

MANUAL

OF INSTRUCTIONS FOR THE

Survey of Dominion Lands

Department of the Interior,

OTTAWA

7

3

Rec. No. 22354

H. G. Barber.

Top Surveys Bk

June 20th 1910.

7

3

DOMINION OF CANADA

Manual of Instructions

FOR THE

Survey of Dominion Lands

*Issued by the authority of the Honourable
the Minister of the Interior.*



OTTAWA
GOVERNMENT PRINTING BUREAU
1910

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 section 31 of the Dominion Lands Surveys 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,
January 2, 1910.

TABLE OF CONTENTS.

CHAPTER I.—SYSTEM OF SURVEY.

	Page.
General description	3
Systems of survey in different districts	6
First system of survey	7
Second system of survey	8
Third system of survey	8
Fourth system of survey	9
Fifth system of survey	10
Settlement surveys	11
Group lots	12
Town sites	12

CHAPTER II.—FIELD WORK.

Direction and measurement of lines	15
Township outlines	19
Subdivision of townships	21
Settlement surveys	28
Survey of group lots	29
Town site surveys	30
Survey of public highways	30
Traverses	32
Boundary monuments	36
Marks on posts	47
Resurveys, retracements and restorations	52
The field book	54

CHAPTER III.—RETURNS OF SURVEY.

Progress reports	65
Township plans	65
Plans, other than township plans	66
Field notes, reports and other returns	69
Inspection and examination of surveys	76

CHAPTER IV.—BLOCK AND BASE LINE SURVEYS.

General directions	78
Instruments	85
Direction of lines	85
Production of lines	101
Marking the survey	103

CHAPTER V.—REGULATIONS FOR THE EMPLOYMENT
OF SURVEYORS.

Surveyors employed by the day	104
Contract surveys	107
General directions	111

APPENDICES.

Appendix A.—Dominion Lands Surveys Act	117
Appendix B.—The determination of the astronomical meridian	151
Appendix C.—The determination of the magnetic meridian..	168
Appendix D.—Instruments	174
Appendix E.—Form of agreement for labourers and cook....	179
Appendix F.—Ration list	181

INDEX TO INSTRUCTIONS.

SUBJECT.	PAGE.	CLAUSE.
Abbreviations, list of	55	204
Accidents, allowances for	104	294
Account, for subdivision at end of field book.....	74	244
of surveyor employed by the day	106	308
statutory declaration to	107	309
Address, surveyor to give his	111	337
Adjusting tapes to standard in block and base line surveys	82	264
Advances to survey contractors	111	333
to surveyors employed by the day.....	106	306
Affidavit, meaning of personal survey	75	247
survey according to law and instructions..	75	248
to field notes	74	246
Allowance for accidents	104	294
assistant	106	302
camp equipage	105	300
living, while at office work	106	304
ration	105	298
ration, etc., not used in special cases.	106	305
stationery	106	303
Allowance, road. (See road allowances.)		
Aneroid readings	60	205 (f)
Angle at block corners	102	286
Area of bed of river, when deducted	34	141
of group lot	12	52
to be in acres or decimals	68	230
to be shown on plan	66	212
Assistant, allowance for	106	302
Astronomical direction, contract rate for determination of	110	326
Astronomical observation, entered in field notes....	70	241
in day time	85	269
in subdividing a township	27	111
Astronomical, surveys of Dominion lands to be....	15	62
Authorized subdivision definition of	4	11
Avenues of town site, distance between	13	57
naming or numbering of....	13	55
on navigable waters	13	56
width and direction	12	54
Azimuth, definition	15	63

SUBJECT.	PAGE.	CLAUSE.
Azimuth observations on		
block and base line surveys, book of record of....	101	281
correction for level in.	88	274
error of chronometer.	88	273
explanation of reduction of	100	278
formula for reduction of	91	276
frequency of	101	280
in daylight	85	269
micrometric method ..	86	272
on base lines referred to central meridian of township	100	278
programme for	86	272
reduction by micrometric method ..	89	275
reference object for ..	86	271
reference object for, near meridian	86	272
sources of error in instrument	86	270
value of one division of striding level ..	88	274
value of one turn of filar micrometer ..	89	275
Bank, definition	32	134
referred to as right or left	34	140
Base line, definition	4	6
in settlement	11	44
numbering of	4	8
survey of in settlement	29	115
survey of. (See block and base line surveys.)		
Bearings, correction for convergence of meridians ..	17	69
definition	15	63
how recorded	16	64
in surveys referred to a single meridian..	17	70
of eastern and western outlines of township	16	66
of meridional boundaries in township....	16	67
of section lines in township of first system	24	97
of section lines in township of third system	23	96
on plan, referred to a single meridian...	68	231
origin of, to be stated on plan	68	223
referred to central meridian of township..	16	65
returned as observed	68	226
to be entered as found	54	201
to be shown on plans	65	211
Bearing trees	37	151
Blazing lines in woods	18	76

SUBJECT,	PAGE.	CLAUSE.
Block and base		
line surveys, adjusting tapes to standard.....	82	264
angle at block corners	102	286
azimuth observations. (See azimuth observations on block and base line surveys.)		
blocks south of second base	78	258
chainage. (See chainage on block and base line surveys.)		
chronometer error for azimuth observations	88	273
chronometer, sidereal	85	268
closing base lines on initial meridians	79	259
comparison of field bands with standard	80	261
convergence not to be applied to azimuth observations along initial meridians	100	278
correction for slope in chaining....	81	263
correction for temperature in chaining	81	262
correction lines—posts planted on..	78	258
correction of base line	79	259
correction of line—by micrometer ..	100	279
correction of line—by offset	100	279
daylight observations for azimuth..	85	269
deflection—angle at township corner	102	285
deflection—to correct base line by ..	79	259
description of blocks	78	257
direction of lines	85	269
field bands—comparison with standard	80	261
initial meridians—closing base lines on	79	259
initial meridians—instruments required for survey	85	267, 268
level, correction for, in observation.	88	274
level, determination of value of one division	88	274
measurement. (See measurement on block and base line surveys.)		
methods of chaining	79	260-264
micrometric method of azimuth observation	86	272
obstruction by lake or marsh	83	266
posts—planted on correction lines..	78	258
posts, to be correctly planted	103	287
production of line, men required for	101	282
production of line, method of	101	284
production of line, pickets for.....	101	283
record of azimuth observations....	101	281
sidereal pocket chronometer	85	268
slope corrections	81	263
specimen of azimuth observations ..	91	277
specimen of chainage	84	..
specimen of field notes	84	..

SUBJECT.	PAGE.	CLAUSE.
Block and base line surveys,— <i>Continued.</i>		
specimen of triangulation	84	..
standard tape	80	261
surveying transits	85	267
temperature correction	81	262
time, determination of	88	273
time for azimuth observations	88	273
triangulation	83	265
triangulation, form for	83	265
turning the angle at block corners..	102	286
Blocks, south of second base, survey of	78	258
Board allowance	105	299
Bond of survey contractor	111	332
Boundaries, courses of a traverse are not	32	134
edge of marsh inadmissible as	34	138
northern and southern, of township, run by subdivider	21	94
of group lots, surveying and marking .	30	121
of group lots to be north and south, etc.	12	51
shown on plans by full lines	68	228
Breadth of group lot	12	50
Camp equipage, allowance for	105	300
articles chargeable to	105	301
Canadian Pacific Railway, traverse of, in British Columbia	26	106
Central meridian, reference for bearings	16	65
Chainage on block and base line surveys, correction for slope	81	263
form for	84	..
method of	79	260-264
of lines	79	260
separate book for	82	264
tapes to be adjusted to standard	82	264
temperature correction for ..	81	262
Chainage over broken ground	18	74
testing, on subdivision survey	21	93
testing on survey of township outlines...	20	84
Chainman oath of	18	73
Chains, steel bands to be compared with standard..	17	72
Chronometer error for azimuth observations, on block and base line surveys	88	273
Chronometer, sidereal	85	268
Classification of soils	61	206
Clinometer, for chaining on slope	18	74
Closing base lines on initial meridians	79	259
Closing error, generally	18	77
in surveying meridian exteriors	20	85
on north and south boundaries of township	24	99
Coast meridian definition	4	5
Comparison of steel bands with standard on block and base line surveys	80	261
Compass not allowed for running lines	15	62

SUBJECT.	PAGE.	CLAUSE.
Connection of group lot	30	123
of public highway	30	127
of town site	30	125
of traverse survey	35	143
Contract surveys, advance on account of	111	333
bond of contractor	111	332
inspection of	111	335
instruments required for	110	331
must be made by contractor	110	330
payments by cheques	111	336
progress payments	111	334
rates for. (See rates.)		
Convergence not to be applied to azimuth obser- vations along initial meridians	100	278
Convergence of meridians, correction of bearings for	17	69
how found	16	68
not allowed for on roads	20	83
Corner of group lot. (See group lot corner.)		
of quarter section. (See quarter section corner.)		
of section. (See section corner.)		
of settlement lot. (See settlement lot corner.)		
of town lot. (See town lot corner.)		
of township. (See township corner.)		
Correction lines, definition	4	7
deflection of, across fractional range	22	95
double row of monuments on....	36	150
establishing	9	37
marking of, in fourth system of survey	9	36
numbering of	4	9
only one side surveyed at one time	21	94
posts planted on, in block surveys	78	258
Correction of bearing for convergence of meridians.	17	69
of chainage for slope	81	263
of chainage for temperature	81	262
to base line	79	259
to field notes	77	256
Correction of line on block and base line surveys by micrometer	100	279
Correction of line on block and base line surveys by offset	100	279
Date of survey, definition	68	232
Daylight observations for azimuth on block and base line surveys	85	269
Declaration. (See Statutory declaration.)		
Deficiency or surplus, in townships of the first sys- tem	7	24
in townships of the second system	8	26
in townships of the third system	8	31
on meridians, how dealt with	5	14
on township outlines, third system	8	32
Deflection angle at township corner	102	285

SUBJECT.	PAGE.	CLAUSE.
Deflection, to correct base line by	79	259
Depth of quarter sections on correction lines	24	98
Description of blocks	78	257
Designation of group lots	12	48
Diagrams of outlines supplied to subdivider.....	21	92
Diary of surveyor employed by the day	107	310
Dimensions of blocks in town sites	13	58
lots in town sites	14	59
quarter sections in fourth system..	9	34
townships in first system	7	23
townships in fourth system	9	35
townships in third system	8	30
Direction of lines on block and base line surveys....	85	267
Distances, expressed in chains except for town sites.	17	71
to be entered in field notes as found....	54	201
to water boundaries, shown on plans	68	227
Division of a block into townships	19	80
of a block into townships when obstacles		
are found	19	81
of a section into quarter quarter sections..	4	11
of a section into quarter sections	4	10
of a township into sections	3	2
Dominion lands, how laid off	3	1
Draft on Department not accepted.....	112	338
Duplicate monuments, erection of, forbidden	47	174
to be reported	52	194
Employment of surveyors. (See surveyors.)		
Error, closing	20	85
closing, generally	18	77
limit of, in subdividing a township	27	112
limit of, in traverses	27	112
resurveys or retracements, in case of	53	196
to be reported	52	194
Field bands, comparison with standard measure on		
block and base line surveys	80	261
Field books, for block surveys	112	340
for field use	112	340
for final returns	112	340
for miscellaneous surveys	112	340
Field notes, abbreviations allowed	55	204
account for subdivision	74	244
affidavit to	74	246
all questions in report to be answered.	70	243
astronomical observations	70	241
corrections to	77	256
data to be entered as found.....	54	201
description of	54	200
every section line on separate page..	54	202
for record	69	235
general report	70	242
information on first pages	69	236
information to be given	55	205
lines described as north and east		
boundaries	54	203
personal survey	75	247

SUBJECT.	PAGE.	CLAUSE.
Field notes—Continued.		
plot of traverse	69	239
road allowances to be ruled.....	69	238
specimens of section lines 56, 57, 58, 59		
specimens of traverses	71, 72	
supplementary	77	255
survey according to law and in-		
structions	75	248
to be checked by surveyor	76	254
to be precise and clear	69	237
topography to be sketched	61	206
traversed line shown on plot	70	240
Fifth system of survey, limits of	10	42
First system of survey, limits of	7	25
Foreshore, definition	32	134
Forms, for accounts of daily paid surveyors.....	106	308
list of, supplied free on requisition	112	340
requisition to state number and kind of		
forms	113	341
Fourth system of survey, limits of	10	39
Fractional range adjoining meridian, how surveyed	5	15
townships and ranges at change of system	6	19
townships and ranges, how numbered..	6	20
Front of lots in settlement, survey of.....	29	117
group lot	30	122
Group lots, area of	12	52
boundaries to be due north and south,		
etc.	12	51
breadth of	12	50
connection of	30	123
designation of	12	48
direction of meridian for survey	29	120
marks on corner posts	51	183
marks on witness posts	51	185
monuments for corners	46	168
number to be applied for before survey	29	119
plan of	66	216
running and marking boundaries	30	121
shape of	12	49
title of plan	67	217
to be connected with subdivision of		
township	26	104
water front	30	122
wooden posts for corners	46	169
Highway, additional monuments	32	131
connections	30	127
in settlements	12	47
in settlements, survey of	29	118
locating corners	31	129
locating corners from centre line	32	130
marks on posts	52	187
monuments	47	170
plan of	67	220
survey of, how made	31	128

SUBJECT.	PAGE.	CLAUSE.
Highway— <i>Continued.</i>		
surveyed along centre line or limit	30	126
title of plan	67	221
Hilly or rough country, contract rate for.....	108	320
Hire of men on surveys paid by the day.....	105	295
Hub, traverse, to be planted by subdivider.....	26	105
Indian reserves, boundaries to be retraced	25	102
marks on posts along	50	178
monuments on limits of	36	150
mounds on limits of	46	161
no lines marked inside of	26	103
road allowance along	25	102
Initial meridians, closing base lines on	79	259
survey of (See block and base line surveys).		
definition	3	4
Inspection of surveys executed under contract....	111	335
Instructions required for surveying townships or sections	28	113
Instrumental stations, to be carefully marked on outlines	21	88
Instruments required for employment by the day.	104	289
required on block and base line surveys	85	267, 268
required on survey contracts	104	290
required on survey contracts	110	331
Iron posts for block corners in town sites	30	124
for township and section corners.....	37	151
requisition for	112	339
supplied free of cost	110	328
Irrigation Act, effect on traverses	34	141
where in force	33	136
Islands, when to be traversed	34	139
Jog, definition	20	82
Lakes, shallow not to be traversed	35	142
to be named when traversed	36	146
when to be traversed	34	139
Lane, when to be laid out in a town block.....	13	57
Legal subdivision, definition	4	11
Lengths, to be expressed in chains, except for town sites	17	71
to be shown on plans	65	211
Level correction for, in azimuth observations	88	274
determination of value of one division of... ..	88	274
Limits of blocks in third system of survey	20	82
of error in subdividing townships	27	112
of error in traverses	27	112
of fifth system of survey	10	42
of first system of survey	7	25
of fourth system of survey	10	39
of railway belt, in British Columbia	27	110
of second system of survey	8	27
of third system of survey	8	28

SUBJECT.	PAGE.	CLAUSE.
Line between two systems of survey	6	21
marks on posts		
on	49	177
monuments on	36	150
mounds on ..	43	161
Lines, base, definition	4	6
block, how produced	101	284
block lengths and directions	79	260
bounding townships	3	3
correction definition	4	7
in woods to be blazed	18	76
not to be extended into another system of survey	25	101
not to be surveyed without instructions ..	28	113
rear, of settlement	29	116
started on an assumed bearing	24	99
to be surveyed in a township	21	90
to be surveyed in a township of the fourth system	21	91
Living allowance while at office work	106	304
Lost monument, definition	52	193
on correction line, fourth system	9	38
when to be reestablished	63	199
Magnetic needle not allowed for running lines	15	62
Marking block lines	103	287
correction lines in fourth system of survey	9	36
township outlines	6	16
town sites	14	60
Marks on posts, at township and section corners	47	175
at township and section corners		
on correction lines	48	176
at township and section corners		
on other lines	49	177
between settlement lots	51	182
in ranges east or west of princi- pal meridian	50	180
of group lots	51	183
of highway	52	187
of town lots	51	186
on limits of Indian reserves ...	50	178
on quarter section corners	50	179
to be cut neatly	52	188
witness	51	181
witness for group lots	51	185
witness for settlement lots	51	184
Marsh, edge of, inadmissible as boundary	34	138
not to be traversed	35	142
Measurement on block		
and base line surveys, by micrometer	83	265
by triangulation	83	265
by trigonometric methods	79	260
of lines	83	265
of lines	79	260

