944
	25	57 48.40	40	0.138 16	.930
	36	58 40.45	55	39	.915
58	1	59 33.15	70	62	.901
	12	54 00 25.20	85	85	.887
	13	01 17.90	0.231 01	0.139 08	.873
	24	02 09.96	16	31	.859
	25	03 02.66	31	55	.845
	36	03 54.71	46	78	{ 39.831 40.171
59	1	04 47.41	62	0.140 01	.157
	12	05 39.46	77	24	.142
	13	06 32.16	92	48	.128
	24	07 24.21	0.232 07	71	.114
	25	08 16.91	23	94	.100
	36	09 08.96	38	0.141 17	.085
60	1	10 01.66	53	41	.071
	12	10 53.71	68	64	.057
	13	11 46.41	84	87	.043
	24	12 38.46	99	0.142 10	.028
	25	13 31.16	0.233 14	34	.014
	36	14 23.21	29	57	40.000
61	1	15 15.91	45	80	39.986
	12	16 07.96	60	0.143 03	.971
	13	17 00.66	76	27	.957
	24	17 52.70	91	50	.943
	25	18 45.40	0.234 06	73	.929
	36	19 37.45	21	96	.914
62	1	20 30.15	37	0.144 20	.900
	12	21 22.20	52	43	.886
	13	22 14.90	68	66	.872
	24	23 06.94	83	89	.857
	25	23 59.64	98	0.145 13	.843
	36	24 51.69	0.235 14	36	{ 39.829 40.173
63	1	25 44.39	29	59	.159
	12	26 36.43	45	83	.144
	13	27 29.13	60	0.146 06	.130
	24	28 21.18	75	29	.115
	25	29 13.88	91	53	.101
	36	30 05.92	0.236 06	76	.086

TABLE II—Latitude, &c.—Continued.

Township.	Section.	Latitude.	Secant L.	Tangent L.	$\frac{1}{4}$ Section.
64	1	54 30 58.62	0.236 22	0.146 99	40.072
	12	31 50.66	37	0.147 22	.058
	13	32 43.36	53	46	.043
	24	33 35.41	68	69	.029
	25	34 28.11	84	93	.014
	36	35 20.15	99	0.148 16	40.000
65	1	36 12.85	0.237 15	39	39.986
	12	37 04.89	30	63	.971
	13	37 57.59	46	86	.957
	24	38 49.63	61	0.149 09	.942
	25	39 42.33	77	33	.928
	36	40 34.37	92	56	.913
66	1	41 27.07	0.238 08	80	.899
	12	42 19.11	24	0.150 03	.884
	13	43 11.80	39	26	.870
	24	44 03.85	55	50	.855
	25	44 56.55	70	73	.841
	36	45 48.59	86	96	(.39.827 40.175)
67	1	46 41.29	0.239 02	0.151 20	.161
	12	47 33.33	17	43	.146
	13	48 26.02	33	67	.131
	24	49 18.06	49	90	.117
	25	50 10.75	64	0.152 13	.102
	36	51 02.80	80	37	.088
68	1	51 55.49	96	60	.073
	12	52 47.54	0.240 11	84	.058
	13	53 40.23	27	0.153 07	.044
	24	54 32.27	43	31	.029
	25	55 24.96	58	54	.015
	36	56 17.01	74	77	40.000
69	1	57 09.70	90	0.154 01	39.985
	12	58 01.75	0.241 05	24	.971
	13	58 54.44	21	48	.956
	24	59 46.48	37	71	.941
	25	00 39.17	53	95	.927
	36	01 31.22	68	0.155 18	.912
70	1	02 23.91	84	42	.898
	12	03 15.95	0.242 00	65	.883
	13	04 08.64	16	89	.868
	24	05 00.69	31	0.156 12	.854
	25	05 53.38	47	36	.839
	36	06 45.42	63	59	(.39.824 40.177)
71	1	07 38.11	79	83	.163
	12	08 30.15	95	0.157 06	.148
	13	09 22.84	0.243 11	30	.133
	24	10 14.89	26	53	.118
	25	11 07.58	42	77	.104
	36	11 59.62	58	0.158 00	.089
72	1	12 51.99	74	24	.074
	12	13 44.35	90	47	.059
	13	14 37.04	0.244 06	71	.044
	24	15 29.09	22	94	.030
	25	16 21.78	38	0.159 18	.015
	36	17 13.82	53	41	40.000
73	1	18 06.51	69	65	39.985
	12	18 58.55	85	89	.970
	13	19 51.24	0.245 01	0.160 12	.956
	24	20 43.28	17	36	.941
	25	21 35.97	33	59	.926
	36	22 28.01	49	83	.911

TABLE II.—Latitude, &c.—Concluded.

Township.	Section.	Latitude.	Secant L.	Tangent L.	$\frac{1}{4}$ Section.
74	1	55 23 20.70	0.245 65	0.161 07	39.896
	12	24 12.74	81	30	.881
	13	25 05.43	97	54	.867
	24	25 57.47	0.246 13	77	.852
	25	26 50.16	29	0.162 01	.837
	36	27 42.20	45	24	(.39.822 40.180)
75	1	28 34.89	61	48	.165
	12	29 26.93	77	72	.150
	13	30 19.62	93	95	.135
	24	31 11.65	0.247 09	0.163 19	.120
	25	32 04.34	25	43	.105
	36	32 56.38	41	66	.090
76	1	33 49.07	57	90	.075
	12	34 41.10	73	0.164 13	.060
	13	35 33.79	90	37	.045
	24	36 25.83	0.248 06	61	.030
	25	37 18.52	22	85	.015
	36	38 10.55	38	0.165 08	40.000
77	1	39 03.24	54	32	39.985
	12	39 55.27	70	55	.970
	13	40 47.96	86	79	.955
	24	41 40.00	0.249 02	0.166 03	.940
	25	42 32.69	19	27	.925
	36	43 24.72	35	50	.910
78	1	44 17.41	51	74	.895
	12	45 09.44	67	98	.880
	13	46 02.13	83	0.167 21	.865
	24	46 54.17	0.250 00	45	.850
	25	47 46.86	16	69	.835
	36	48 38.89	32	92	(.39.820 40.182)
79	1	49 31.58	48	0.168 16	.167
	12	50 23.61	64	40	.152
	13	51 16.29	81	64	.137
	24	52 08.33	97	87	.122
	25	53 01.01	0.251 13	0.169 11	.106
	36	53 53.05	30	35	.091
80	1	54 45.73	46	59	.076
	12	55 37.76	62	82	.061
	13	56 30.44	79	0.170 06	.046
	24	57 22.48	95	30	.030
	25	58 15.16	0.252 11	54	.015
	36	59 07.20	27	77	40.000
81	1	59 59.88	44	0.171 01	39.985
	12	00 51.92	60	25	.970
	13	01 44.60	77	49	.954
	24	02 36.63	93	72	.939
	25	03 29.31	0.253 09	96	.924
	36	04 21.35	26	0.172 20	.909
82	1	05 14.03	42	44	.893
	12	06 06.06	58	68	.878
	13	06 58.74	75	92	.863
	24	07 50.78	91	0.173 15	.848
	25	08 43.56	0.254 08	39	.833
	36	09 35.49	24	63	(.39.817 40.185)

TABLE III.