SUBJECT.	PAGE.	CLAUSE.
Measurements,		
on meridian exteriors to be made with care	20	86
with steel bands	17	72
Meridian, assumed, for subdividing township	27	111
between first base and first correction line	5	13
central, bearings referred to	16	65
coast	4	5
convergence of	16	68
direction of, for survey of group lots ..	29	120
in subdivision when over 50 links out ..	24	99
initial	3	4
outlines, contract rate for survey of ..	109	322
outlines, survey of	20	85
principal position of	4	5
Methods of chaining in block and base line surveys	79	260-264
Micrometer,		
determination of value of one turn on block instrument	89	275
for correcting direction of line on block and base line surveys	100	279
for traverse survey	35	145
Micrometric method of azimuth observation	86	272
Mineral claims to be connected with subdivision ..	26	104
Monuments, additional, for highways	32	131
at section corners marked by wooden posts	52	194
contract rate for erecting	109	324
described on plan	68	229
description of mounds	38	154
description of pits	38	155
double row of, on correction and other lines	36	150
duplicate, to be reported	52	194
erection of duplicate, forbidden	47	174
for corners of group and settlement lots	46	168
for limits of highways	47	170
generally a single row of, on survey lines	36	149
in settlements	12	46
iron post for township, section and quarter section corner	12	46
lost, definition	52	193
mound and pits in woods	42	158
mound and pits, quarter section corner	44	163
mounds, how placed generally	43	160
mounds on correction lines	43	161
no witness mound for quarter section ..	45	165
not in good condition to be restored ..	52	194
not to be erected where liable to destruction	47	172
not to be made on travelled road	47	173
obliterated, definition	52	192

SUBJECT.	PAGE.	CLAUSE.
Monuments,— <i>Continued.</i>		
of highway, how located from centre ..	32	130
of highway, how located from limit	31	129
pits, how placed	44	162
pits without mound	41	157
post to be placed exactly at corner	38	153
posts for corners of town lots	47	171
quarter section post	38	152
rules for pits in prairie enforced	43	159
stone mound	41	156.
when to reestablish lost corner	53	199
witness, description of	44	164
witness mound	46	167
witness trench	45	166
wooden post for group and settlement lots	46	169
Mound and pits in woods	42	158
at quarter section corner	44	163
description of	38	154
how placed on correction lines, etc.	43	161
how placed on other lines	43	160
stone, description of	41	156
witness	46	167
Navigable water, avenue on	13	56
Number of group lot, to be applied for before survey	29	119
Numbering of base lines	4	8
blocks in town sites	13	58
correction lines	4	9
fractional townships and ranges..	6	20
lots in settlements	11	43
lots in town sites	14	59
quarter quarter sections	4	11
sections in a township	3	2
streets and avenues in a town site.	13	55
townships and ranges	3	4
townships in fifth system of survey	10	41
Oath of chainman	18	73
Obliterated monument, definition	52	192
how shown on plan	68	225
to be restored when retracing	53	198
Observations. (See astronomical observations.)		
Obstruction, by lake or marsh on block and base line surveys	83	266
Offsets in traverse surveys	35	145
Outfit of survey party to be sold or stored	106	307
Outlines, contract rate for survey of meridian	109	322
diagram of, supplied to subdivider	21	92
report on survey of	75	249
resurvey in case of error	53	196
retracement in case of error	53	197
Payments made by cheques	111	336
Personal survey, meaning of	75	247
required from contractor	110	330

SUBJECT.	PAGE.	CLAUSE.
Ration allowance	105	298
Rear line of settlement, survey of	29	116
Record of azimuth observation for block and base line surveys	101	281
Reports, all questions for report to be answered... ..	70	243
on subdivisions of townships	70	242
on survey of outlines	75	249
sketches with progress reports	65	209
surveyors to report at least once a month	65	208
timber	74	245
Requisitions, for forms	112	340
for iron posts	112	339
to state distinctly what is wanted ..	113	341
Restoration survey, definition	52	191
how shown on plan	68	224
Resurvey, contract rate for	109	323
definition	52	189
when to be made	53	196
Retracement, contract rate for	109	323
definition	52	190
how shown on plan	68	224
when to be made	53	197
Returns, final	76	250
immediate preparation of	76	251
of contract survey, no further payment for	110	327
Riparian owners, rights of	33	136
River, area of bed, when deducted	34	141
bank or middle of river to be traversed	33	137
riparian owners upon unnavigable	33	136
to be named when traversed	36	146
when to be traversed	34	139
Road allowances, along Indian reserve boundaries	25	102
in first system of survey	7	22
in fourth system of survey	9	33
in third system of survey	8	29
to be ruled in field notes	69	238
Roads. (See highway.)		
in settlements	12	47
in settlements, survey of	29	118
Rough or hilly country, contract rate for	108	320
Salaries of surveyors	104	291
paid for Sundays	104	292
Scales of plans	66	213
Second system of survey, limits of	8	27
Section corner, iron post for	37	151
locating, in railway belt, British Columbia	26	107
marks on post at, generally	47	175
marks on post at, in ranges east or west of principal meridian	50	180
marks on post at, on correction lines	48	176
marks on post at, on other lines	49	177

SUBJECT.	PAGE.	CLAUSE.
Section lines, bearings of, in township of first system	24	97
bearings of, in township of third system	23	96
contract rate for irregular	108	318
contract rate for survey of	107	312
definition of, for rate	108	315
described as north or east boundaries	54	203
field notes of every, on separate page locating, in British Columbia railway belt	54	202
to be surveyed in a township	27	108
to be surveyed in a township of fourth system	21	90
Sections, definition	3	1
divided into quarter quarter sections ..	4	11
divided into quarter sections	4	10
numbering of	3	2
width of	4	6
Settlement, base line	11	44
monuments	12	46
numbering of lots in	11	43
roads in	12	47
side lines	12	45
Settlement, survey, azimuth observation	29	115
base line	29	115
connection to other surveys	29	118
front of lots	29	117
highway and roads	29	118
marks on corner posts	51	182
marks on witness posts	51	184
monuments for corners	46	168
plan of	66	214
preliminary sketch	28	114
rear line	29	116
title of plan	66	215
Shape of group lot	12	49
Shoe plates for mounds	38	155
Shore, definition	32	134
Sidereal pocket chronometer	85	268
Sketches, with progress reports	65	209
Slope corrections to chainage on block surveys	81	263
Soils, classification of	61	206
Spades for digging pits	38	155
Specimens, azimuth observations on block and base line surveys	91	277
chainage on block and base line surveys	84	..
field notes of block and base line surveys	84	..
field notes of chained traverse	72, 73	..
field notes of micrometer traverse	71	..
field notes of subdivision survey, 56, 57, 58, 59
triangulation on block and base line surveys	84	..
Stadia for traverse survey	35	145

SUBJECT.	PAGE.	CLAUSE.
Standard measure, for block and base line surveys..	80	261
testing steel bands with	17	72
Stationery allowance	105	303
Statutory declaration of settler	63	207
contract rate for, of settler..	110	327
none to be taken on resurveys, retracements or restora- tion surveys	63	207
to accounts	107	309
Stone mound	41	156
Streets of town site, distance between	13	57
numbering of	13	55
width and direction	12	54
Subdivider, to resurvey or retrace outlines in error	52	195
when to resurvey outlines	53	196
when to retrace outlines	53	197
Subdivision, authorized	4	11
legal	4	11
Subdivision of townships	21	89
account for, at end of field book	74	244
all questions for report to be answered	70	243
general report	70	242
made at certain rates per mile	107	311
Surplus. (See deficiency.)		
Surveying transits for block and base line surveys..	85	267
Surveyor employed by the day	104	288
accounts in duplicate	106	308
actual expenses charged in special cases	106	305
advances to	106	306
allowance for board	105	299
allowance for camp equipage	105	300
allowance for living	106	304
allowance for ration	105	298
allowance for stationery....	106	303
allowances for accidents ...	104	294
allowances for assistant ..	106	302
articles chargeable to camp equipage	105	301
diary to be furnished	107	310
hire of men allowed	105	295
instruments for block sur- veys	104	289
instruments for other sur- veys	104	289
items chargeable to trans- port	105	297
outfit to be sold or stored ...	106	307
payment for office work.....	104	293
payment for Sundays	104	292
salary for temporary ser- vices	104	291
statutory declaration to ac- counts	107	309

SUBJECT.	PAGE.	CLAUSE.
Surveyor employed by the day, transport of survey party	105	296
Surveyor is responsible for accuracy of survey	76	252
to check his plans and field notes	76	254
to give his address	111	337
Systems of survey	6	17
Temperature, correction of measurements for	81	262
Third system of survey, limits of	8	28
Timber report	74	245
Time, determination of, for azimuth observations..	88	273
Topography, to be sketched in field notes	61	206
Town lots, marks on posts of	51	186
monuments for corners of	47	171
numbering and dimensions of	14	59
Town site, avenue on navigable water	13	56
connection of	30	125
dimensions and numbering of blocks	13	58
dimensions and numbering of lots	14	59
distance between avenues and between streets	13	57
how made	12	53
how surveyed and marked	30	124
lane, when laid out	13	57
marking of	14	60
mode of, laying out may be modified....	14	61
modified to suit provincial regulations..	14	61
naming and numbering streets and ave- nues	13	55
plan of	67	218
title of plan of	67	219
width and direction of streets and ave- nues	12	54
Township corner, iron post for.....	37	151
marks on post at, east or west of principal meridian	50	180
marks on post at, generally	47	175
marks on post at, on correction lines	48	176
marks on post at, on other lines..	49	177
Townships adjoining another system of survey....	25	101
country laid out into	5	12
definition	3	1
dimensions of, in first system of survey	7	23
dimensions of, in fourth system of survey	9	35
dimensions of, in third system of survey.	8	30
how subdivided	21	89
marking outlines of	6	16
numbering of	3	4
numbering of, in fifth system of survey.	10	41
plans of, made in department.....	65	210
plans to show areas	66	212
plans to show bearings and lengths	65	211
Transit theodolite, mode of setting for traverse sur- vey	35	144
Transport, items chargeable to	105	297
of survey party	105	296

SUBJECT.	PAGE.	CLAUSE
Traverse, alluvion and recession of the water	33	135
area of river bed, when deducted	34	141
bank or middle of river to be traversed .	33	137
bank referred to as right or left	34	140
connection of	35	143
contract rate for	109	325
courses of, are not boundaries	32	134
edge of marsh, inadmissible as boundary	34	138
hub, planted by subdivider	26	105
lakes and rivers to be named	36	146
limit of error allowed in	27	112
line defined by, shown on plot	70	240
mode of setting transit theodolite	35	144
not to be omitted when necessary	36	147
of Canadian Pacific Railway in British Columbia	26	106
of water front or lake	32	133
plot of, in field book	69	239
purposes of	32	132
rights of riparian owners	33	136
shallow lakes or marshes not to be trav- ersed	35	142
specimen of field notes of chained	72-3	..
specimen of field notes of micrometer....	71	..
survey with stadia, micrometer or chain.	35	145
which islands, rivers and lakes are to be traversed	34	139
Trench, witness, description of	45	166
Triangulation, contract rate for, in woods	108	317
for passing obstacles	18	75
form for on block and base line sur- veys	83	265
on block and base line surveys	83	265
Trigometrical survey, may be used for locating sections	27	109
Vouchers to be in duplicate	106	308
Water, avenue on navigable	13	56
front, in group lot	30	122
front, in settlement	29	117
front, rights of grantee	33	135
lands bordering upon unnavigable	33	136
Witness monument, description of	44	164
not at quarter section corners	45	165
post, marks on	51	181
trench	45	166
Wooden post, for group and settlement lots	46	169
for highway	47	170
for quarter section corners	38	152
section corners marked by	52	194
Woods, contract rate for line in, less than 10 chains.	107	313
contract rate for line in, more than 10 chains	107	314
lines in, to be blazed	18	76

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	
W.	19	20	21	22	23	24	E.
	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 certain 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 $97^{\circ} 27' 08''$ ^{30'} west of Greenwich.

The second meridian is placed in longitude 102° (very nearly), the Third in 106° 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 each base measure therefore in an east and west direction more than four hundred and eighty chains exclusive of the road allowances, while those north of the base measure less than this. The interval between any base line and the next is equal to the depth of four townships.

7. "*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, equidistant from the bases at the depth of two townships. The interval between 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, every section is taken to be divided

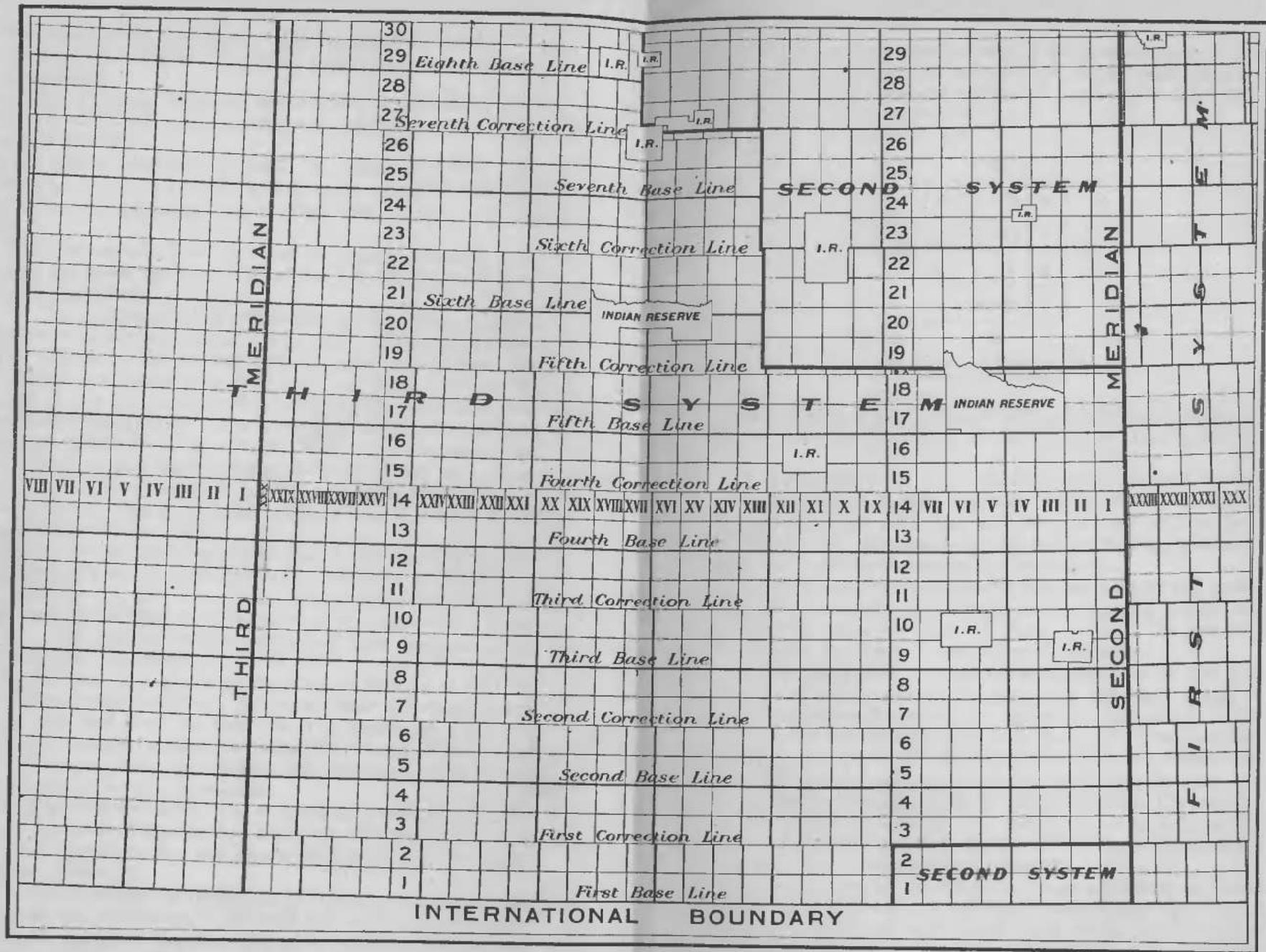


FIG. 2. ILLUSTRATING THE SUBDIVISION OF THE COUNTRY INTO BLOCKS AND TOWNSHIPS.

into quarter quarter sections each of forty acres, more or less, and such quarter quarter sections are styled legal subdivisions and are bounded and numbered as shown in the following diagram of a section:—

				N.								
				13	14	15	16					
				12	11	10	9					
W.					5	6	7	8	E.			
				4	3	2	1					
				S.								

Fig. 8. Division of a section into quarter quarter sections.

An authorized subdivision is any subdivision of land surveyed under the authority of the Dominion Lands Surveys Act.

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 meridian outlines closing on the first correction line, on which outlines the quarter sections adjoining the correction line are given the theoretical depth of forty chains. On all the meridians of township one, the deficiency or surplus, as the case may be, must be left in the quarter sections adjoining the first base line or international boundary.