For finding the time by transits across the vertical of Polaris.

DECLINATION OF TIME STAR NORTH.														
A	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	
H.M.														M.H.
0 10	1.0806	1.0814	1.0821	1.0829	1.0837	1.0846	1.0856	1.0866	1.0878	1.0892	1.0908	1.0929	1.0954	50 11
20	1.3812	1.3820	1.3827	1.3835	1.3844	1.3852	1.3862	1.3872	1.3884	1.3898	1.3914	1.3934	1.3960	40
or 30	1.5566	1.5574	1.5581	1.5589	1.5597	1.5606	1.5616	1.5626	1.5638	1.5652	1.5668	1.5688	1.5713	30 or
40	1.6806	1.6813	1.6821	1.6829	1.6837	1.6846	1.6855	1.6865	1.6877	1.6891	1.6907	1.6927	1.6952	20
12 50	1.7762	1.7770	1.7777	1.7785	1.7793	1.7802	1.7811	1.7822	1.7833	1.7847	1.7863	1.7882	1.7907	10 23
1 00	1.8539	1.8546	1.8554	1.8562	1.8570	1.8578	1.8587	1.8598	1.8609	1.8622	1.8638	1.8658	1.8682	60 10
10	1.9191	1.9198	1.9205	1.9213	1.9221	1.9229	1.9238	1.9248	1.9260	1.9273	1.9288	1.9308	1.9332	50
20	1.9750	1.9757	1.9764	1.9772	1.9779	1.9788	1.9797	1.9807	1.9818	1.9831	1.9846	1.9865	1.9889	40
or 30	2.0238	2.0245	2.0252	2.0259	2.0267	2.0275	2.0284	2.0294	2.0305	2.0316	2.0332	2.0351	2.0375	30 or
40	2.0669	2.0675	2.0682	2.0690	2.0697	2.0705	2.0714	2.0724	2.0734	2.0747	2.0762	2.0780	2.0804	20
13 50	2.1053	2.1060	2.1067	2.1074	2.1081	2.1089	2.1098	2.1107	2.1118	2.1130	2.1144	2.1162	2.1185	10 22
2 00	2.1399	2.1405	2.1412	2.1419	2.1426	2.1434	2.1442	2.1451	2.1462	2.1474	2.1488	2.1505	2.1528	60 9
10	2.1711	2.1718	2.1724	2.1731	2.1738	2.1745	2.1754	2.1762	2.1773	2.1784	2.1798	2.1815	2.1837	50
20	2.1995	2.2001	2.2008	2.2014	2.2021	2.2028	2.2036	2.2045	2.2055	2.2066	2.2079	2.2096	2.2117	40
or 30	2.2254	2.2260	2.2266	2.2272	2.2279	2.2286	2.2293	2.2302	2.2311	2.2322	2.2335	2.2351	2.2372	30 or
40	2.2490	2.2496	2.2502	2.2508	2.2514	2.2521	2.2528	2.2536	2.2545	2.2556	2.2569	2.2584	2.2604	20
14 50	2.2706	2.2712	2.2717	2.2723	2.2729	2.2736	2.2743	2.2751	2.2760	2.2770	2.2782	2.2797	2.2816	10 21
3 00	2.2904	2.2909	2.2915	2.2920	2.2926	2.2933	2.2939	2.2947	2.2955	2.2965	2.2977	2.2991	2.3009	60 8
10	2.3085	2.3091	2.3096	2.3101	2.3107	2.3113	2.3119	2.3126	2.3135	2.3144	2.3155	2.3169	2.3186	50
20	2.3252	2.3257	2.3261	2.3267	2.3272	2.3278	2.3284	2.3291	2.3298	2.3307	2.3318	2.3331	2.3348	40
or 30	2.3404	2.3408	2.3413	2.3418	2.3423	2.3428	2.3434	2.3441	2.3448	2.3457	2.3467	2.3479	2.3495	30 or
40	2.3543	2.3547	2.3552	2.3556	2.3561	2.3566	2.3572	2.3578	2.3584	2.3592	2.3602	2.3614	2.3628	20
15 50	2.3669	2.3673	2.3678	2.3682	2.3686	2.3691	2.3696	2.3702	2.3709	2.3716	2.3725	2.3736	2.3750	10 20
4 00	2.3784	2.3788	2.3792	2.3796	2.3800	2.3805	2.3809	2.3815	2.3821	2.3828	2.3836	2.3846	2.3859	60 7
10	2.3888	2.3892	2.3895	2.3899	2.3903	2.3907	2.3912	2.3916	2.3922	2.3928	2.3936	2.3945	2.3958	50
20	2.3982	2.3985	2.3988	2.3992	2.3995	2.3999	2.4003	2.4008	2.4013	2.4019	2.4026	2.4034	2.4045	40
or 30	2.4065	2.4068	2.4071	2.4074	2.4077	2.4081	2.4084	2.4089	2.4093	2.4098	2.4105	2.4113	2.4123	30 or
40	2.4139	2.4142	2.4144	2.4147	2.4150	2.4153	2.4156	2.4160	2.4164	2.4169	2.4174	2.4181	2.4190	20
16 50	2.4203	2.4206	2.4208	2.4210	2.4213	2.4215	2.4218	2.4222	2.4225	2.4229	2.4234	2.4241	2.4248	10 19
5 00	2.4259	2.4261	2.4263	2.4265	2.4267	2.4269	2.4272	2.4274	2.4277	2.4281	2.4285	2.4291	2.4297	60 6
10	2.4305	2.4307	2.4308	2.4310	2.4312	2.4314	2.4316	2.4318	2.4321	2.4324	2.4327	2.4332	2.4337	50
20	2.4343	2.4344	2.4345	2.4347	2.4348	2.4350	2.4351	2.4353	2.4355	2.4358	2.4361	2.4364	2.4369	40
or 30	2.4372	2.4373	2.4374	2.4375	2.4376	2.4377	2.4378	2.4380	2.4381	2.4383	2.4385	2.4388	2.4391	30 or
40	2.4393	2.4393	2.4394	2.4395	2.4395	2.4396	2.4397	2.4398	2.4399	2.4400	2.4402	2.4403	2.4406	20
17 50	2.4405	2.4405	2.4406	2.4406	2.4406	2.4407	2.4407	2.4408	2.4408	2.4409	2.4409	2.4410	2.4412	10 18
6 00	2.4409	2.4409	2.4409	2.4409	2.4409	2.4409	2.4409	2.4409	2.4409	2.4409	2.4409	2.4409	2.4409	60 5
10	2.4405	2.4405	2.4404	2.4404	2.4404	2.4403	2.4403	2.4403	2.4402	2.4401	2.4400	2.4400	2.4398	50
20	2.4393	2.4392	2.4391	2.4391	2.4390	2.4389	2.4388	2.4387	2.4386	2.4385	2.4383	2.4382	2.4379	40
or 30	2.4372	2.4371	2.4370	2.4369	2.4368	2.4366	2.4365	2.4364	2.4362	2.4360	2.4358	2.4356	2.4352	30 or
40	2.4343	2.4341	2.4340	2.4339	2.4337	2.4336	2.4334	2.4332	2.4330	2.4327	2.4325	2.4321	2.4316	20
18 50	2.4305	2.4303	2.4302	2.4300	2.4298	2.4296	2.4294	2.4292	2.4289	2.4286	2.4282	2.4278	2.4272	10 17
7 00	2.4259	2.4257	2.4255	2.4252	2.4250	2.4248	2.4245	2.4243	2.4240	2.4236	2.4232	2.4226	2.4219	60 4
10	2.4203	2.4201	2.4199	2.4196	2.4194	2.4191	2.4188	2.4185	2.4181	2.4177	2.4172	2.4166	2.4158	50
20	2.4139	2.4136	2.4134	2.4131	2.4128	2.4125	2.4122	2.4118	2.4114	2.4109	2.4103	2.4096	2.4087	40
or 30	2.4065	2.4062	2.4059	2.4056	2.4053	2.4050	2.4046	2.4042	2.4037	2.4032	2.4025	2.4017	2.4007	30 or
40	2.3982	2.3979	2.3975	2.3972	2.3968	2.3965	2.3961	2.3956	2.3951	2.3945	2.3938	2.3929	2.3917	20
19 50	2.3888	2.3885	2.3881	2.3878	2.3874	2.3870	2.3865	2.3860	2.3854	2.3848	2.3840	2.3830	2.3818	10 16
	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	A
DECLINATION OF TIME STAR SOUTH.														

TABLE III.—Concluded.

For finding the time by transits across the vertical of Polaris.—Concluded.

DECLINATION OF TIME STAR NORTH.														
A	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	
H. M.														M. H.
8 00	2.3784	2.3781	2.3777	2.3773	2.3769	2.3764	2.3759	2.3754	2.3748	2.3741	2.3732	2.3722	2.3708	60 3
10	2.3669	2.3665	2.3661	2.3657	2.3652	2.3647	2.3642	2.3636	2.3630	2.3622	2.3613	2.3602	2.3587	50
20	2.3543	2.3538	2.3534	2.3529	2.3524	2.3519	2.3514	2.3508	2.3501	2.3492	2.3483	2.3471	2.3455	40
or 30	2.3404	2.3399	2.3394	2.3390	2.3384	2.3379	2.3373	2.3366	2.3359	2.3350	2.3340	2.3327	2.3311	30 or
40	2.3252	2.3247	2.3242	2.3237	2.3231	2.3225	2.3219	2.3212	2.3204	2.3195	2.3184	2.3171	2.3153	20
20 50	2.3085	2.3080	2.3075	2.3070	2.3064	2.3058	2.3051	2.3044	2.3036	2.3026	2.3015	2.3000	2.2982	10 15
9 00	2.2904	2.2899	2.2893	2.2887	2.2881	2.2875	2.2868	2.2861	2.2852	2.2842	2.2830	2.2815	2.2796	60 2
10	2.2706	2.2700	2.2695	2.2689	2.2682	2.2676	2.2669	2.2661	2.2652	2.2641	2.2629	2.2613	2.2593	50
20	2.2490	2.2484	2.2478	2.2472	2.2465	2.2459	2.2451	2.2443	2.2433	2.2422	2.2409	2.2393	2.2372	40
or 30	2.2254	2.2248	2.2241	2.2235	2.2228	2.2221	2.2213	2.2205	2.2195	2.2184	2.2170	2.2154	2.2132	30 or
40	2.1995	2.1989	2.1982	2.1976	2.1969	2.1962	2.1954	2.1945	2.1935	2.1923	2.1909	2.1892	2.1870	20
21 50	2.1711	2.1705	2.1698	2.1692	2.1684	2.1677	2.1669	2.1659	2.1649	2.1637	2.1623	2.1605	2.1582	10 14
10 00	2.1399	2.1392	2.1385	2.1379	2.1371	2.1363	2.1355	2.1346	2.1335	2.1323	2.1308	2.1290	2.1266	60 1
10	2.1053	2.1046	2.1039	2.1032	2.1025	2.1017	2.1008	2.0999	2.0988	2.0975	2.0960	2.0941	2.0917	50
20	2.0669	2.0662	2.0655	2.0647	2.0640	2.0632	2.0623	2.0613	2.0602	2.0589	2.0573	2.0554	2.0529	40
or 30	2.0238	2.0230	2.0223	2.0216	2.0208	2.0200	2.0191	2.0180	2.0169	2.0156	2.0140	2.0121	2.0096	30 or
40	1.9750	1.9742												

TABLE V.

Addition and Subtraction Logarithms.