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

SYSTEMS OF SURVEY IN DIFFERENT DISTRICTS.

17. All Dominion lands 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., systems 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 lying between two townships or ranges numbered consecutively, but surveyed according to different systems, is designated by the larger 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 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 side of a section.

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, as the case may be.

24. In the survey of the 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 as far as the shore of lake Winnipeg at the point where it intersects the east boundary of township nineteen, range seven; by the shore of lake Winnipeg and the southwesterly bank of the Winnipeg river as far as the fifth correction line; by the said correction line as far as the meridian between ranges ten and eleven east of the principal meridian; by the 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, range 21; townships 45, ranges 21, 22,

26, 27 and 28; township 47, range 24; townships 46 and 47, ranges 25, 26, 27 and 28; townships 48, ranges 24, 25 and 26, and that portion of township 48, range 27, lying south of the Saskatchewan river, all west of the second meridian.

Townships 42 to 47 inclusive, range 1; and townships 43 and 44, ranges 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 townships 1 and 2, ranges 1 to 8 inclusive; townships 19 to 30, ranges 1 to 12 inclusive; and townships 27 to 30, ranges 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 along every section line running north and south and along 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 theoretically 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, modified by adding to each quarter section of 160 acres, an allowance of three acres for roads, instead of locating this allowance along 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 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 reestablishing lost corners on a township outline (see clause b, subsection 1, of section 66, of the Dominion Lands Surveys 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 provinces of Alberta and 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 township 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 were surveyed by the provincial government according to the local system of survey, previous to the transfer of the lands to the Dominion. 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. This system of numbering must be adhered to even when a settlement is laid out in ranges, instead of giving the same number to corresponding lots in the several ranges.

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.

When the course is changed, the direction of the lot lines is also changed, so as to remain perpendicular to the base line.

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 usually 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 wider, as for instance one chain and fifty links, or ninety-nine feet, when a Gunter's chain is used, or one hundred feet when a tape graduated in feet is used for making the survey.

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. No street or avenue is made less than sixty-six feet in width.

55. Some systematic method of naming or numbering the streets must be adopted. For instance, one of the streets called "Centre Street" may be 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 a similar manner.

Both streets and avenues may be given individual names when the surveyor's instructions call for such names.

56. In a town site fronting on navigable waters, an avenue or street is laid out along the shore, from which the numbering of the other avenues or streets may commence. It is advisable to make this avenue or street a wide one.

57. Lots are usually made sixty-six by ninety-nine feet or fifty by one hundred and fifty feet, but these dimensions may be departed from to suit the ground or to comply with special requirements. In what is expected to become the business portion of the town it may, for example, be advisable to make the lots only half the width of those in the remaining or residential portion.

When lots are made sixty-six by ninety-nine feet the distance between the middle of two adjacent avenues, when there is no lane at the back of the lots, is four chains; between the middle of two adjacent 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.

When lots are made less than sixty-six feet in width, a lane not less than twenty feet wide must be laid out at the rear of the lots.

58. A town block is the land comprised between two adjacent streets and two adjacent avenues. With lots sixty-six feet by ninety-nine feet it is nine chains in length and three chains in width, provided no lane is laid out. With lots of

different size, the dimensions vary. A block four hundred and fifty feet in length by three hundred and twenty feet in width can be divided into two tiers of lots with nine lots in each tier, separated by a twenty foot lane, the lots measuring fifty by one hundred and fifty feet.

Blocks are numbered in regular succession from one upwards.

59. A block is usually subdivided into eighteen town lots when the lots are of normal size, that is to say, sixty-six by ninety-nine feet or fifty by one hundred and fifty feet, or thereabouts. When lots are made smaller the number in each block is increased in order to make the block of normal size.

Lots are numbered from one upwards in each block.

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

61. The method of laying out town sites is modified to suit circumstances as appears desirable. In any of the organized provinces due attention must be given to the provincial statutes and regulations governing such surveys.

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. 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°. 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°, east being 90°, south 180°, west 270°, and north 360° or 0°. 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.

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

65. All bearings in a township are referred to the astronomical meridian through the centre of the township, or in the case of a fractional township to the meridian through the point which would be the centre if the township were a full one, that is to say the bearing returned for any line within the township is the angle formed by that line with the central meridian, such angle being reckoned from 0° to 360° .

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°) or due west (270°).

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 VIII of the Supplement, under the headings "Deflection Sexagesimal" and "Deflection Decimal."

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

72. Measurements are 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 must be corrected; in using bands not so provided, allowance is made for the error. Steel bands are very liable to break; this fact cannot be impressed too strongly upon the chainman. In case of accident the surveyor should be pro-

vided with some means of repairing breaks. The subsidiary standard is not used on field work, but is carefully preserved for purposes of comparison.

73. Previous to entering on their duties the chainmen are to be sworn according to the form below, and such oath is 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 is made with such portion thereof as may be easily levelled, and particular care is 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 leveling 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 may pass it by right-angled offsets, or, if more convenient, 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 not more than seventy-five links apart. 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 section 62, of the Dominion Lands Surveys 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 being 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. An exception to the above method of procedure is given in clause 14. The monuments for township corners are then 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 must 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 XVIII of the Supplement 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 endeavors to find the pickets marking the instrumental stations on the outline which are better guides for direction than the monuments.

94. The meridian exteriors of a township having been established by the surveyor of township outlines, the subdivider

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 must 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° , $0^{\circ} 01'$, $0^{\circ} 02'$, $0^{\circ} 03'$ 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 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 gives 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, with the exception noted below, 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 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 post 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 trial 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 land 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, laid out along the boundary of an Indian reserve. In determining whether a road allowance is necessary or not, the invariable rule is that every quarter section shall be rendered accessible by a road. Road allowances may also be laid out along a reserve boundary if they are considered necessary to provide the means of going from one part of a 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 indicated by proper posts or monuments. When a reserve not yet surveyed

is formed of a certain number of full sections, the surveyor, in establishing the same, plants the posts as usual on the west and south boundaries; but on the north and east sides they are planted in the north or east limit of the road allowance. The side of the road allowance adjoining the township is the only one 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 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 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 planted, nor permanent marks of any kind left within the boundaries of the reserve.

104. Connection is 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 made with the nearest survey stake and the marks on it are 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.

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 as 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 is made in each township, but two or more are desirable. A record of the observations and of their calculations must 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.

The exception is when one or more of the boundaries of a block have been previously surveyed by another surveyor, in which case a closing error of one chain and fifty links is allowed. When the error exceeds this limit the previously surveyed lines must be retraced, or resurveyed 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 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 of their improvements; he shall also enquire into 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. With a view to avoiding causes of future boundary disputes the mode of division adopted must be as simple and regular as the circumstances of the case admit of. Preferably, the lots should be laid out north and south or east and west. Where this would prove inconven-

ient, a direction can usually be found to which all the lots are parallel. In some cases, the improvements are so placed that lots have to be laid out in several directions, but the changes of direction should be as few as possible.

A base line is located approximately upon the plan of the compass survey, placing it close to the improvements and perpendicular to the lot lines. The base line is offsetted along lot lines where necessary for keeping close to the improvements; it is deflected at the places where the direction of the lots changes, so as to remain perpendicular to the lots.

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, the bearings being corrected after the survey is completed.

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

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.

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 settlement.

SURVEY OF GROUP LOTS.

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

120. An astronomical observation for ascertaining the direction of the meridian is 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 runs from this corner and marks 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 must 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 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.

When either end of a highway is not connected with some other surveyed street, road or road allowance, the boundary at the end is definitely located on the ground and indicated in the field notes.

128. In running his lines, the surveyor sets 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 established at every instrumental station. The position of the corner in the opposite

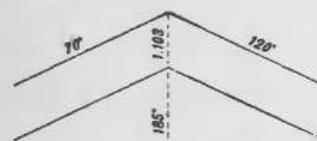


Fig. 7.

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°. This gives the bearing of the line bisecting the angle formed by the two courses. For instance, the bearing of the back course being 70° and of the front course 120°, (Fig. 7), the bearing of the line bisecting the angle formed by the two courses is:

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

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 XX. 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. Lands abutting on tidal waters are bound by the line of ordinary high water mark. 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 wrest it from vegetation, or as to mark a distinct character upon the vegetation and upon the soil itself where vegetation extends into the water. According to this definition, the limit of the bank is the line where vegetation ceases, or where the character of the vegetation and soil changes.

The *foreshore* or *shore* is the strip of land lying along tidal

water, over which the daily tide ebbs and flows; it is the space between high and low water marks at ordinary tides.

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 aquae*. 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. An exception is made by the Irrigation Act for the provinces of Saskatchewan and Alberta and for the North West Territories, except the provisional districts of Mackenzie, Franklin and Ungava, Section 7 of the Act providing that no grant shall be made by the Crown of any exclusive property or right in the land forming the bed or shore of any lake, river, stream or other body of water. The word shore in this section is presumed to be intended to designate that part of the bed which is uncovered when the water is low.

137. From the foregoing it follows that along tidal waters, the line to be traversed is the high-water mark at ordinary tides.

For a lake or navigable river, and also, where the Irrigation Act applies, for a river not navigable, the line to be traversed is the bank. A parcel fronting on the lake or river does not

include the bed, nor does it include the adjoining islands unless the survey shows distinctly that they are included.

Where the Irrigation Act does not apply, the middle of the main channel is the line to be traversed for an unnavigable stream which is adopted as a boundary between the adjoining lands. In such a case, a parcel fronting on the stream includes the bed of the stream 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. Islands smaller than twenty acres are located by offsets to their extremities and their width is measured.

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, a separate traverse of the middle being omitted, although the middle remains the boundary between the adjoining lands in territory outside of the jurisdiction of the Irrigation Act. When both banks are traversed, the middle of the river, if required, is located by offsets from the banks. Islands less than twenty acres in extent may be included in the adjoining fractional subdivisions.

Where the Irrigation Act applies, the area of every river, whether over three chains wide or less, is deducted from the area of a subdivision. An unnavigable river averaging less than one chain in width is not traversed, but its area is estimated and deducted from the area of the subdivision. An unnavigable river averaging more than one chain, but not more than three chains is not surveyed along both banks, but by a single traverse line, its area being calculated by means of the width measured at proper intervals. In both cases islands may be included in the adjoining subdivisions.

142. Shallow lakes or marshes which occasionally dry up are not to be traversed. Marshes or lakes surrounded by 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. In this case the surveyor must supply a sketch showing this information. 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 must 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° when the telescope is pointing north, 90° for east, 180° for south, and 270° 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 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 stadia or micrometer must be tested on a measured base and a table must be prepared giving the distances corresponding to the readings.

The number of points of the bank or traversed line fixed by the survey is determined by the irregularity of the shore line, but such points must not be more than ten chains apart on township surveys and five chains on other surveys. Dis-

tances measured by stadia or micrometer must not exceed one-half a mile. In chained traverses, offsets must not be greater than four chains on township surveys and two chains on other surveys.

Other traverses must 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 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 allow-

ance 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. A township, section or quarter section corner is indicated by a pointed iron tube marked as hereinafter described and driven to within ten inches of the top. The iron tube for township corners is five feet long and one and three-eighths of an inch in diameter and weighs about nine pounds and three ounces. The one used for section and quarter section corners is three feet long and three-quarters of an inch in diameter and weighs about two pounds and eight ounces. The upper end in both cases is squared and a crown is stamped on one of the faces together with the following inscription "Penalty for Removal, Seven Years Imprisonment."

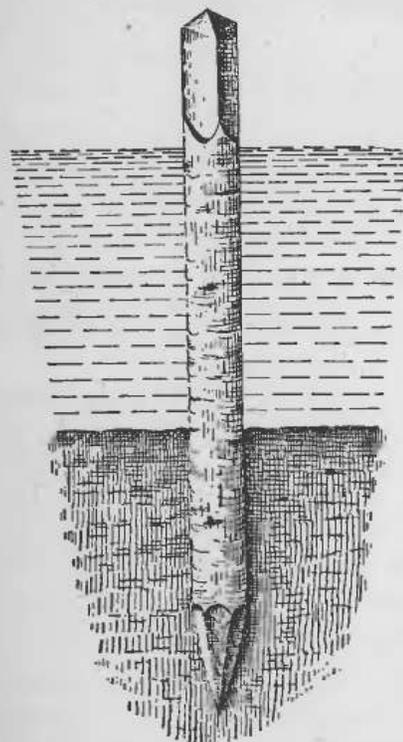


Fig. 8. Long post in shallow water at section corner.

When a township or section corner in bush country falls in a marsh or slough not over three feet deep, necessitating the erection of a witness monument more than five chains distant from the true corner, such corner must also be indicated by a wooden post planted at the true corner. The post used for this purpose must be of the most durable wood obtainable in the vicinity. It is squared at the top and inscribed with the same marks and planted in the same manner as prescribed for iron posts at section corners. It must be not less than five inches in diameter and long enough to be driven firmly and show the marking thereon above the water.

The position of the monument erected at a section, quarter section or other corner may be witnessed by ascertaining the

astronomical bearing and distance therefrom of one or more adjacent trees, where the nature of the woods is such that the trees will be permanent marks. A blaze is cut on the side of the tree facing the post and the letters "B T" and the distance from the post to the tree are marked on the blaze with a knife or scribing iron. The bearing from the corner to the tree is recorded in the field notes and may be marked on the blaze with red chalk or paint. The size and description of the tree are also recorded.

152. A quarter section corner falling in a lake or marsh not over three feet deep is marked by a wooden post, flattened on two sides and marked as described below. The post must be 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.

A quarter section post whether wooden or iron is marked on one side with the fraction " $\frac{1}{4}$ " (fraction wise) to identify it as a quarter section post.

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.

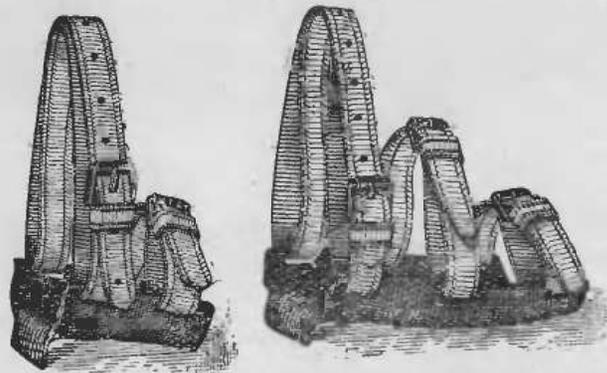


Ditching spade.

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, $7\frac{1}{2}$ inches wide at the head and $5\frac{1}{2}$ inches at the point; the blade of No. 4 is 18 inches long, $4\frac{1}{2}$ inches 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 mowers.

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.

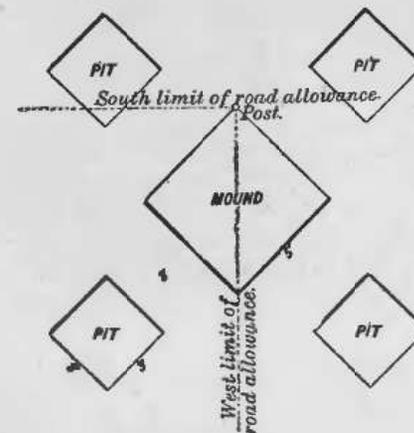


Fig. 12. Post, mound and pits—Plan.

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.

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.

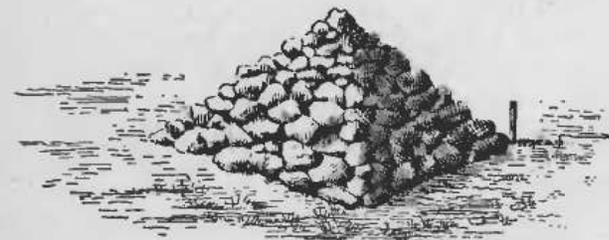


Fig. 13. Stone mound—Perspective.



Fig. 14. Post and pits—Perspective.

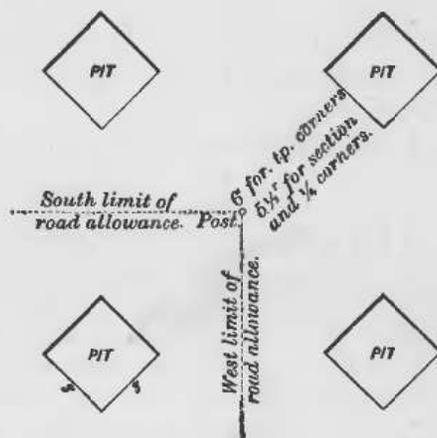


Fig. 15. Post and pits—Plan.

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.

Small openings of two chains or less in extent, in continuous bush country, are not to be classed as prairie, and therefore mounds should be built in such places. If a corner falls in a wooded bluff, two chains or more in extent, in prairie country, it is preferable to erect a mound instead of pits only.