A.	0	1	2	3	4	5	6	7	8	9	A.
	B										
5.0	0.0000	0001	0001	0001	0001	0001	0002	0002	0003	0003	5.0
6.0	0.0004	0004	0005	0005	0005	0005	0005	0005	0005	0005	6.0
1	0005	0006	0006	0006	0006	0006	0006	0006	0007	0007	1
2	0007	0007	0007	0007	0008	0008	0008	0008	0008	0008	2
3	0009	0009	0009	0009	0010	0010	0010	0010	0010	0011	3
4	0011	0011	0011	0012	0012	0012	0013	0013	0013	0013	4
5	0014	0014	0014	0015	0015	0015	0016	0016	0017	0017	5
6	0017	0018	0018	0019	0019	0019	0020	0020	0021	0021	6
7	0022	0022	0023	0023	0024	0024	0025	0026	0026	0027	7
8	0027	0028	0029	0029	0030	0031	0031	0032	0033	0034	8
9	0034	0035	0036	0037	0038	0039	0040	0041	0041	0042	9
7.0	0.0043	0044	0045	0047	0048	0049	0050	0051	0052	0053	7.0
1	0055	0056	0057	0059	0060	0061	0063	0064	0066	0067	1
2	0069	0070	0072	0074	0075	0077	0079	0081	0083	0085	2
3	0087	0089	0091	0093	0095	0097	0099	0102	0104	0106	3
4	0109	0111	0114	0117	0119	0122	0125	0128	0131	0134	4
5	0137	0140	0144	0147	0150	0154	0157	0161	0165	0169	5
6	0173	0177	0181	0185	0189	0194	0198	0203	0207	0212	6
7	0217	0222	0227	0233	0238	0244	0249	0255	0261	0267	7
8	0273	0280	0286	0293	0299	0306	0313	0321	0328	0336	8
9	0344	0352	0360	0368	0377	0385	0394	0403	0413	0422	9
8.00	0.0432	0433	0434	0435	0436	0437	0438	0439	0440	0441	8.00
01	0442	0443	0444	0445	0446	0447	0448	0449	0450	0451	01
02	0452	0453	0454	0456	0457	0458	0459	0460	0461	0462	02
03	0463	0464	0465	0466	0467	0468	0469	0470	0471	0473	03
04	0474	0475	0476	0477	0478	0479	0480	0481	0482	0483	04
05	0485	0486	0487	0488	0489	0490	0491	0492	0494	0495	05
06	0496	0497	0498	0499	0500	0502	0503	0504	0505	0506	06
07	0507	0508	0510	0511	0512	0513	0514	0515	0517	0518	07
08	0519	0520	0521	0523	0524	0525	0526	0527	0529	0530	08
09	0531	0532	0533	0535	0536	0537	0538	0540	0541	0542	09
8.10	0.0543	0545	0546	0547	0548	0550	0551	0552	0553	0555	8.10
11	0556	0557	0558	0560	0561	0562	0564	0565	0566	0567	11
12	0569	0570	0571	0573	0574	0575	0577	0578	0579	0581	12
13	0582	0583	0585	0586	0587	0589	0590	0591	0593	0594	13
14	0595	0597	0598	0599	0601	0602	0604	0605	0606	0608	14
15	0609	0611	0612	0613	0615	0616	0618	0619	0620	0622	15
16	0623	0625	0626	0628	0629	0630	0632	0633	0635	0636	16
17	0638	0639	0641	0642	0644	0645	0646	0648	0649	0651	17
18	0652	0654	0655	0657	0658	0660	0661	0663	0664	0666	18
19	0667	0669	0671	0672	0674	0675	0677	0678	0680	0681	19

TABLE V.—Concluded.

Addition and Subtraction Logarithms.—Concluded.

A.	0	1	2	3	4	5	6	7	8	9	A.
	B										
8.20	0.0683	0684	0686	0688	0689	0691	0692	0694	0696	0697	8.20
21	0699	0700	0702	0703	0705	0707	0708	0710	0712	0713	21
22	0715	0716	0718	0720	0721	0723	0725	0726	0728	0730	22
23	0731	0733	0735	0736	0738	0740	0741	0743	0745	0747	23
24	0748	0750	0752	0753	0755	0757	0759	0760	0762	0764	24
25	0766	0767	0769	0771	0773	0774	0776	0778	0780	0781	25
26	0783	0785	0787	0789	0790	0792	0794	0796	0798	0799	26
27	0801	0803	0805	0807	0809	0810	0812	0814	0816	0818	27
28	0820	0822	0823	0825	0827	0829	0831	0833	0835	0837	28
29	0839	0841	0842	0844	0846	0848	0850	0852	0854	0856	29
8.30	0.0858	0860	0862	0864	0866	0868	0870	0872	0874	0876	8.30
31	0878	0880	0882	0884	0886	0888	0890	0892	0894	0896	31
32	0898	0900	0902	0904	0906	0908	0910	0912	0915	0917	32
33	0919	0921	0923	0925	0927	0929	0931	0933	0936	0938	33
34	0940	0942	0944	0946	0948	0951	0953	0955	0957	0959	34
35	0962	0964	0966	0968	0970	0973	0975	0977	0979	0981	35
36	0984	0986	0988	0990	0993	0995	0997	0999	1002	1004	36
37	1006	1009	1011	1013	1016	1018	1020	1022	1025	1027	37
38	1030	1032	1034	1037	1039	1041	1044	1046	1048	1051	38
39	1053	1056	1058	1060	1063	1065	1068	1070	1073	1075	39
8.40	0.1077	1080	1082	1085	1087	1090	1092	1095	1097	1100	8.40
41	1102	1105	1107	1110	1112	1115	1117	1120	1122	1125	41
42	1128	1130	1133	1135	1138	1140	1143	1146	1148	1151	42
43	1153	1156	1159	1161	1164	1167	1169	1172	1175	1177	43
44	1180	1183	1185	1188	1191	1193	1196	1199	1202	1204	44
45	1207	1210	1213	1215	1218	1221	1224	1226	1229	1232	45
46	1235	1238	1240	1243	1246	1249	1252	1255	1257	1260	46
47	1263	1266	1269	1272	1275	1278	1280	1283	1286	1289	47
48	1292	1295	1298	1301	1304	1307	1310	1313	1316	1319	48
49	1322	1325	1328	1331	1334	1337	1340	1343	1346	1349	49
8.50	0.1352	1355	1358	1361	1364	1368	1371	1374	1377	1380	8.50
51	1383	1386	1389	1393	1396	1399	1402	1405	1408	1412	51
52	1415	1418	1421	1424	1428	1431	1434	1437	1441	1444	52
53	1447	1450	1454	1457	1460	1464	1467	1470	1474	1477	53
54	1480	1484	1487	1490	1494	1497	1501	1504	1507	1511	54
55	1514	1518	1521	1525	1528	1531	1535	1538	1542	1545	55
56	1549	1552	1556	1559	1563	1566	1570	1574	1577	1581	56
57	1584	1588	1591	1595	1599	1602	1606	1610	1613	1617	57
58	1621	1624	1628	1632	1635	1639	1643	1646	1650	1654	58
59	1658	1661	1665	1669	1673	1676	1680	1684	1688	1692	59
8.60	0.1695	1699	1703	1707	1711	1715	1719	1722	1726	1730	8.60

TABLE VI.

DEFLECTION of a Trial Line for Deviations from 1 to 149 Links at the end of eighty-one chains.