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,

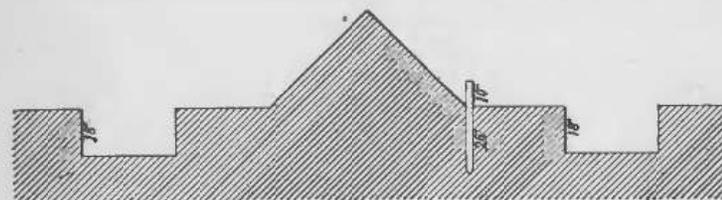


Fig. 16. Post, mound and pits on correction line—Section.

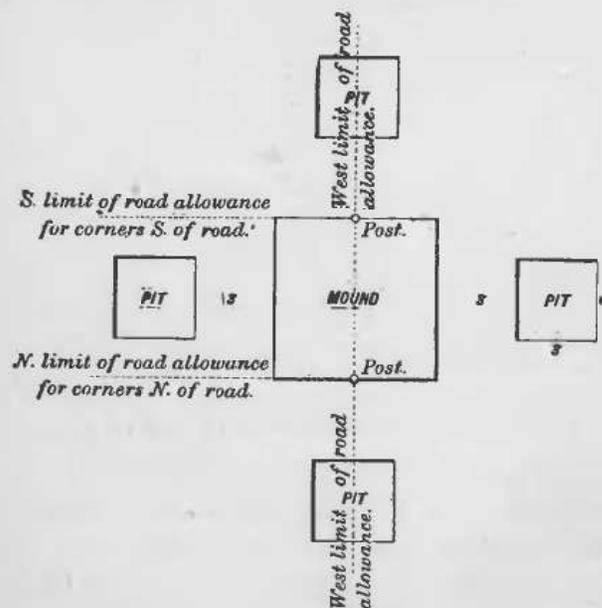


Fig. 17. Post, mound and pits on correction line—Plan.

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).

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).

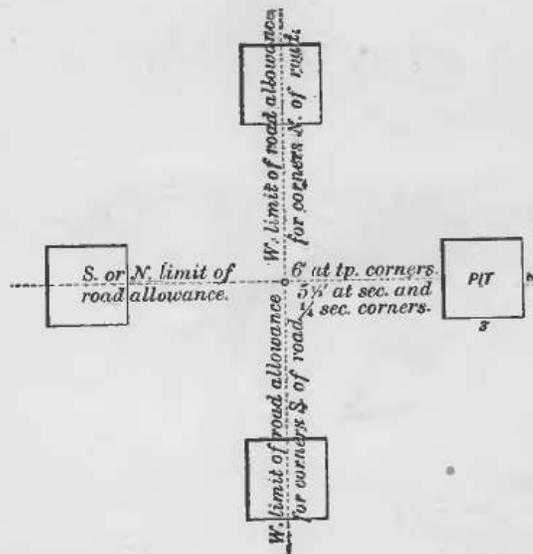


Fig. 18. Post and pits on correction line—Plan.

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 cor-

ner 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 must not be placed on a road allowance, public highway, or travelled road.

A witness monument must not be erected when it is possible to make a permanent monument at the true corner.

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).



Fig. 19. Witness post and mound—Perspective.

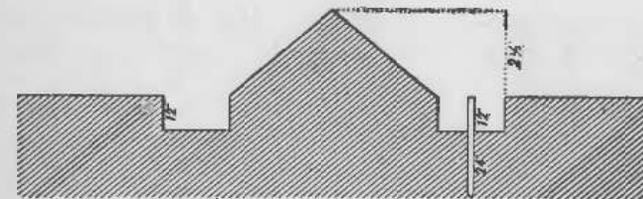


Fig. 20. Witness post and mound—Section.

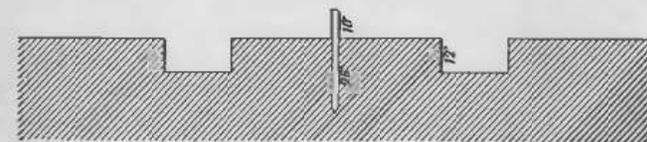


Fig. 21. Witness post and trench—Section.

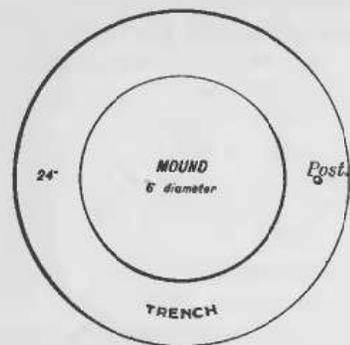


Fig. 22. Witness post and mound—Plan.

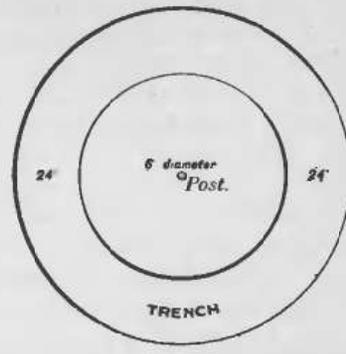


Fig. 23. Witness post and trench—Plan.

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.

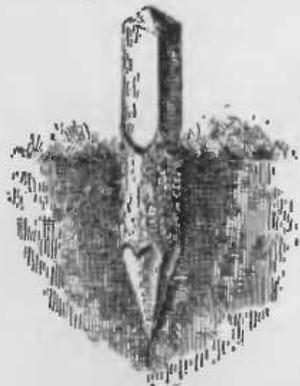


Fig. 24. Wooden post for lot corners and public highways.

169. A wooden post for the corner of a group or settlement lot must be thirty-six inches long, eighteen inches in the ground and eighteen inches above. It is squared twelve inches from the top, and the faces must be at least three inches wide. The top is bevelled to turn off rain. Such a post, when perpetuated by a mound, must be placed not in the centre of the mound, but in the same

position as an iron post would occupy.

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 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.



Fig. 26. Section corner.

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



Fig. 27. Section corner.

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

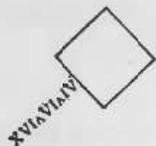


Fig. 28. Section corner.

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

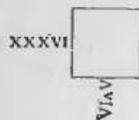
176. Posts at township and section corners on correction lines are marked exclusively for the townships and sections on the respective sides of the road allowance. They have the number of section on the west side, and the number of township and range on the north or south side for posts north or south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

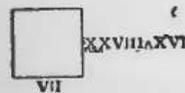


Fig. 33. Section corner on line between two systems of survey.

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.

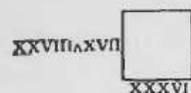


Fig. 34. Township corner on line between two systems of survey.

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

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 set diagonally, and the posts are marked accordingly; but those which govern only townships and sections on one side of the road are set square to the cardinal points.

179. A quarter section post is always set so that two of its flat sides face the direction of the line, and is marked on one of these sides with the fraction $\frac{1}{4}$ (fraction-wise).

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:—

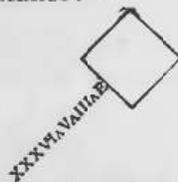


Fig. 35. Township corner east of Principal Meridian.

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. A witness post is marked on the side facing the corner with the distance in chains and the bearing thereto and on the opposite side with the number of the section, which number is to be the same as would have been marked on the post had it been placed at the true corner.

The distance to be marked on the post is the distance to that section corner where the corner monument would have been erected had the spot been suitable.

When a road intervenes between a witness monument and the true corner the distance marked on the post includes the width of the road allowance.

The section number to be marked on the post is the number which would have been marked on the corner post, which is not always the number of the section adjoining the witness post. Thus the witness post three chains north of the southeast corner of section twenty-nine (3rd system) must be marked IV. S. and XX, not IV. S. and XXIX. Thus:



For witness post standing four chains north of the northeast corner of section 20

Fig. 37. Witness post.

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 must be cut neatly and distinctly.

No mark is 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 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 dia-

gram of outlines, he may resurvey or retrace the outline, as provided hereinafter. 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 is resurveyed when the sections on both sides are vacant, or when the owners or occupants of lands affected by the correction give in writing their consent to the resurvey.

When the error is five chains or greater, and the owners or occupants of the lands affected do not agree to the resurvey, the circumstances of the case must be reported to the Department for further action under the authority of section 57 of the Dominion Lands Surveys Act.

When a correction is made on an outline adjoining a township previously subdivided, the section boundaries closing on the part of the outline corrected must be resurveyed and the quarter section monuments thereon moved to correct positions.

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

A new monument must not be erected before destroying the old one.

197. When the error is less than five chains and the owners or occupants of lands affected refuse their consent to its correction or to the reestablishment of the lost corners, the defective outline is retraced. A part of the line 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 must be restored and marked as directed for original surveys.

199. Lost monuments are reestablished when the lands affected are vacant or when the owners give their consent in writing. In case the owner of a lost corner objects to the reestablishment, the surveyor, instead of erecting a new monument may, in order to be able to carry out his survey operations, plant a temporary picket at the place shown by his survey to be the location of the corner, and connect to the picket the lines of his subdivision.

In making a survey under the authority of section 58 of the Dominion Lands Surveys Act, the surveyor has power to reestablish all lost corners affecting the lands in the town-

ship. He may also destroy any monuments of the original survey if they are found to be in error and erect new ones in proper position provided the lands affected by such monuments are unoccupied, and the correction does not affect any improved roads or other improvements.

In all cases where a monument is reestablished or moved, it is necessary to retrace all lines closing thereon to the nearest existing monuments for the purpose of determining their lengths and bearings.

THE FIELD BOOK.

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 56, 57, 58 and 59.)

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 must 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 must 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.	Lat. for latitude.
A.M. for forenoon.	Lks for links.
Asc. for ascent.	Long. for longitude.
Astro. for astronomical.	L.S. for legal subdivision.
Az. for azimuth.	M. for mound.
Bar. for barometer.	Mag. for magnetic.
Bea. for bearing.	Mer. for meridian.
Bet. for between.	Mkd. for marked.
B.T. for bearing tree.	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.
Diff. for difference.	Sec. for section.
Diam. for diameter.	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.
	W.P. for wooden post.

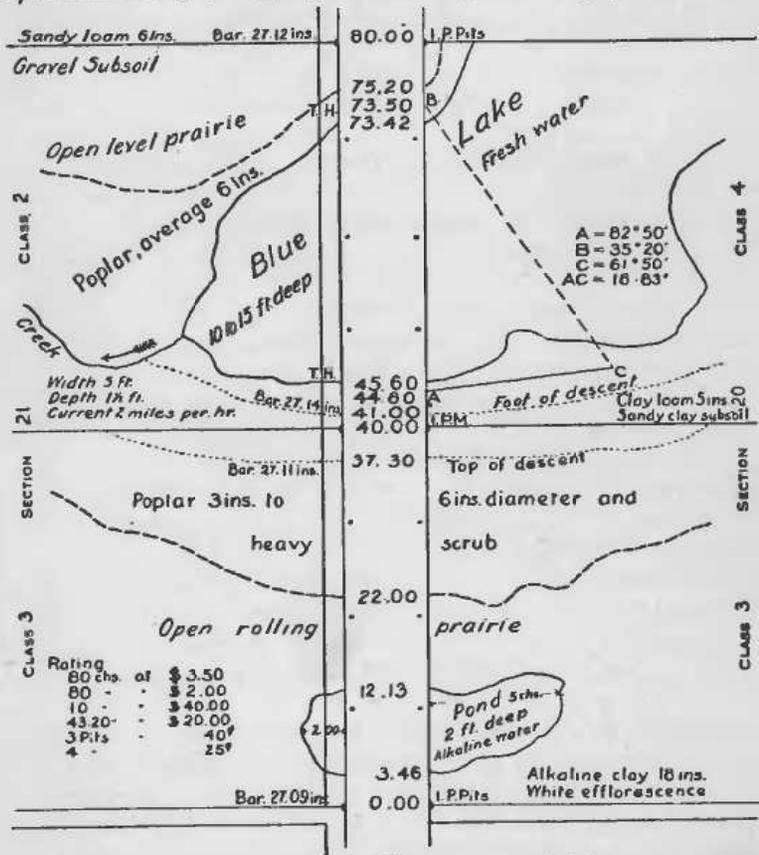
205. The field notes must be always written down on the spot, leaving nothing to be supplied from memory, and are to give the following information in relation to the survey:—

(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

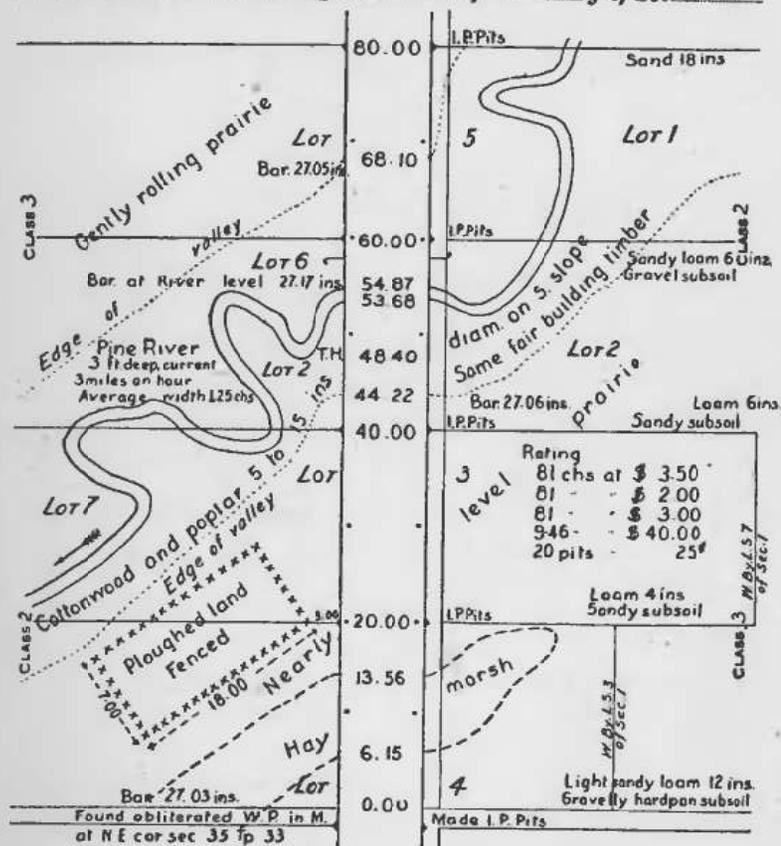
Tp. 34 R. 15 W. Mer. E. By. of Sec. 20 Course 180° 01'
 produced from bearing 180° 01' of E. By. of Sec. 29



The above line was run on the 20th day of October 1900

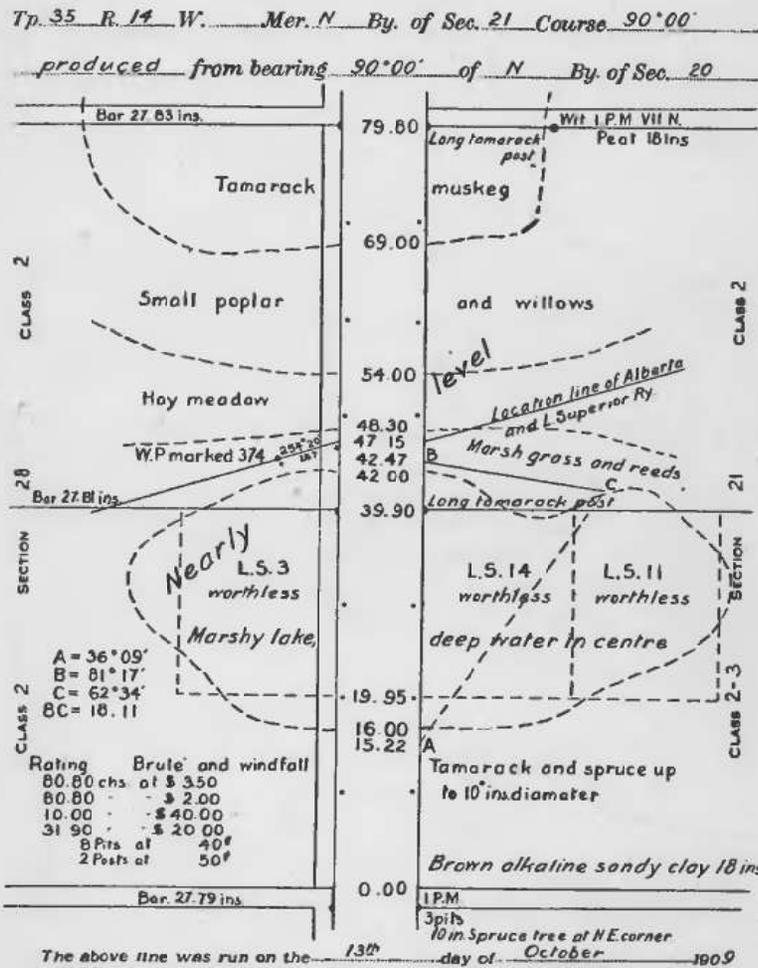
SPECIMEN OF FIELD NOTES OF SUBDIVISION SURVEY.