Links.	Decimal Division.		Links.	Decimal Division.										
	'	"		'	"		'	"		'	"		'	"
0	0	000	40	0	283	80	0	566	120	0	849	50	55	
1		007	41		290	81		573	121		856	51	21	
2		014	42		297	82		580	122		863	52	46	
3	1	021	43	18	304	83	35	587	123	870	52	12		
4		028	44		311	84		594	124		877	53	37	
5	2	035	45	19	318	85	36	601	125	884	53	03		
6		042	46		325	86		608	126		891	54	28	
7		050	47		332	87		615	127		898	54	54	
8	3	057	48	20	340	88	37	622	128	905	54	19		
9		064	49		347	89		630	129		912	55	45	
10	4	071	50	21	354	90	38	637	130	919	55	10		
11		078	51		361	91		644	131		927	55	35	
12	5	085	52	22	368	92	39	651	132	934	56	01		
13		092	53		375	93		658	133		941	56	26	
14		099	54		382	94		665	134		948	57	52	
15	6	106	55	23	389	95	40	672	135	955	57	17		
16		113	56		396	96		679	136		962	58	43	
17	7	120	57	24	403	97	41	686	137	969	58	08		
18		127	58		410	98		693	138		976	59	34	
19	8	134	59	25	417	99	42	700	139	983	59	59		
20		141	60		424	100		707	140		990	59	25	
21		149	61		432	101		714	141		997	60	50	
22	9	156	62	26	439	102	43	721	142	1004	60	16		
23		163	63		446	103		729	143		011	61	41	
24	10	170	64	27	453	104	44	736	144	018	61	06		
25		177	65		460	105		743	145		026	62	32	
26	11	184	66	28	467	106	45	750	146	033	62	57		
27		191	67		474	107		757	147		040	63	23	
28		198	68		481	108		764	148		047	63	48	
29	12	205	69	29	488	109	46	771	149	054	63	14		
30		212	70		495	110		778						
31	13	219	71	30	502	111	47	785						
32		226	72		509	112		792						
33	14	233	73	31	516	113	48	799						
34		241	74		523	114		806						
35		248	75		531	115		813						
36	15	255	76	32	538	116	49	820						
37		262	77		545	117		828						
38	16	269	78	33	552	118	50	835						
39		276	79		559	119		842						

TABLE VII.

CORRECTION in Links to Slope Measurements.

SLOPE.	CORRECTION FOR		SLOPE.	CORRECTION FOR	
	100 lks.	800 lks.		100 lks.	800 lks.
1 00	0.0	0.1	22 00	7.3	58.2
2 00	0.1	0.5	30	7.6	60.9
3 00	0.1	1.1	23 00	7.9	63.6
4 00	0.2	2.0	30	8.3	66.3
5 00	0.4	3.0	24 00	8.6	69.2
6 00	0.5	4.4	30	9.0	72.0
7 00	0.7	6.0	25 00	9.4	74.9
8 00	1.0	7.8	30	9.7	77.9
9 00	1.2	9.8	26 00	10.1	81.0
10 00	1.5	12.1	30	10.5	84.0
11 00	1.8	14.7	27 00	10.9	87.2
12 00	2.2	17.5	30	11.3	90.4
13 00	2.6	20.5	28 00	11.7	93.6
14 00	3.0	23.8	30	12.1	96.9
15 00	3.4	27.3	29 00	12.5	100.3
15 30	3.6	29.1	30	13.0	103.7
16 00	3.9	31.0	30 00	13.4	107.2
30	4.1	32.9	30	13.8	110.7
17 00	4.4	35.0	31 00	14.3	114.3
30	4.6	37.0	30	14.7	117.9
18 00	5.0	39.1	32 00	15.2	121.6
30	5.2	41.3	30	15.7	125.3
19 00	5.5	43.6	33 00	16.1	129.1
30	5.7	45.9	30	16.6	132.9
20 00	6.0	48.2	34 00	17.1	136.8
30	6.3	50.7	30	17.6	140.7
21 00	6.6	53.1	35 00	18.1	144.7
30	7.0	55.7	30	18.6	148.7

TABLE VIII.

TABLE for laying out roads one chain wide.

Diff. of <i>Bearing</i> Azimuth.		Links.	Diff. of <i>Bearing</i> Azimuth.		Links.	Diff. of <i>Bearing</i> Azimuth.		Links.	
°	'		°	'		°	'		
343	52	16 08	101	275 35	84 25	135	252 34	107 26	169
337	16	22 44	102	274 40	85 20	136	252 04	107 56	170
332	16	27 44	103	273 46	86 14	137	251 35	108 25	171
328	07	31 53	104	272 53	87 07	138	251 06	108 54	172
324	30	35 30	105	272 01	87 59	139	250 38	109 22	173
321	16	38 44	106	271 10	88 50	140	250 10	109 50	174
318	19	41 41	107	270 21	89 39	141	249 42	110 18	175
315	37	44 23	108	269 32	90 28	142	249 15	110 45	176
313	06	46 54	109	268 44	91 16	143	248 48	111 12	177
310	46	49 14	110	267 58	92 02	144	248 22	111 38	178
308	33	51 27	111	267 12	92 48	145	247 56	112 04	179
306	28	53 32	112	266 28	93 32	146	247 30	112 30	180
304	30	55 30	113	265 44	94 16	147	247 05	112 55	181
302	37	57 23	114	265 01	94 59	148	246 40	113 20	182
300	49	59 11	115	264 19	95 41	149	246 15	113 45	183
299	06	60 54	116	263 37	96 23	150	245 50	114 10	184
297	27	62 33	117	262 57	97 03	151	245 26	114 34	185
295	53	64 07	118	262 17	97 43	152	245 03	114 57	186
294	21	65 39	119	261 38	98 22	153	244 40	115 20	187
292	53	67 07	120	260 59	99 01	154	244 16	115 44	188
291	28	68 32	121	260 21	99 39	155	243 53	116 07	189
290	06	69 54	122	259 44	100 16	156	243 31	116 29	190
288	47	71 13	123	259 08	100 52	157	243 07	116 53	191
287	30	72 30	124	258 32	101 28	158	242 47	117 13	192
286	16	73 44	125	257 57	102 03	159	242 25	117 35	193
285	03	74 57	126	257 22	102 38	160	242 03	117 57	194
283	53	76 07	127	256 48	103 12	161	241 42	118 18	195
282	45	77 15	128	256 14	103 46	162	241 21	118 39	196
281	39	78 21	129	255 41	104 19	163	241 01	118 59	197
280	34	79 26	130	255 09	104 51	164	240 40	119 20	198
279	31	80 29	131	254 37	105 23	165	240 20	119 40	199
278	30	81 30	132	254 05	105 55	166	240 00	120 00	200
277	30	82 30	133	253 34	106 26	167			
276	32	83 28	134	253 04	106 56	168			

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## ASTRONOMICAL FIELD TABLES

OCTOBER 1st, 1904, TO MARCH 31st, 1905.

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TABLE FOR FINDING THE POLE

Altitude of Pole Star	Side-real Time.	BEARING OF POLE STAR.					Altitude of Pole Star	Side-real Time.	BEARING OF POLE STAR.					Degrees
		Tp. 0	Tp. 20	Tp. 40	Tp. 60	Tp. 80			Tp. 0	Tp. 20	Tp. 40	Tp. 60	Tp. 80	
	h. m.						h. m.							
67	0 00	40.7	42.2	44.0	45.9	48.0	6 00	16.9	13.0	08.8	04.0	58.8	357°	
68	10	36.1	37.5	39.0	40.7	42.6	10	15.3	11.4	07.1	02.3	57.0		
69	20	31.4	32.6	34.0	35.5	37.1	20	14.0	10.0	05.7	00.8	55.4		
70	30	26.7	27.7	28.9	30.1	31.5	30	12.9	08.9	04.5	59.6	54.1	359°	
71	40	21.9	22.8	23.7	24.7	25.9	40	11.9	07.9	03.5	58.6	53.1		
71	50	17.1	17.8	18.5	19.3	20.2	50	11.2	07.2	02.7	57.8	52.3		
72	1 00	12.3	12.7	13.3	13.8	14.5	7 00	10.7	06.6	02.2	57.2	51.7	357°	
72	10	07.4	07.7	08.0	08.3	08.7	10	10.4	06.3	01.9	56.9	51.4		
72	20	02.5	02.6	02.7	02.8	02.9	20	10.3	06.2	01.8	56.8	51.3		
72	30	57.6	57.5	57.4	57.3	57.1	30	10.4	06.4	01.9	57.0	51.5	357°	
72	40	52.7	52.4	52.1	51.8	51.4	40	10.7	06.7	02.3	57.4	51.9		
71	50	47.8	47.3	46.8	46.2	45.6	50	11.2	07.3	02.9	58.0	52.6		
71	2 00	42.9	42.3	41.6	40.8	39.9	11	8 00	12.0	08.0	03.7	58.8	53.4	359°
71	10	38.1	37.3	36.4	35.3	34.2	14	10	12.9	09.0	04.7	59.9	54.6	
70	20	33.4	32.3	31.2	29.9	28.5	17	20	14.1	10.2	05.9	01.2	56.0	
69	30	28.6	27.4	26.1	24.6	23.0	20	30	15.4	11.6	07.4	02.7	57.6	359°
68	40	24.0	22.6	21.1	19.4	17.5	23	40	16.9	13.2	09.0	04.5	59.4	
67	50	19.4	17.8	16.1	14.2	12.1	26	50	18.6	15.0	10.9	06.4	01.4	
66	3 00	14.9	13.2	11.2	09.1	06.8	29	9 00	20.6	17.0	13.9	08.6	03.7	358°
65	10	10.5	08.6	06.5	04.1	01.6	32	10	22.6	19.1	15.3	11.0	06.2	
63	20	06.2	04.1	01.8	59.3	56.5	35	20	24.9	21.5	17.7	13.5	08.9	
61	30	02.0	59.7	57.3	54.6	51.5	37	30	27.4	24.0	20.4	16.3	11.8	358°
60	40	57.9	55.5	52.9	50.0	46.7	40	40	30.0	26.8	23.2	19.2	14.9	
58	50	53.9	51.4	48.6	45.5	42.1	43	50	32.8	29.6	26.2	22.4	18.1	
56	4 00	50.1	47.5	44.5	41.2	37.6	45	10 00	35.7	32.7	29.4	25.7	21.6	358°
54	10	46.4	43.6	40.5	37.1	33.2	47	10	38.8	35.9	32.7	29.2	25.2	
52	20	42.8	39.9	36.7	33.1	29.1	50	20	42.1	39.3	36.2	32.8	29.0	
50	30	39.5	36.4	33.0	29.3	25.1	52	30	45.4	42.8	39.8	36.6	33.0	358°
47	40	36.2	33.1	29.6	25.7	21.3	54	40	49.0	46.4	43.6	40.5	37.1	
45	50	33.2	29.9	26.3	22.2	17.8	56	50	52.6	50.2	47.6	44.6	41.4	
43	5 00	30.3	26.9	23.2	19.0	14.4	58	11 00	56.4	54.1	51.6	48.9	45.8	359°
40	10	27.6	24.1	20.3	16.0	11.2	60	10	00.2	58.1	55.8	53.2	50.3	
37	20	25.1	21.5	17.5	13.2	08.3	62	20	04.2	02.3	00.1	57.7	55.0	
35	30	22.7	19.1	15.0	10.6	05.6	63	30	08.3	06.5	04.5	02.2	59.8	359°
32	40	20.6	16.9	12.7	08.2	03.1	65	40	12.5	10.8	09.0	06.9	04.6	
29	50	18.6	14.8	10.6	06.0	00.8	66	50	16.8	15.2	13.5	11.7	09.6	

STAR AND THE ASTRONOMICAL MERIDIAN.

Altitude of Pole Star	Side-real Time.	BEARING OF POLE STAR.					Altitude of Pole Star	Side-real Time.	BEARING OF POLE STAR.					Degrees
		Tp. 0	Tp. 20	Tp. 40	Tp. 60	Tp. 80			Tp. 0	Tp. 20	Tp. 40	Tp. 60	Tp. 80	
	h. m.						h. m.							
67	12 00	21.1	19.7	18.2	16.5	14.7	26	18 00	41.3	45.0	49.1	53.5	58.5	1°
68	10	25.5	24.3	23.0	21.5	19.8	23	10	43.0	46.8	50.9	55.5	00.6	
69	20	30.0	28.9	27.8	26.5	25.0	20	20	44.6	48.4	52.6	57.3	02.4	
70	30	34.5	33.6	32.6	31.5	30.3	17	30	45.9	49.8	54.1	58.8	04.0	359°
71	40	39.1	38.3	37.5	36.6	35.1	14	40	47.1	51.0	55.3	00.1	05.4	
71	50	43.7	43.1	42.5	41.8	41.0	11	50	48.0	52.0	56.3	01.2	06.5	
72	13 00	48.3	47.9	47.4	46.9	46.4	8	19 00	48.8	52.7	57.1	02.0	07.4	2°
72	10	53.0	52.7	52.4	52.1	51.8	5	10	49.3	53.7	58.2	03.1	08.1	
72	20	57.6	57.5	57.4	57.3	57.2	2	20	49.6	53.6	58.1	03.0	08.5	
72	30	02.3	02.4	02.5	02.6	02.7	2	30	49.7	53.8	58.2	03.2	08.7	359°
72	40	07.0	07.2	07.5	07.8	08.1	5	40	49.6	53.7	58.2	03.1	08.6	
71	50	11.6	12.0	12.5	13.0	13.5	8	50	49.3	53.4	57.9	02.8	08.3	
71	14 00	16.3	16.8	17.5	18.2	18.9	11	20 00	48.8	52.9	57.3	02.3	07.8	0°
71	10	20.9	21.6	22.4	23.3	24.3	14	10	48.1	52.1	56.6	01.5	06.9	
70	20	25.4	26.3	27.3	28.4	29.6	17	20	47.2	51.2	55.6	00.5	05.9	
69	30	29.9	31.0	32.2	33.5	34.9	20	30	46.0	50.0	54.4	59.2	04.6	359°
68	40	34.4	35.6	37.0	38.5	40.1	23	40	44.7	48.6	52.9	57.7	03.0	
67	50	38.8	40.2	41.7	43.4	45.2	26	50	43.1	47.0	51.3	56.0	01.3	
66	15 00	43.2	44.7	46.4	48.2	50.3	29	21 00	41.4	45.2	49.4	54.1	59.2	1°
65	10	47.4	49.1	51.0	53.0	55.3	32	10	39.4	43.2	47.3	51.9	57.0	
63	20	51.6	53.4	55.5	57.7	00.2	35	20	37.3	41.0	45.0	49.5	54.5	
61	30	55.7	57.7	59.9	02.3	04.9	37	30	35.0	38.5	42.5	46.9	51.8	359°
60	40	59.7	01.8	04.1	06.7	09.6	40	40	32.5	35.9	39.8	44.1	48.8	
58	50	03.6	05.8	08.3	11.1	14.1	43	50	29.7	33.1	36.9	41.0	45.7	
56	16 00	07.3	09.7	12.4	15.3	18.5	45	22 00	26.9	30.2	33.8	37.8	42.3	1°
54	10	11.0	13.5	16.3	19.4	22.8	47	10	23.8	27.0	30.5	34.4	38.7	
52	20	14.5	17.2	20.1	23.3	26.9	50	20	20.6	23.6	27.0	30.8	35.0	
50	30	17.9	20.7	23.7	27.1	30.9	52	30	17.2	20.1	23.4	27.0	31.0	359°
47	40	21.1	24.0	27.2	30.8	34.7	54	40	13.7	16.5	19.5	23.0	26.8	
45	50	24.2	27.3	30.6	34.3	38.4	56	50	10.0	12.6	15.6	18.9	22.5	
43	17 00	27.2	30.3	33.8	37.6	41.6	58	23 00	06.2	08.7	11.5	14.6	18.0	0°
40	10	30.0	33.2	36.8	40.5	45.1	60	10	02.2	04.6	07.2	10.1	13.4	
37	20	32.6	35.9	39.6	43.7	48.2	62	20	58.1	00.3	02.8	05.5	08.5	
35	30	35.0	38.5	42.3	46.4	51.1	63	30	53.9	56.0	58.3	00.8	03.6	359°
32	40	37.3	40.8	44.7	49.0	53.8	65	40	49.6	51.5	53.6	55.9	58.5	
29	50	39.4	43.0	47.0	51.4	56.3	66	50	45.2	46.9	48.8	51.0	53.3	