Tp. 34 R. 15 W. Mer. E. By. of Sec. 36 Course 359° 58'
 turned off from bearing 89° 59' of N By. of Sec. 36, Tp. 33

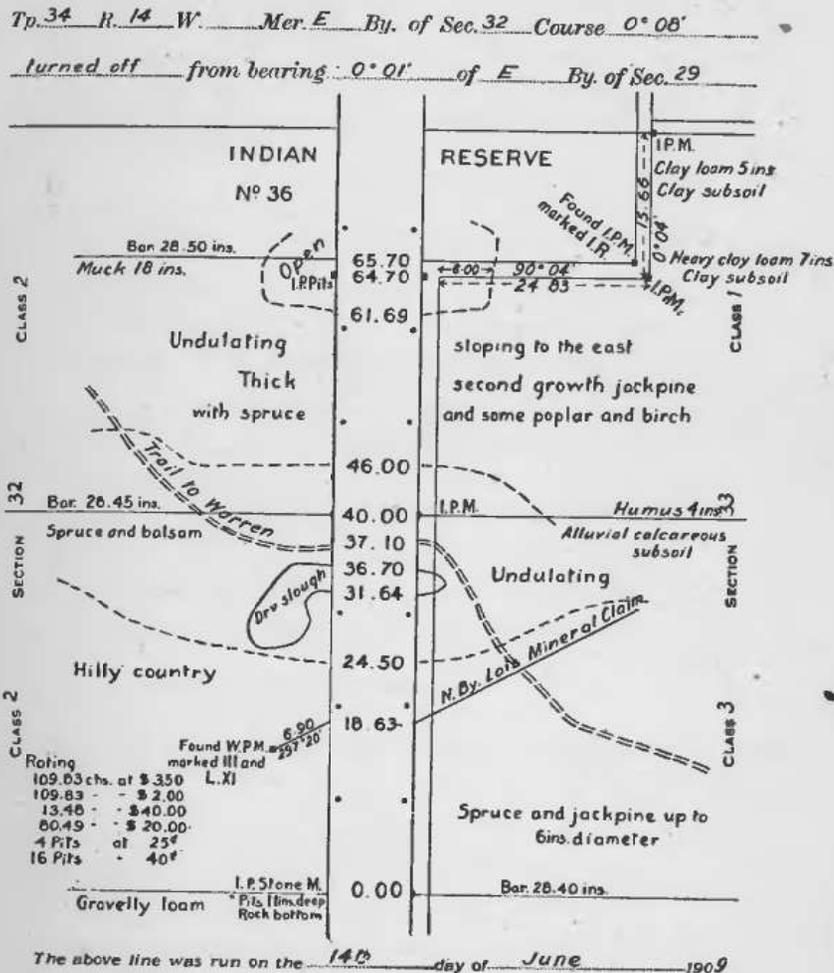


The above line was run on the 31st day of October 1900.

SPECIMEN OF FIELD NOTES OF SUBDIVISION SURVEY.



SPECIMEN OF FIELD NOTES OF SUBDIVISION SURVEY.



SPECIMEN OF FIELD NOTES OF SUBDIVISION SURVEY.

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.

In surveys other than township outlines or township subdivision the field notes must show the markings made on all posts planted and the markings found on all posts closed upon.

(d) The bearing and distance to any stake or post of any railway or highway survey crossed by the line, and also to such corner or corners of any lot, mineral claim, timber berth, reserve, etc., within the survey, as may be necessary to afford proper connection between the several surveys.

(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, or aneroid readings if crossed by the line; 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. (See following clause).

(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 aneroid barometer reading in inches at the top or bottom of all prominent elevations or depressions, or when none such exist, at section and quarter section corners.

When crossing a large valley the aneroid readings should be recorded at the bottom of the valley and at the top of both slopes instead of entering the depth of the valley.

The index error of the aneroid should be determined whenever convenient by comparison at a Meteorological Station or at the Department in Ottawa. At the same time no opportunities should be neglected of recording the readings at places of known elevation such as railway stations. From these readings the index error can be determined at the head office.

(o) The date of the survey.

(p) 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 must be sketched in the field book as far as it can be ascertained without undue delay. It may be necessary, in bush country especially, for the surveyor to go off the line for this purpose. 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.

The following definitions, used in the publications of the Chemical Division of the Dominion Experimental Farms, will assist surveyors in describing the nature of the soil.

Drift soils are of glacial origin and consequently of variable composition. They consist usually, however, of loose material—chiefly fine and coarse sand and gravel with more or less rounded small stones and boulders. As a class, these soils are "light" and frequently poor, not necessarily from lack of the mineral constituents of plant food but from unsuitable physical condition and deficiency in vegetable matter and its concomitant nitrogen.

Alluvial soils are those which have been transported and deposited by water, fresh or salt. There are many classes or varieties, both as to texture and composition, according to the character of the country furnishing the detritus and the velocity of the current; usually the particles are fine or mod-

erately fine. Many of the most fertile soils are of alluvial origin, *e.g.* deltaic and valley soils, their productiveness being due largely to the intimate association of an ample supply of organic matter with the rock debris forming the mineral basis of the soil.

Gravelly soils are those consisting essentially of gravel or small water-worn fragments of rock with more or less coarse sand. The amount of fine material will not usually exceed twenty-five per cent. and the humus content is never large. As a class, they are among the poorest of arable soils.

Sandy soils contain 80 per cent. or more of sand principally finely comminuted quartz, with not infrequently fine material from the disintegration of crystalline rocks in general. The amount of clay present is less than 10 per cent. They may contain notable percentages of oxide of iron, carbonate of lime, &c.

Clay soils contain at least 60 per cent. of clay, the remainder being chiefly made up of sand and vegetable matter.

Loams are essentially mixtures of clay and sand and are classified according to the degree of preponderance of one or other of the constituents, as follows:

Heavy Clay Loam: containing from 75 to 90 per cent. of clay.

Clay Loam: containing from 60 to 75 per cent. of clay.

Loam: containing approximately equal amounts of clay and sand.

Sandy Loam: containing from 60 to 75 per cent. of sand.

Light Sandy Loam: containing from 75 to 90 per cent. of sand.

N.B. Organic matter (humus forming material) and carbonate of lime, are present to a greater or less extent in all productive loams.

Marl is a calcareous clay, containing from 10 to 20 per cent. of carbonate of lime. (Shell marl is essentially carbonate of lime. It occurs as an earthy deposit at the bottom of lakes and ponds and is composed largely of the disintegrated shells of fresh water mollusca. When dried it has a chalky appearance).

Lime or Calcareous soils contain carbonate of lime as a characteristic or distinguishing feature.

Alkali soils occur in arid and semi-arid districts and are characterized by the presence of considerable amounts of certain soluble salts, chiefly the sulphate, chloride and carbonate of sodium. These salts may appear on the surface of

the soil as an efflorescence, usually white, in seasons of scanty precipitation. "Black" alkali, due to carbonate of sodium, is the most injurious form and may be recognized by the incrustation being dark brown or black, from the presence of organic matter dissolved from the soil by the alkali.

Peaty and Muck soils have resulted from the gradual accumulation in the presence of water of plant remains and hence consist largely of organic matter.

In peat the structure is essentially fibrous, clearly indicating the origin from sphagnum and other aquatic plants. In muck (swamp muck), further decay has destroyed or broken down the fibrous structure, resulting in a black or dark brown material, which is usually of a more or less cheesy consistency when wet.

Humus soils are those rich in semi-decomposed vegetable matter but which have not been formed under water, as in the case of peats and mucks.

Surface soil, generally spoken of as the soil or as the arable soil, is the upper or surface stratum used in cultivation and which in addition to disintegrated rock material contains as a rule more or less humus—the decaying remains of plants.

Subsoil is the unweathered, naturally undisturbed stratum immediately underlying the surface soil and may consist of sand, clay, gravel, etc., or mixtures of these. It is practically destitute of organic matter.

Hardpan, the name applied to the subsoil when such has become converted, by chemical and physical agencies, into a hard, tenacious rock-like stratum.

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

A bona fide settler is a person already residing on the quarter section or lot at the time of its survey, or who has made substantial improvements on the said piece of land, proving his prior occupation. A declaration should not be accepted from other than such persons, nor in a case where the answers are clearly untrue or in opposition to the facts.

The object of the declaration is to show the persons who squatted on the land before the survey. A declaration taken from a person locating after the survey would mislead the department as it would be inferred from the declaration being made before the surveyor that the person was found on the ground or that improvements were in existence.

All declarations from squatters who reside on the land or have made improvements are to be accepted, no matter how many there may be on a quarter section or lot.

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

209. Each progress report is accompanied by sketches on the forms supplied showing the work done up to date. The sketches give the bearings and lengths of all section lines surveyed and the jogs on correction lines when measured. Traversed lines are marked red. A quarter section made fractional by a traversed body of water, is designated by the letter "F." It must also show the quarter quarter section lines selected as boundaries of bodies of water in accordance with clause 142 of the Manual.

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, the monuments erected to define the

boundaries of the lands, 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 are made on the following scales:

Settlements, not less than one inch to twenty chains.

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

Town plots, not less than one inch to four chains.

Highways, not less than one inch to ten chains.

214. The plan of a settlement exhibits 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 gives 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 exhibits 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 must state the number of the lot, the number of the group, a concise designation of the locality, the district, province or territory, the name of the surveyor, the date of survey and the scale. The designation of the locality must be that one which is in general use among the public in referring to the place.

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 must 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 must 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. The dates of commencement and ending of the survey which are entered on the title page of the field notes should include all traverse or other surveys within the field book.

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 Department of the Interior 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; evident errors in the original notes may, however, be corrected in the copy. 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.

When portions of different townships are surveyed, it is preferable to have the notes of as many townships as possible copied into one book, but if it can be avoided the notes for one township should not be copied partly in one book and partly in another.

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 monuments 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. For British Columbia surveys a scale of fifteen chains to an inch is used. If a traverse extends into two or more townships a separate traverse plot is required for each township. The lines of the traverse are

in red and the shore lines as well as the section lines are in black. The numbers of the stations should be indicated on the plot. 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 specimen pages 71, 72 and 73.)

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, are entered in the blank forms at the end of the book.

242. A report, also entered at the end of the field book, must 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.—Heights 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.

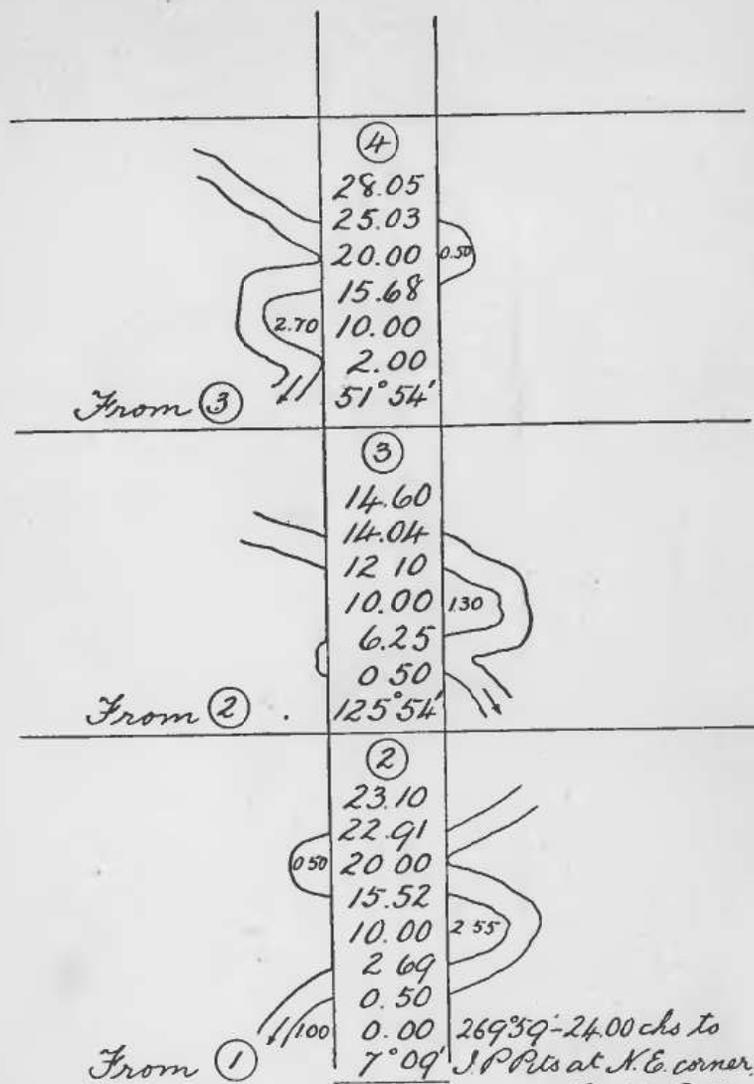
243. Every question must be answered: when, for instance, there is no timber, water-powers, minerals, &c., the fact must be stated.

EXAMPLE OF FIELD NOTES OF MICROMETER TRAVERSE SURVEY.

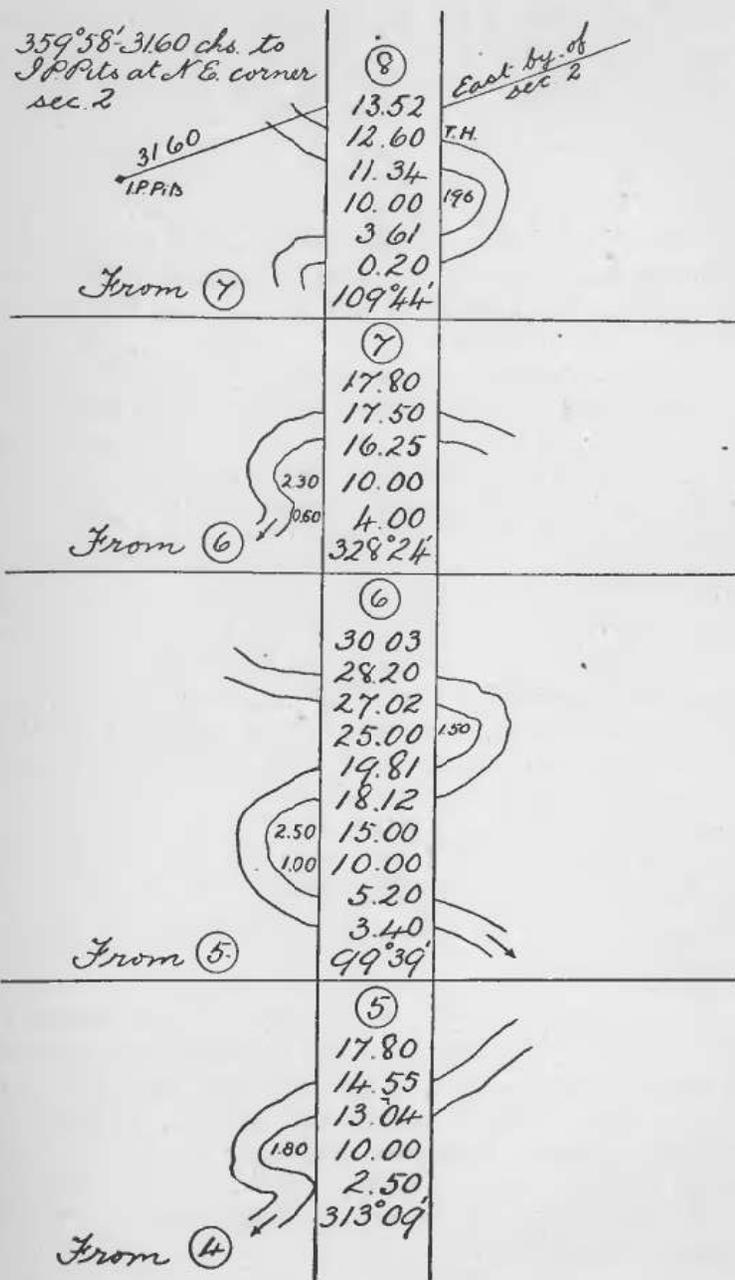
MICROMETER TRAVERSE OF BLUE LAKE.

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

BEARING.	DISTANCE.	
0 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 06	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	" "



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



244. At the end of the field book of a township subdivided under contract, there must 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 performing the original subdivision of a township must make a separate report upon the timber to be found within the township. In his report, the surveyor states 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 must 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 must be stated. The report for each township must be on a separate sheet of foolscap or on forms supplied by the department.

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 is left out when there is no plan.

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 must 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.

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 in the survey, 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 corrections.

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

CHAPTER IV.

BLOCK AND BASE LINE 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.

If time does not permit the survey of whole blocks, the base lines are established first.