TIME STARS.

STAR.	Mag.	Sidereal Time of Meridian Transit.			Polar Distance.	
		h.	m.	s.	°	'
Aldebaran.....	1	4	30	29	73	41
Capella.....	1	5	09	41	44	06
Rigel.....	1	5	09	59	98	19
α Orionis.....	1	5	50	02	82	37
Sirius.....	1	6	40	58	166	35
Procyon.....	1	7	34	20	84	32
Pollux.....	1.3	7	39	30	61	45
Spica.....	1	13	20	10	100	40
Arcturus.....	1	14	11	18	70	19
Antares.....	1.3	16	23	33	116	13
Vega.....	1	18	33	42	51	18
Altair.....	1.3	19	46	08	81	23
α Andromedae.....	2	0	03	28	61	26
β Ceti.....	2	0	38	10	108	31
β Andromedae.....	2.3	1	04	25	54	53
γ Andromedae.....	2.4	1	58	04	48	07
α Arietis.....	2	2	01	49	66	59
β Tauri.....	2	5	20	18	61	28
ε Orionis.....	2	5	31	24	91	16
β Aurigae.....	2	5	52	35	45	04
γ Geminorum.....	2.3	6	32	14	73	31
ε Canis Majoris.....	1.6	6	54	54	118	51
δ Canis Majoris.....	2	7	04	32	116	15
Castor.....	2	7	28	33	57	54
α Hydrae.....	2	9	22	53	98	15
Regulus.....	1.3	10	03	18	77	34
β Leonis.....	2	11	44	12	74	54
α Ophiuchi.....	2	17	30	30	77	22
α Cygni.....	1.6	20	38	11	45	03
Fomalhaut.....	1.3	22	52	23	120	08

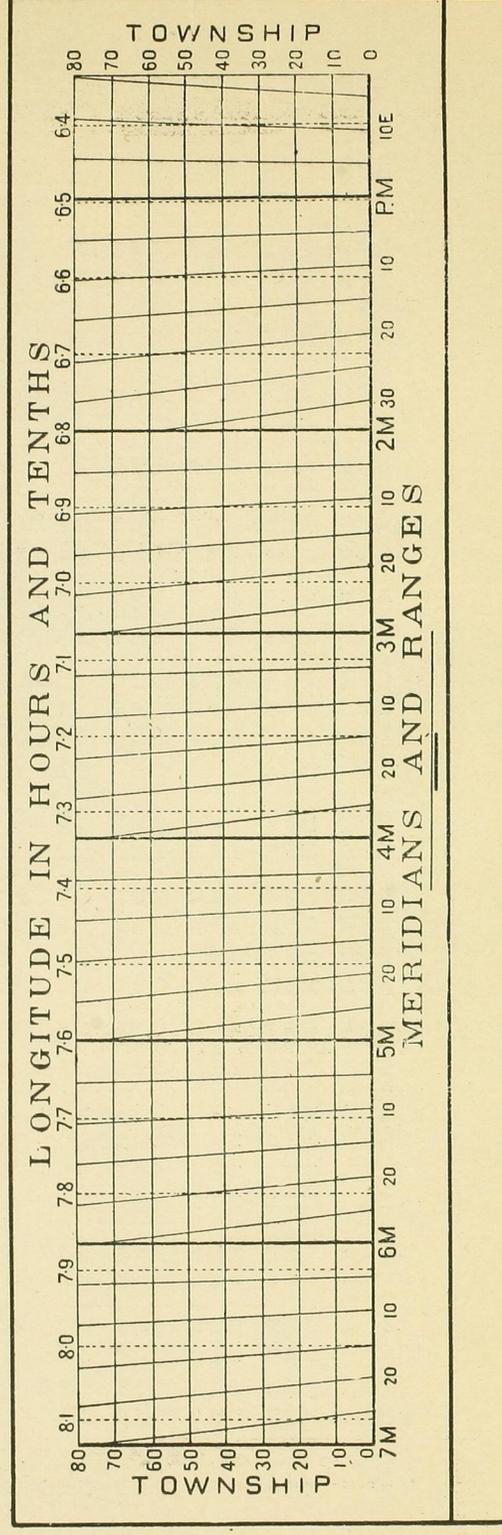
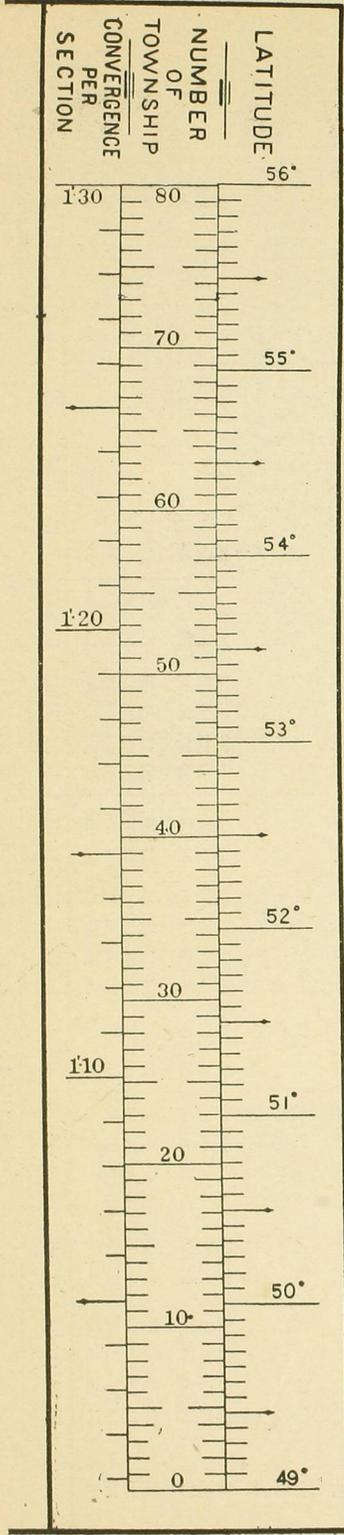
To find altitude of star on meridian, subtract Polar Distance from supplement of Latitude (180°-L).