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 second base, where the meridians are surveyed from the second base to the first correction line, and after laying off the theoretical jog, south to the first base, leaving all the north and south closing error at the first 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. The jog on the correction line is left 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 affect 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 notes are kept and posts planted. The following band, used as a control is 100 feet or more in length.

With a steel tape several hundred feet in length, the inequalities of the ground would frequently prevent the rear chainman from seeing the front chainman if the tape were used to the full length. The method of chaining in such a case is to have the zero of the tape in front, the rear chainman holding whatever "ten" links or feet happens to be nearest over the last pin, while the front chainman always drops his pin from zero.

As the front chainman advances, unless the ground is exceptionally level, he generally encounters a small rise which if the full chain were used would obstruct his view of the rear chainman. To pull the chain out to its full length, and then come back to the summit of the rise, and put in a pin or to read the clinometer for the two parts of the chain on each side of the rise is very laborious and complicated. Instead of this the front chainman, when he reaches the summit, estimates if he can get to the next summit and see the rear chainman. If not he stops at the top. The rear chainman comes up to the last pin, picks up the chain beside it, takes the nearest "ten" and holding this mark exactly over the pin he gets the front chainman to tighten the chain and

set his pin in the usual way at the zero always. The mark read on the chain is entered in the book, the clinometer is read and the front chainman advances again either to the full length of the chain or to the top of the next rise as the ground may dictate. It is best to use only the "tens" as a means of avoiding errors in reading. It seldom happens odd feet or links between tens must be used.

At the last distance, the front chainman holds the zero exactly over the post put in by the first chainage, and the rear chainman coming up to the last pin, pulls the chain back tight from the front chainman who is holding the zero over the post. The rear chainman then reads the odd feet or links and tenths.

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.

When 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.

261. The field bands must 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 western provinces a season of field work, extending from summer to winter, may include variations of temperature covering a range as high as 130° , a base line chained in summer across four ranges, might, from this cause alone, differ from the adjoining base lines north or south, chained across the same ranges in midwinter, by more than one chain and a half.

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° 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.

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 in-

clination 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 XIX, "Corrections in links to slope measurements," is intended for the subdivision of townships; it is not sufficiently precise for block surveyors. A more accurate table is pasted inside the cover of the field book for block surveys. This book contains a form for applying the correction to the chainage. (See specimen, page 84.) 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.

An alternative method, more convenient and probably better when using a long tape for the check chainage, is to reverse the method and reduce the slope measurements to the horizontal. The temperature correction in this case is of course reversed in sign, the correction over standard being additive and under standard negative.

This method gives the correct distance between the monuments previously established by the first chainage while the first method gives the number of chains to be laid out in order that the monuments be at the correct distance. When using the second method with a long tape, it is convenient to use a separate field book, which may be of very small size, for entering the measurements.

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 both with the Gunter's chain and with the longer chain used for control.

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, in exceptional cases, 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 84. 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.

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

270. 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 yield in the instrument stand to that part of the impulse of revolution that passes down through the foot screws to the stand head. 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.

The tangent and micrometer screws should always be turned so as to push against the counteracting spring; because in turning in the opposite direction, the spring might fail to bring back the plate at once and do so only during the interval between the observation and the reading of the drum.

271. The reference object for azimuth work should be, if possible at least half a mile from the observer.

272. In observing for azimuth the following programme may generally be adopted:

1. Level the instrument very carefully using the striding level for this purpose, so that the level correction may be small.
2. Point on the reference object and read the microscopes five times.
3. Point approximately on Polaris and place the striding level in position (zero of graduation to the right or east). Point accurately on Polaris noting the time by sidereal chronometer. Read the striding level, reverse it, read it again and *remove* it. Read the microscopes five times.
The direction to remove the striding level is most important and must not be overlooked. If forgotten the striding level would be knocked off and broken in reversing the telescope.
4. Reverse the telescope in altitude, turn the instrument 180° in azimuth and repeat as in No. 3.
5. Same as No. 2.

A complete observation as above should, under favourable conditions, give a result correct within a few seconds.

In the special cases where the reference object is on or near the meridian, the observation for azimuth can be arranged so as to be independent of the readings of the graduation which need not be taken, the difference in azimuth between the star and the reference object being measured by means of the eyepiece micrometer. This measurement is far more accurate than an angle read on the graduated circle. On base lines the reference object being usually east or west of the instrument, an angle of about 90° has to be measured. In cases where the greatest accuracy on a base line is desired, a reference object may be placed on or near the meridian and its azimuth determined entirely by means of the movable wire. The angle between the reference object and the base line may then be measured by the usual method of reiteration, shifting the horizontal circle several times.

The programme is as follows:

1. Level the instrument very carefully using the striding level for this purpose, so that the level correction may be small.
2. Point approximately on Polaris and place striding level in position (zero graduation to the right or east). Bisect the star twice with the movable thread, noting the times by sidereal chronometer. Read the striding level and reverse it. Bisect the star three times with movable thread noting the chronometer times. Read the striding level and remove it.
3. Lower the telescope and bisect the reference object five times with the movable thread.
4. Set the movable thread in the symmetrical position on the opposite side of the middle thread, reverse the telescope and turn the instrument around in azimuth until the movable thread is on the reference object. Fasten the clamping screw, and bisect the reference object five times with the movable thread.
5. Same as No. 2.

Under favourable conditions, the result by this method should be accurate within three or four seconds. It is important that the telescope be set to solar focus very accurately. An error of one-thousandth part of the focal length in the adjustment causes a corresponding error in any angle measured with the eyepiece micrometer. If the angle is, for

instance, fifty minutes, the error is one-thousandth part of fifty minutes or three seconds. It is therefore, advisable to use a magnifying glass in extending the telescope to the focal mark.

Whatever programme be adopted, it will be found convenient in order to prevent mistakes to always begin the observation with the same position of the instrument.

273. The chronometer error is required for the reduction of the observations. In observing Polaris near upper or lower transit an error of one second of time corresponds in the latitude of the western provinces to an error in azimuth of half a second of arc more or less. The error of the watch should therefore be known with some precision. An observation for time should be taken either shortly before or shortly after every azimuth observation. The instrument should be carefully levelled with the striding level and the observed transit corrected for level and azimuth errors according to the methods prescribed in any of the standard text books on astronomy.

If Polaris is sufficiently close to the meridian, a convenient way of setting the instrument in the meridian is by the eyepiece micrometer. Set the azimuth of Polaris off from the collimation (correcting for altitude by dividing by the secant of the altitude) with the movable wire and by turning the tangent screw bisect the star with the movable wire. Observe the times of transit of some time star across the fixed wires.

Another method of getting the time is by observing the transit of a star across the vertical of Polaris and following the directions given in the explanation of "Table XIV."

The result of the observations for time must always be entered in the form at the beginning of the book of record of astronomical observations.

274. The striding level is graduated from zero at one end, continuously upwards to the other end. Representing by w and e the readings of the west or left and east or right extremities of the bubble respectively when the zero of the graduation is at the east or right end and by w^1 and e^1 , the corresponding west and east readings after the level is reversed, that is to say, when the zero of the graduation is at the west or left end, d being the value of one division in seconds of arc, the level correction

$$= \frac{d}{4} \left\{ (w - w^1) - (e - e^1) \right\} \tan h$$

$\tan h$, the inclination factor for Polaris, is tabulated in the azimuth observation book.

If the observation is taken according to the first programme the level correction is applied to the horizontal circle readings according to sign; but if taken by the micrometric method the level correction is applied to the angle "Polaris from collimation" according to sign if Polaris is east of collimation, opposite to sign if west.

Provision has been made for the determination of the value of one division of the level at the head office. If, however, the surveyor has no knowledge of his level value and wishes to determine it in the field, he may adopt the following method:—

The level is placed on the upper plate parallel to the plane of revolution of the telescope, and a mark set up at a distance not less than half a mile (so that the telescope may be in solar focus) and in the direction of one of the foot screws. The bubble is, by turning this foot screw, brought close to one end of its run, the telescope is pointed on the mark and firmly clamped. A careful pointing is now made on the mark with the movable thread of the eyepiece micrometer and the readings of the micrometer and level noted. The foot screw is then turned until the bubble is close to the other end of its run, the drum of the eyepiece micrometer turned until the movable thread again bisects the mark and the micrometer and level readings noted. The difference of micrometer readings gives the angular displacement from which the value of one division of the level may be derived. The operation should be repeated several times. The level may be reversed end for end during the course of the determination if desired.

Instead of a distant point, the pointings may be made upon the telescope of a transit or level used as a collimator.

275. In the reduction of an observation taken according to the second programme, "circle east" and "circle west" are reduced independently, the mean of the micrometer readings on the reference object and star and of the chronometer times being taken in each case. The correction for curvature of the path of Polaris, being in extreme cases only a fraction of a second, may be neglected.

The angle measured by the micrometer between the star and the line of collimation and, when the reference object has any appreciable altitude, between the reference object and the line of collimation, must be multiplied by the secant of the altitude to reduce it to the horizontal. When Polaris is sufficiently close to the meridian to allow it, it will be better to make the pointing with the movable thread on Polaris not

far from the centre of the field. In this way the factor for the reduction to the horizontal of the angle "Polaris from collimation" affects only a small angle while the factor for the reduction of the large angle "Reference object from collimation" is nearly unity. The altitude of Polaris may be taken from the Astronomical Field Tables for the mean of the times of the two observations, "circle right" and "circle left," without appreciable error. At or near elongation when the altitude is changing rapidly and when the angle "Polaris from collimation" is necessarily large, the altitude is better read off the vertical circle, each half of the observation being reduced with its own altitude.

To reduce the micrometer readings to arc the value of one turn is required. Provision has been made to have this value determined at the head office. But if the surveyor is without this value, he may find it by any of the methods described in standard text books on astronomy.

The following method will be found convenient:—

Set the movable wire of the micrometer close to one end of its run and move the upper part of the instrument with the tangent screw until the movable wire bisects some distant object (solar focus) at the same level as the transit; read the micrometer once and the horizontal circle microscopes three times. Now bring the movable wire close to the other end of its run and bisect again the same point with the movable wire by means of the tangent screw, reading the micrometer and circle microscopes as before. The horizontal angle as shown by the microscope readings divided by the difference of micrometer turns gives the value of one turn of the micrometer.

The operation should be repeated a number of times and, in order to eliminate as much as possible periodic errors of the circle graduation, the instrument should be revolved by means of the shifting head on the stand to give readings on different parts of the circle.

The uniformity of the micrometer screw may be tested by measuring the value of one turn over different parts of the screw.

Another transit or a level may be used as a collimator and gives a better reference object than a distant point. Set up the collimator a few feet from the transit to be tested and with the telescope at the same level. Adjust both to solar focus and point on the object glass of the transit. Now looking to the collimator through the telescope of the tran-

sit, the cross wires or points of the collimator telescope will be seen as at an infinite distance. These cross wires or points make an excellent reference object.

276. 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:—

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

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

The logarithms of secant and tangent L are given in tables IX and X for the north side of every section.

The subtraction logarithm is found in Table XVII, 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 .

277. The following observations, one in each quadrant, show the form of record and method of computation:

FIRST

Place *Sta. 109-54 73° E of N.E. cor. of sec. 34 tp. 60 R. 1W. 5th Mer.*
 R. O. *Sta. 107-71 13° E of N.E. cor. of sec. 33 tp. 60 R. 1W. 5th Mer.*
 Date *6-11-09* Observer *J. Smith D.L.S.*

Position	Pointing No.	Horizontal Circle Readings			
		Reference Object		Polaris	
		Microscope A	Micr. B	Microscope A	Micr. B
Circle Right Drum Right	1	359-16-43	18-15	87-15-55	17-09
	2	45	13	54	07
	3	43	14	55	09
	4	43	15	56	10
	6	43	14	56	09
	Mean	359-17-28.8		87-16-32	
Circle Left Drum Left	1	179-20-37	21-53	267-18-48	20-27
	2	37	55	46	26
	3	37	52	47	27
	4	39	55	47	27
	5	37	54	47	26
	Mean	179-21-15.6		267-19-36.8	
Mean H.C.R. of Pol		87-16-32	267-19-37	Mean Chron. time	
Level correction		3	11	Chron. error	
Corrected H.C.R. of Pol		87-16-29	267-19-26	Sidereal time	
" H.C.R. of R.O.		359-17-29	179-21-16	R. A. Polaris	
Angle Pol. to R.O.		87-59-00 _W	87-58-10 _N	t in time	
Poi. from collimation		log		t in arc	
One turn micrometer		log		Log. tan P	
Altitude Pol.		log. sec.		Log. tan & Sec. L	
log. sum				Log. cos. & sin. t	
Poi. fr. coll. reduced to horiz. l.				Log. sum	
Level Correction				Subtraction log	
Microm. angle Pol. fr. coll				Log. tan Z	
R.O. from collimation		log.		Log. T	
One turn micrometer		log.		Log. Z, (in sec.)	
Altitude R.O.		log. sec.		Bearing Pol	
log. sum				Angle Pol. to R. O	
Microm. angle R.O. from coll				Bearing R. O	
Angle Pol. to R. O.				Mean	
				Convergence	
				Bea. ref. to centre tp.	

SPECIMEN OF RECORD

QUADRANT

Instrument *Stanley # 108 187*
 One turn of micrometer *146.9*
 One division of striding level *3.7*

Chron. Time	Micrometer Readings		Level		
	Polaris	R. O.	W.	E.	Corr.
6-42-17			24.0	7.0	-2 × 0.92 × 1.39 = -3"
			8.0	25.0	
			+ 16	- 18	
6-52-46.5			20.0	3.0	-8.6 × 0.92 × 1.39 = -11
			7.3	24.3	
			+ 12.7	- 21.3	
Circle Right		Circle Left			
6-42-17		6-52-46.5			
+ 3-05.6		3-05.6			
6-45-22.6		6-55-52.1			
1-27-30		1-27-30			
5-17-52.6		5-28-22.1			
79-28-15		82-05-30			
2.31159	2.31159	2.31159	2.31159	2.31159	
.14257	.23329	.14257	.23329	.23329	
7.26182	7.99262	7.13858	7.99585	7.99585	
3.71598	2.53750	3.59274	2.54073	2.54073	
	+ .00225		+ .00170	+ .00170	
	2.53975		2.54243	2.54243	
	5.31426		5.31426	5.31426	
	3.85401		3.85669	3.85669	
	358-00-55		358-00-11	358-00-11	
	87-59-00 _N		87-58-10 _N	87-58-10 _N	
	270-01-55		270-02-01	270-02-01	
			270-01-58	270-01-58	
			- 2.03	- 2.03	
			269-59-55	269-59-55	

OF AZIMUTH OBSERVATION.

SECOND

Place Sta. 45 73° 69 S. of N.E. cor. sec. 12 tp. 60 R. 1 W. 5th Mer.
 R. O. Sta. 43 0° 23 S. of N.E. cor. sec. 12 tp. 60 R. 1 W. 5th Mer.
 Date 1-11-09 Observer J. Smith D.L.S.

Position	Pointing No.	Horizontal Circle Readings			
		Reference Object		Polaris	
		Microscope A	Micr. B	Microscope A	Micr. B
Circle Right Drum Right	1				
	2				
	3				
	4				
	5				
	Mean				
Circle Left Drum Left	1				
	2				
	3				
	4				
	5				
	Mean				

Mean H.C.R. of Pol.....	Circle Right	Circle Left	Mean Chron. time....
Level correction.....			Chron. error.....
Corrected H.C.R. of Pol.....			Sidereal time.....
" H.C.R. of R.O.....			R. A. Polaris.....
Angle Pol. to R.O.....			t in time.....
			t in arc.....
Pol. from collimation.....log.	7.59106	7.85370	Log. tan P.....
One turn micrometer.....log.	2.16702	2.16702	Log. tan & Sec. L....
Altitude Pol. 53° 01' log. sec.	0.22070	0.22070	Log. cos. & sin. t....
log. sum	1.97878	2.24142	Log. sum.....
Pol. fr. coll. reduced to hor'z.	0-01-35 ^W	0-02-54 ^W	Subtraction log.....
Level Correction.....	+ 1	- 4	Log. tan Z.
Microm. angle Pol. fr. coll.....	0-01-36 ^W	0-02-50 ^W	Log. T.....
R.O. from collimation.....log.	1.03294	0.97234	Log. Z. (in sec.)....
One turn micrometer.....log.	2.16702	2.16702	Bearing Pol.....
Altitude R.O. 44° 36' log. sec.	0.00140	0.00140	Angle Pol. to R. O....
log. sum	3.20136	3.14076	Bearing R. O.....
Microm. angle R.O. from coll.....	0-26-30 ^E	0-23-03 ^E	Mean.....
Angle Pol. to R. O.....	0-28-06 ^E	0-25-53 ^E	Convergence.....
			Sea. ref. to centre tp.

QUADRANT

Instrument Stanley # 108187
 One turn of micrometer 146.9
 One division of striding level 3.7

Chron. Time	Micrometer Readings		Level		
	Polaris	R. O.	W.	E.	Corr.
12-29-30 30-18	25.475 .305	14.210 .215 .210 .210 .215	23.8 8.3	8.0 24.0	-0.5 x 0.92 x 1.33 = -1"
12-29-54	25.390	14.212	+15.5	-16.0	
12-34-08 -45	24.225 .347	34.380 385 380 .385 .385	24.1 6.8	8.5 22.4	+ 3.4 x 0.92 x 1.33 = + 4"
12-34-26.5	24.286	34.383	+17.3	-13.9	
	Circle Right	Circle Left			
	12-29-54	12-34-26.5			
	+ 2-25	+ 2-25			
	12-32-19	12-36-51.5			
	1-27-31.4	1-27-31.4			
	11-04-47.6	11-09-20.1			
	116-12-00	167-20-00			
2.31178 14143 7.98728	2.31178 .23254 7.37755	2.31178 14143 7.98930	2.31178 14143 7.34100	2.31178 .23254 7.34100	
2.44049	3.92187 - .01181	2.44251	3.88532 - .01186	3.88532 - .01186	
	3.91006 5.31442		3.87346 5.31442	3.87346 5.31442	
	3.22448		3.18788	3.18788	
	359-32-03 0-28-06 ^E		359-34-19 0-25-53 ^E	359-34-19 0-25-53 ^E	
	360-00-09		360-00-12	360-00-12	
			360-00-11	360-00-11	

THIRD

Place Sta. 97-5th 26 E. of N.E. cor. sec. 31 to 60 R. 1 W. 5th Mer.
 R. O. Sta. 94-14th 97 E. of N.E. cor. sec. 36 to 60 R. 1 W. 5th Mer.
 Date 29-10-09 Observer J. Smith D.L.S.

Position	Pointing No	Horizontal Circle Readings			
		Reference Object		Polaris	
		Microscope A	Micr. B	Microscope A	Micr. B
Circle Right Drum Right	1	358-54-58	56-33	90-58-53	60 08
	2	56	33	51	10
	3	57	34	52	12
	4	57	33	52	10
	5	57	34	53	12
	Mean	358-55-45.2		90-59-31.3	
Circle Left Drum Left	1	178-55-36	56-44	270-59-06	60.30
	2	37	45	05	32
	3	37	45	04	32
	4	38	44	03	33
	5	37	43	05	32
	Mean	178-56-10.6		270-59-48.2	

Mean H.C.R. of Pol.	Circle Right 90-59-31	Circle Left 270-59-48	Mean Chron. time
Level correction	- 7	+ 19	Chron. error
Corrected H.C.R. of Pol.	90-59-24	271-00-07	Sidereal time
H.C.R. of R.O.	358-55-45	178-56-11	R. A. Polaris
Angle Pol. to R.O.	92-03-39 ^W	92-03-56 ^W	t in time
Pol. from collimation			t in arc
One turn micrometer			Log. tan P.
Altitude Pol.			Log. tan & Sec. L.
log. sum			Log. cos. & sin. t.
Pol. fr. coll. reduced to horizal.			Log. sum
Level Correction			Subtraction log.
Microm. angle Pol. fr. coll.			Log. tan Z.
R.C. from collimation			Log. T.
One turn micrometer			Log. Z. (in sec.)
Altitude R.O.			Bearing Pol.
log. sum			Angle Pol. to R. O.
Microm. angle R.O. from coll.			Bearing R. O.
Angle Pol. to R. O.			Mean
			Convergence
			Sea. ref. to centre tp.

SPECIMEN OF RECORD

QUADRANT

Instrument Stanley #108187
 One turn of micrometer 146.9
 One division of striding level 3.7

Chron. Time	Micrometer Readings		Level		
	Polaris	R. O.	W.	E.	Corrn.
19-09-36			23.5 8.8	6.0 26.0	-5.3 x 0.92 x 1.39 =-7
19-16-16			28.9 4.0	11.3 21.3	+14.9 x 0.92 x 1.39 =+19
	Circle Right	Circle Left			
	19-09-36	19-16-16			
	+ 2-19	+ 2-19			
	19-11-55	19-18-35			
	- 1-27-31.5	- 1-27-31.5			
	17-44-23.5	17-51-03.5			
	266-06-00	267-46-00			
2.31189	2.31189	2.31189	2.31189	2.31189	
14257	23329	14257	23329	23329	
2.83261	7.99899	2.59072	7.99967	7.99967	
3.28707	2.54417	3.04518	2.54485	2.54485	
	- 00084		- 00049	- 00049	
	2.54332		2.54436	2.54436	
	5.31426		5.31426	5.31426	
	3.85759		3.85862	3.85862	
	2-00-04		2-00-21	2-00-21	
	92-03-39 ^W		92-03-56 ^W	92-03-56 ^W	
	269-56-25		269-56-25	269-56-25	
			+ 3.14	+ 3.14	
			269-59-39	269-59-39	

OF AZIMUTH OBSERVATION.

FOURTH

Place *Sta. 41-26° 81 S. of N.E. cor. sec. 13 tp. 60 R. 1 W. 5th Mer.*
 R. O. *Sta. 38-29° 37 S. of N.E. cor. sec. 24 tp. 60 R. 1 W. 5th Mer.*
 Date *29-10-09* Observer *J. Smith Dd. S.*

Position	Pointing No.	Horizontal Circle Readings			
		Reference Object		Polaris	
		Microscope A	Micro. B	Microscope A	Micro. B
Circle Right Drum Right	1				
	2				
	3				
	4				
	5				
	Mean				
Circle Left Drum Left	1				
	2				
	3				
	4				
	5				
	Mean				

	Circle Right	Circle Left	
Mean H.C.R. of Pol.....			Mean Chron. time....
Level correction.....			Chron. error.....
Corrected H.C.R. of Pol.....			Sidereal time.....
" H.C.R. of R.O.....			R. A. Polaris.....
Angle Pol. to R.O.....			t in time.....
			t in arc.....
Pol. from collimation.....log.	<i>T. 69108</i>	<i>T. 39094</i>	Log. tan P.....
One turn micrometer.....log.	<i>2.16702</i>	<i>2.16702</i>	Log. tan & Sec. L....
Altitude Pol. <i>55° 19'</i> log. sec.	<i>.24486</i>	<i>.24486</i>	Log. cos. & sin. t....
log. sum	<i>2.10296</i>	<i>1.80282</i>	Log. sum.....
Pol. fr. coll. reduced to horiz'd.	<i>0-02-07 E</i>	<i>0-01-04 E</i>	Subtraction log.....
Level Correction.....	<i>+ 5</i>	<i>+ 8</i>	Log. tan Z.....
Microm. angle Pol. fr. coll.....	<i>0-02-12 E</i>	<i>0-01-12 E</i>	Log. T.....
R.O. from collimation.....log.	<i>1.12885</i>	<i>1.10058</i>	Log. Z. (in sec.)....
One turn micrometer.....log.	<i>2.16702</i>	<i>2.16702</i>	Bearing Pol.....
Altitude R.O. <i>2° 14'</i> log. sec	<i>0.00033</i>	<i>.00033</i>	Angle Pol. to R.O....
log. sum	<i>3.29620</i>	<i>3.26793</i>	Bearing R. O.....
Microm. angle R.O. from coll.....	<i>0-32-58 W</i>	<i>0-30-53 W</i>	Mean.....
Angle Pol. to R. O.....	<i>0-35-10 W</i>	<i>0-32-05 W</i>	Convergence.....
			Bea. ref to centre tp

SPECIMEN OF RECORD

QUADRANT

Instrument *Stanley # 108187*
 One turn of micrometer *146.9*
 One division of striding level *3.7*

Chron. Time	Micrometer Readings		Level		
	Polaris	R. O.	W.	E.	Corrn.
	<i>0-19-11</i> <i>-54</i>	<i>24 445</i> <i>.573</i>	<i>11 540</i> <i>550</i> <i>545</i> <i>.550</i> <i>.545</i>	<i>25.7</i> <i>6.4</i>	<i>8.1</i> <i>24.0</i>
<i>0-19-32.5</i>	<i>24 509</i>	<i>11 546</i>	<i>+19.3</i>	<i>-159</i>	
<i>0-25-00</i> <i>35</i>	<i>25 297</i> <i>.195</i>	<i>37 605</i> <i>.605</i> <i>.605</i> <i>.605</i> <i>.610</i>	<i>26.8</i> <i>6.0</i>	<i>9.0</i> <i>23.8</i>	<i>+ 6.0</i> <i>x 0.92</i> <i>x 1.45</i> <i>= + 8"</i>
<i>0-25-17.5</i>	<i>25 246</i>	<i>37 606</i>	<i>+20.8</i>	<i>-14.8</i>	
	Circle Right		Circle Left		
	<i>0-19-32.5</i>		<i>0-25-17.5</i>		
	<i>+ 2-19</i>		<i>+ 2-19</i>		
	<i>0-21-51.5</i>		<i>0-27-36.5</i>		
	<i>1-27-31.5</i>		<i>1-27-31.5</i>		
	<i>22-54-20.0</i>		<i>23-00-05.0</i>		
	<i>343-35-00</i>		<i>345-01-15.</i>		
<i>2 31188</i>	<i>2 31188</i>	<i>2.31188</i>	<i>2.31188</i>	<i>2.31188</i>	
<i>0.14179</i>	<i>0 23279</i>	<i>.14179</i>	<i>.23279</i>	<i>.23279</i>	
<i>T. 98192</i>	<i>T. 45120</i>	<i>T. 98498</i>	<i>T. 41246</i>	<i>T. 41246</i>	
<i>2.43559</i>	<i>3.99587</i>	<i>2.43865</i>	<i>3.95707</i>	<i>3.95707</i>	
	<i>+ 1168</i>		<i>+ 1176</i>	<i>+ 1176</i>	
	<i>2 00755</i>		<i>3.96883</i>	<i>3.96883</i>	
	<i>5 31442</i>		<i>5.31442</i>	<i>5.31442</i>	
	<i>3 32197</i>		<i>3.28325</i>	<i>3.28325</i>	
	<i>0-34-59</i>		<i>0-32-00</i>	<i>0-32-00</i>	
	<i>0-35-10 W</i>		<i>0-32-05 W</i>	<i>0-32-05 W</i>	
	<i>359-59-49</i>		<i>359-59-55</i>	<i>359-59-55</i>	
			<i>359-59-52</i>	<i>359-59-52</i>	

OF AZIMUTH OBSERVATION.

278. In the form, R.O. is for reference object; H.C.R. for horizontal circle reading; coll. for collimation, and R.A. for right ascension.

The observations in the first and third quadrants are taken according to the first programme; those in the second and fourth quadrants according to the micrometric method of the second programme.

In the second and fourth quadrant observations, as the angle between Polaris and the R.O. is less than one half the run of the screw, the pointing on Polaris is made in the approximate line of collimation.

It is not necessary that the collimation be correctly known. An approximate value may be taken; the bearings of the R.O. deduced from the two sets "circle right" and "circle left" will then differ by twice the error of collimation, but the mean of the two will be correct. In the observations the collimation is taken as 25·000 turns of the drum, which is only approximately correct.

In the position "drum right," the micrometer readings increase from right to left or as the horizontal circle readings decrease. And in the position "drum left," the micrometer readings increase from left to right, or as the horizontal circle readings increase. Hence in the second quadrant observation Polaris is west of collimation and the level correction is reversed in sign, while in the fourth quadrant observation Polaris is east of collimation and the sign of the level correction remains unchanged.

The observations in the first and third quadrants being taken on a base line the convergence must, of course, be applied to the mean bearing of the R.O. to refer it to the centre of the township. The observations in the second and fourth quadrants being taken along a meridian, no convergence is applied.

279. The correction to the line found from the observation for azimuth may be laid off with the eyepiece micrometer by setting the movable wire the required correction from the middle fixed wire and correcting accordingly.

If a surveyor should happen to survey a block line with a transit lacking the eyepiece micrometer, he can correct the direction of the line 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.

280. Surveyors are expected to observe for azimuth every four miles or thereabouts. 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 take much time. It is hoped that with the forms and tables supplied, the work has been made so short and easy that no objection to the frequency of observation should fairly exist.

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.

284. The following method for the production of the line has been found to give good results. The flagman carries an ordinary surveying picket, about nine feet long, and terminated at the lower end by a heavy iron point. 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 points 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.

Other methods are sometimes adopted with satisfactory results.

285. The deflection angle at a township corner on the base line is most readily turned off with the eyepiece micrometer, if the instrument is set up at the corner. Otherwise, it may be laid off by using the "deflection offset" given in Tables V. and VI. of the Supplement. 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 12×1.501 , or 18.01 inches south of the line, and the instrument set up at 15×1.501 , 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 either by means of the eyepiece micrometer or by offsetting the instrument at the next station.

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

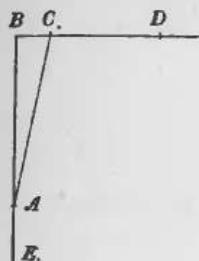


Fig. 38.

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° 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 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*.

Neglect of precautions in this behalf inevitably leads to 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, in addition to the standard measure required by section 35 of the Dominion Lands Surveys Act, a transit theodolite with a telescope of not less than one inch and a half aperture, a sidereal watch, a surveying aneroid barometer, a clinometer and a sixty-six foot steel band chain.

These instruments must be of approved patterns and in good order.

A spare transit theodolite is recommended.

The aneroid barometer must be compared with a standard barometer at every convenient opportunity.

290. A block surveyor must have in addition thereto a six-inch transit of approved pattern and a steel band chain not less than one hundred feet in length.

291. When the services of a surveyor are of a temporary character, his salary is at the rate of eight dollars per day for ordinary surveys, but for surveys of block outlines and for services requiring special qualifications, the rate is ten dollars 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, horseshoe 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 in charge of a survey party is 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 is further 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 is 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 must be owned and furnished by the surveyor. For its use, he is allowed while in the field forty 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. When an assistant is regularly appointed as such by the Minister of the Interior, the board and camp equipage allowance for him are twenty-five cents and ten cents per day, respectively.

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 and vouchers must be rendered 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.

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 for at the rate of three dollars and fifty cents per mile of line surveyed.

313. A further payment at the rate of fifty cents per chain 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 for at the rate of twenty-five cents per chain. If the mileage charged for by the contractor for opening, cutting and blazing of lines exceeds that reported by the Inspector of Surveys, the contractor's account is reduced accordingly, the deduction being applied over the whole contract. No deduction, however, is

made if the contractor's charge does not differ from the Inspector's by more than five per cent. If the lines are not sufficiently blazed a deduction may be made at such rate as the Inspector of Surveys recommends, but not exceeding two dollars per mile.

315. 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.

316. No payment is made under the provisions of Clauses 313 and 314, where the line could have been measured without opening and cutting. A strict interpretation is given to this clause, and the field notes must show every opening of half a chain or more where no cutting was necessary in order to measure the line.

317. The part of a line chained across a marsh or other body of water, except on the ice, or measured across water by means of a triangulation, is up to half a mile, paid for as opening through woods when the body of water is surrounded by continuous woods. When such measurement exceeds a mile in length, one half the distance is paid for as opening through woods. Distances measured by means of improper triangles are not paid for.

318. When the side of a section, exclusive of road allowance, is greater than ninety chains or smaller than seventy chains, the number of chains of opening or cutting which may be paid for 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. A single payment only is made for the north and south boundaries of townships, although they must always be run twice under the provisions of the Manual of Survey.

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 classed as rough or hilly when the field notes show that it crosses a ravine not less than 100 feet deep or two ravines 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 200 feet, the depths or heights being measured by aneroid barometer. In case the corner of a 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 Inspector of Surveys, concurred in by the Surveyor-General, stating that the survey presented unusual difficulties on account of large rivers flowing through deep valleys with the surrounding country broken by gullies; or on account of exceptionally extensive and deep marshes. This payment is not made for difficulties other than those mentioned or for marshes which have been crossed on the ice. Payment, if made, is for the number of miles recommended in the Inspector's 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 surveying or retracing lines previously surveyed.

323. Section lines resurveyed or retraced by direction of the Surveyor-General, or under the provisions of the Manual of Survey, 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 the Manual of Survey for testing the chainage. Lines resurveyed or retraced without authority are not paid for. The fact that a line is obliterated or that a monument cannot be found is not to be deemed sufficient authority to resurvey 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 to cover the cost of planting and marking the post, building the mound and otherwise completing the monument. A witness trench is paid for 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 paid for as two prairie pits.