SIDEREAL TIME AT NOON, MOUNTAIN TIME.

	h.	m.		h.	m.
15 September.....	11	37	15 January.....	19	38
15 October.....	13	35	15 February.....	21	40
15 November.....	15	38	15 March.....	23	31
15 December.....	17	36	15 April.....	1	33

THE SUN'S APPARENT RIGHT ASCENSION AND VARIATION FOR ONE HOUR AT GREENWICH APPARENT NOON.

Day of the Month.	OCTOBER.		NOVEMBER.		DECEMBER.		JANUARY.		FEBRUARY.		MARCH.		Day of the Month.
	h. m. s.	h. m. s.	h. m. s.										
1	12 28 52.03	9 05.2	14 24 59.64	9 7.91	16 28 40.63	10 7.95	18 45 24.77	11 04.9	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	1
2	12 32 29.44	9 06.5	14 28 55.03	9 8.25	16 33 0.04	10 8.22	18 49 49.80	11 03.6	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	2
3	12 36 7.17	9 07.9	14 32 51.25	9 8.60	16 37 20.10	10 8.49	18 54 14.50	11 02.1	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	3
4	12 39 45.25	9 09.4	14 36 48.31	9 8.95	16 41 40.78	10 8.74	18 58 38.83	11 00.5	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	4
5	12 43 23.70	9 11.0	14 40 46.20	9 9.30	16 46 2.05	10 8.98	19 3 2.76	10 98.8	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	5
6	12 47 2.53	9 12.6	14 44 44.93	9 9.64	16 50 23.89	10 9.21	19 7 26.26	10 97.0	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	6
7	12 50 41.76	9 14.3	14 48 44.51	10 0.00	16 54 46.26	10 9.43	19 11 49.30	10 95.0	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	7
8	12 54 21.40	9 16.1	14 52 44.93	10 0.35	16 59 9.13	10 9.63	19 16 11.84	10 92.8	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	8
9	12 58 1.48	9 17.9	14 56 46.19	10 0.70	17 3 32.47	10 9.81	19 20 33.86	10 90.6	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	9
10	13 1 42.00	9 19.8	15 0 48.29	10 1.05	17 7 56.24	10 9.99	19 24 55.32	10 88.2	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	10
11	13 5 22.98	9 21.7	15 4 51.23	10 1.40	17 12 20.43	11 0.15	19 29 16.20	10 85.7	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	11
12	13 9 4.43	9 23.7	15 8 55.00	10 1.75	17 16 44.98	11 0.30	19 33 36.47	10 83.1	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	12
13	13 12 46.37	9 25.8	15 12 59.61	10 2.10	17 21 9.87	11 0.43	19 37 56.11	10 80.5	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	13
14	13 16 28.82	9 28.0	15 17 5.06	10 2.44	17 25 35.06	11 0.55	19 42 15.11	10 77.8	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	14
15	13 20 11.79	9 30.2	15 21 11.33	10 2.79	17 30 0.53	11 0.66	19 46 33.43	10 74.9	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	15
16	13 23 55.30	9 32.5	15 25 18.44	10 3.13	17 34 26.24	11 0.76	19 50 51.06	10 72.0	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	16
17	13 27 39.37	9 34.8	15 29 26.37	10 3.48	17 38 52.16	11 0.84	19 55 7.99	10 69.0	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	17
18	13 31 24.01	9 37.2	15 33 35.12	10 3.82	17 43 18.25	11 0.90	19 59 24.19	10 66.0	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	18
19	13 35 9.24	9 39.7	15 37 44.68	10 4.15	17 47 44.49	11 0.96	20 3 39.66	10 62.9	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	19
20	13 38 55.09	9 42.4	15 41 55.06	10 4.49	17 52 10.84	11 1.00	20 7 54.38	10 59.8	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	20
21	13 42 41.58	9 45.0	15 46 6.25	10 4.83	17 56 37.27	11 1.03	20 12 8.34	10 56.6	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	21
22	13 46 28.71	9 47.8	15 50 18.23	10 5.16	18 1 3.76	11 1.04	20 16 21.55	10 53.4	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	22
23	13 50 16.51	9 50.6	15 54 31.01	10 5.49	18 5 30.26	11 1.04	20 20 33.99	10 50.2	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	23
24	13 54 5.00	9 53.5	15 58 44.58	10 5.81	18 9 56.76	11 1.03	20 24 45.65	10 47.0	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	24
25	13 57 54.19	9 56.5	16 2 58.92	10 6.14	18 14 23.21	11 1.01	20 28 56.54	10 43.7	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	25
26	14 1 44.11	9 59.5	16 7 14.03	10 6.45	18 18 49.60	11 0.98	20 33 6.64	10 40.5	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	26
27	14 5 34.76	9 62.6	16 11 29.89	10 6.76	18 23 15.90	11 0.93	20 37 15.96	10 37.2	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	27
28	14 9 26.17	9 65.8	16 15 46.50	10 7.07	18 27 42.06	11 0.87	20 41 24.50	10 33.9	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	28
29	14 13 18.35	9 69.0	16 20 3.84	10 7.37	18 32 8.06	11 0.79	20 45 32.23	10 30.6	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	29
30	14 17 11.31	9 72.3	16 24 21.89	10 7.66	18 36 33.87	11 0.70	20 49 39.17	10 27.2	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	30
31	14 21 5.07	9 75.7	16 28 40.63	10 7.95	18 40 59.45	11 0.60	20 53 45.30	10 23.9	20 57 50.62	21 57 50.62	22 47 6.33	9 37.3	31



## WESTERN CANADA

ASTRONOMICAL BEARINGS OF MAGNETIC NORTH - 1904