325. Traverses of lakes and rivers and connecting traverses are paid for at the rate of eleven dollars per mile. For traverses of lakes and rivers, the distance 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. When both banks of a river are located from a single traverse line the full traverse rate of eleven dollars per mile is paid for one bank only and the additional work for locating the other bank is paid for at the rate of four dollars per mile.

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

Nothing is paid for offsets, but one dollar is deducted for every offset short of the number required by the Manual of Survey.

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 line of the survey.

327. The above allowances are to cover the cost of preparing the returns 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 storekeeper by the surveyor.

329. A deduction at the rate of six cents per cubic foot for deficiency in the size of the pits in excess of a foot and a half per pit is made from the payments to survey contractors. Further deductions at such rates as the Inspector of Surveys may recommend, are made for deficiencies in survey monuments, whether the deficiency be in the scattering of earth away from the pits, the marking or driving of the posts or in the general character of the monument. These deductions are averaged on the monuments examined by the Inspector and are applied to the whole contract. Should the total amount of the deductions calculated as above, exceed thirty per cent. of the amount allowed for erecting the monuments, or should the Inspector report that the monuments are too unsatisfactory to be accepted, the contractor is required to repair and correct them according to the standard required by the Manual of Survey.

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

331. To be eligible for employment as a survey contractor, a surveyor must own, in addition to the standard measure required by section 35 of the Dominion Lands Surveys Act, a transit theodolite with a telescope of not less than one inch and a half aperture, a sidereal watch, a surveying aneroid barometer, a clinometer and a sixty-six foot steel band chain.

These instruments must be of approved patterns and in good order.

A spare transit theodolite is recommended.

The aneroid barometer must be compared with a standard barometer at every convenient opportunity.

The instruments of a contractor are subject to inspection by the examiner of surveys at any time.

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.

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.

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

337. It is of the utmost importance that the department should be kept well informed of the surveyor's address. Par-

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. No money is placed to the credit of third parties without such power of attorney.

Credits may be telegraphed through banks having agencies in Ottawa, but only after receipt of the sketches.

The banks with branches in Ottawa are:—

Bank of Montreal,
Bank of Ottawa,
Imperial Bank of Canada,
Canadian Bank of Commerce,
Merchants Bank of Canada,
La Banque Nationale,
Quebec Bank,
Molsons Bank,
Union Bank of Canada,
Royal Bank,
Bank of Nova Scotia,
Northern Crown Bank,
Standard Bank,
Dominion Bank,
Bank of British North America,
Traders Bank.

339. Iron posts are stored at Winnipeg, Saskatoon and Edmonton. A small stock is kept in British Columbia for local needs. A surveyor requiring posts must send a requisition to the department stating the number and kind wanted. Upon receipt of this requisition, the storekeeper is instructed to deliver the posts to the order of the surveyor. Shipping instructions must be sent to the storekeeper by the surveyor; besides the correct address, the instructions must state whether the shipment is to be by freight or express. The department does not undertake to transmit these shipping instructions to the storekeeper.

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.

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.

Timber reports.

Astronomical Field Tables.

Azimuth observation forms.

Table XIX., printed on cardboard for the pocket.

Table XX., printed on cardboard for the pocket.

Accounts for surveys paid by the day:

Form A.—Personal service.

Form B.—Pay-list.

Form C.—Transport.

Form E.—Statement of disposal of outfit.

Form D.—Miscellaneous.

Form F.—Balance sheet.

Form G.—Estimate of cost of survey.

Official diary.

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.

7-8 EDWARD VII.

CHAP. 21.

An Act respecting the Surveys of the
Public Lands of the Dominion and the
Surveyors entitled to make such surveys.

(Assented to 17th March, 1908.)

His Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:—

SHORT TITLE.

1. This Act may be cited as *The Dominion Lands Surveys Act*. Short title.

INTERPRETATION.

2. In this Act, unless the context otherwise requires,— Interpretation.

(a) "Minister" means the Minister of the Interior;

(b) "Surveyor-General" means the officer of the Department of the Interior who bears that designation, and has, subject to the direction of the Minister, the management of surveys of Dominion lands, or the chief clerk performing his duties for the time being;

(c) "Board" means the Board of Examiners for Dominion Land Surveyors;

(d) "Dominion land surveyor" means a surveyor authorized to survey Dominion lands under the provisions of this Act;

(e) "Dominion lands" means any lands to which *The Dominion Lands Act* applies;

(f) "monument" means a post, stake, peg, mound, pit or trench, or anything used to mark a boundary corner.

APPLICATION OF ACT.

Application.

3. This Act applies to the public lands of the Dominion to which *The Dominion Lands Act* applies.

POWERS OF THE GOVERNOR IN COUNCIL.

Cases unprovided for, etc.

4. The Governor in Council may—

(a) make such orders as are deemed necessary to carry out the provisions of this Act, according to their true intent, or to meet any cases which arise, and for which no provision is made in this Act; and further make and declare any regulations which are considered necessary to give the provisions in this section full effect;

(b) impose penalties not exceeding two hundred dollars, or not exceeding three months' imprisonment, for violation of any regulations under this Act;

(c) provide that any statement or return required to be made by such regulations shall be verified on oath.

Orders and regulations must be published.

5. Every order or regulation made by the Governor in Council by virtue of the provisions of this Act shall, unless herein otherwise specially provided, have force and effect only after it has been published for four successive weeks in *The Canada Gazette*; and all such orders or regulations shall be laid before both Houses of Parliament within the first fifteen days of the session next after the date thereof.

And laid before Parliament.

Fees.

6. The Governor in Council may establish a tariff of fees to be charged by the Minister for all copies of maps, township plans, field notes and other records; and all fees received under such tariff shall form part of the revenue from Dominion lands.

ADMINISTRATION.

7. The Minister shall have the administration, ^{Administration.} direction and control of the surveys of Dominion lands.

SURVEYORS.

8. No person shall act as surveyor of any lands ^{Qualified to survey.} to which this Act applies unless he has become qualified to do so under the provisions herein-after set forth or was, before the fourteenth day of April, 1872, duly qualified by certificate, diploma or commission, to survey Crown lands in some one of the provinces of Canada.

9. There shall be a Board of Examiners for the ^{Board of examiners.} examination of candidates for admission as articulated pupils, for commissions as Dominion land surveyors or for certificates as Dominion topographical surveyors, which shall consist of the Surveyor-General and two Dominion topographical surveyors appointed from time to time by the Governor in Council.

2. The Board shall meet annually for such ^{Dates of examinations.} examination on the second Monday in the month of February, and the Minister may require the Board to meet and to hold examinations at such other times and places as are necessary.

3. Notice of such annual and other meetings ^{Notice of meetings.} shall be given in *The Canada Gazette*.

10. Every member of the Board shall take an ^{Oath of office.} oath of office, in the form A in the schedule to this Act, which may be administered by a judge of any court in Canada.

11. The Minister shall, from time to time, ap- ^{Secretary.} point a fit and proper person to be secretary of the Board who shall keep a record of its proceedings.

12. The Minister may cause examinations of ^{Examinations.} candidates for admission as articulated pupils or for commissions as Dominion land surveyors 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 is a Dominion land surveyor, and is appointed thereto by the Governor in Council.

- Notice of. 2. Notice of any such examinations shall be given for four consecutive weeks in *The Canada Gazette*.
- Rules for. 3. Such examinations shall be subject to any 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.
- Filling vacancies on Board *pro tem*. 13. The Governor in Council may appoint one or more Dominion topographical surveyors for the purpose of filling the place of any member or members of the Board who may, through illness or other cause, be unable to attend any meeting of the Board.
- Secretary to be notified by candidate for examination. 14. Every person who desires to be examined by the Board shall notify the secretary in writing at least one month previous to the meeting of the Board at which the examination is to take place, and shall, with such notice, transmit the fee hereinafter prescribed.
- Examination for admission as articulated pupil. 15. No person shall be admitted as an articulated pupil with any Dominion land surveyor unless he has previously passed an examination before the Board, or before one of the members thereof, or before a special examiner as hereinbefore provided, 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 in penmanship and orthography, and has obtained from the Board a certificate of having passed such examination.
- Conditions precedent to examination for commission. 16. Except as hereinafter provided, no pupil shall be entitled to be examined for a commission as a Dominion land surveyor unless he has previously served regularly and faithfully for and during the period of three years, under articles in form B in the schedule to this Act, as pupil of a Dominion land surveyor, and unless he produces an affidavit from such surveyor in form C in the schedule to this Act, together with his own affidavit in form D in the schedule to this Act, that he has so served; or, if for some good and valid rea-

son the surveyor's affidavit cannot be produced, unless he produces such evidence of service as the Board requires: Provided that such three years' service shall include at least twelve months' actual practice in the field.

17. Any Dominion land surveyor may, by an instrument in writing, in form E in the schedule to this Act, 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 form C in the schedule to this Act, together with his own affidavit in form D in the schedule to this Act, that he has so served: Provided that, if such pupil is unable to obtain the surveyors' affidavits, or either of them, as aforesaid, the Board may accept evidence of service, in such form as it sees fit.

18. If an articulated pupil is, at the time of his entering into articles or of his transfer, of the full age of twenty-one years, form B or E may be so varied as to provide for the articles being entered into or the transfer made on the responsibility of such articulated pupil himself without reference to the consent and approbation of his father or of any other person.

19. If any Dominion land surveyor dies, or leaves Canada, or is suspended, or has had his commission as a surveyor cancelled, his pupil may complete his term under articles, as aforesaid, with any other Dominion land surveyor.

20. Articled pupils shall transmit to the secretary of the Board, by registered letter, within three months of the date of their articles, a duplicate thereof, together with a fee of two dollars for filing such duplicate.

2. They shall also transmit to the secretary, by registered letter, within three months of the transfer, if any, of their articles, a duplicate of such transfer.

3. The secretary shall acknowledge the receipt of such duplicates and shall file and keep them with the records of the Board.

4. In any case in which a duplicate of the articles of a pupil or of the transfer of his articles is not transmitted to the secretary of the Board within a period of three months, as aforesaid, the time of service of the pupil under the said articles or transfer shall count from the date of the receipt of the duplicate thereof by the secretary.

As to provincial surveyors.

21. Every person who upon or after the fourteenth day of April, 1872, became, or hereafter becomes, by certificate, diploma, or commission, qualified to survey lands in any province of Canada and who is still so qualified, and who, in order to become so qualified, has—

- (a) served a term under articles to a surveyor, similar to the term prescribed by this Act, and
- (b) passed examinations before the Board of Examiners of the province for which he is so qualified, in the subjects prescribed by this Act for the examination of candidates for admission as articted pupils and for commissions as Dominion land surveyors,

shall be entitled to obtain a commission as a 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.

Further service and examination if necessary.

2. If, in the opinion of the Board,—

- (a) the service of any person so qualified who applies for a commission is not equivalent to that required by this Act for pupils of Dominion land surveyors, or—
- (b) the subjects of the examination passed by him for certificate, diploma, or commission as a surveyor, in the province for which he is qualified, are not sufficiently similar to those by this Act prescribed for qualification as a Dominion land surveyor—

the Board may, in its discretion, require the candidate to complete such further term of service or practice in surveying and may examine him in such of the subjects prescribed by this Act as appear necessary.

22. 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, 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, after examination, has thereupon received from such college or university a diploma or certificate, shall be exempt from serving three years as aforesaid, and shall be entitled to examination for a commission after being admitted upon examination as aforesaid as an articted pupil and serving one year under articles with a Dominion land surveyor, including six months' actual practice with him in the field, on producing an affidavit from the said surveyor in said form C, together with his own affidavit in said form D, that he has served for one year as herein provided; but it shall rest with the Board to decide whether the course of instruction in such college or university meets the requirements of this section.

As to graduates of Royal Military College and other graduates.

23. Except as in this Act otherwise provided, no person shall receive a commission from the Board authorizing him to practise as a Dominion land surveyor until he has complied with the general requirements of this Act in that behalf, 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, or before a special examiner as hereinbefore provided, in the following subjects:—

Examination for commission as a surveyor.

- (a) plane and solid geometry;
- (b) spherical trigonometry, as far as the solution of triangles;
- (c) the use of logarithms;
- (d) the measurement of areas, including their calculation by latitude and departure;
- (e) the dividing or laying off of land;
- (f) the elements of astronomy and their practical application in the determination of latitude, longitude, time and azimuth:

Proviso.

Provided that no commission shall issue unless the Board is satisfied that the person is well informed as to the system of survey prescribed by this Act; that he is conversant with the Manual of instructions for the survey of Dominion lands issued from time to time, under the authority of the Minister, by the Surveyor-General for the guidance of Dominion land surveyors; and that his practical knowledge is such that—

(a) he can properly conduct surveying operations and report thereon;

(b) he can correctly keep field notes and plot and represent them on plans of survey;

(c) he can describe land by metes and bounds for title;

(d) he can properly adjust and use ordinary surveying instruments.

Examine candidate on oath.

24. 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 or as to any matter relating to his examination.

Issue of commission.

25. Every person who qualifies in the manner prescribed by this Act shall receive a commission from the Board in form F in the schedule to this Act, constituting him a Dominion land surveyor; Provided that he shall, jointly and severally with two sufficient securities to the satisfaction of the Board, enter into a bond to the Crown in the sum of one thousand dollars, conditioned for the due and faithful performance of his duties as a surveyor, and that he shall take and subscribe before a judge of any court in Canada, or before any member of the Board who is hereby authorized to administer it, the oath of allegiance and an oath in form G in the schedule to this Act.

Security and oath.

Registering of commission. Depositing of oath and bond and enuring of bond.

2. The commission shall be registered in the office of the Registrar-General of Canada; the oaths shall be deposited in the office of the Surveyor-General; and the bond shall be deposited and kept in the manner prescribed by, and shall be subject to the provisions of the Act respecting public officers, and shall enure to the benefit of any person who sustains damage by breach of any condition thereof.

26. Any Dominion land surveyor, who has previously given the notice of examination required by this Act, may present himself for examination as to his knowledge of the higher branches of surveying, qualifying him for the prosecution of extensive, governing or topographical surveys, and geographic explorations; and a syllabus of the subjects of such examination shall be prepared from time to time by the Board and published in *The Canada Gazette* at least six months before the examination.

Examinations in higher branches.

27. Persons who pass the examination provided for in the next preceding section shall receive a certificate to that effect from the Board, and shall be designated Dominion topographical surveyors.

Certificate as topographical surveyor.

28. The following fees shall be paid to the secretary of the Board:—

Fees.

(a) by each person, on giving notice of his desire for examination for admission as an articled pupil, one dollar;

(b) by each candidate for such preliminary examination, ten dollars;

(c) for certificate of preliminary examination, two dollars;

(d) by each pupil, at the time of transmitting his indenture or articles, two dollars;

(e) by each applicant for examination for a commission as Dominion land surveyor or for a certificate as Dominion topographical surveyor, with his notice thereof, two dollars;

(f) by each applicant upon obtaining a commission, two dollars;

(g) for admission to practice after receiving a commission, twenty dollars;

(h) by each applicant who obtains a certificate as Dominion topographical surveyor, two dollars;

(i) for a subsidiary standard of the Dominion measure of length, tested and stamped as hereinafter provided, eight dollars;

(j) for each subsequent testing of such subsidiary standard, two dollars;

Provided that the fees payable under paragraphs (b), (g) and (i) shall be deposited to the credit of the Receiver-General on account of

Dominion lands; and that the other fees payable under this section shall belong to the secretary.

Allowances to members of Board, secretary and special examiners.

29. Every member of the Board who attends at the meetings thereof, or who holds an examination, and every Dominion topographical surveyor who fills the place of an absent member, shall receive seven dollars and fifty cents for each day's sitting; and every special examiner who holds an examination for admission as articulated pupils or for commissions as Dominion land surveyors, and the secretary of the Board, shall receive five dollars for each day's sitting; and, in addition to such per diem allowance, there shall be paid the actual travelling and living expenses incurred by such member, surveyor, special examiner or secretary, and consequent upon such attendance or examination.

Suspension or cancellation of commissions.

30. The Board may suspend for such period as it deems meet, or may cancel, the commission or certificate of any Dominion land or topographical surveyor, or debar from surveying under this Act any provincial land surveyor authorized to act as a Dominion land surveyor under the provisions of this Act, whom it finds guilty of—

(a) gross negligence or corruption in the performance of his duties as a surveyor;

(b) certifying to false returns of a survey;

(c) certifying as his own surveys not made by himself; or,

(d) making a survey without being in possession of a standard measure, as required by this Act:

Provided that the Board shall not suspend or cancel the commission or certificate of such surveyor, or debar any surveyor from surveying under this Act, unless he has, at least thirty days in advance of action by the Board, been notified by the secretary by registered letter, mailed to his last known address, of the charges against him, and been summoned to appear before the Board to make his defence, nor before having heard the evidence offered both in support of the charges and by the surveyor himself, or, in the event of his failure to appear, by a person appointed by the Board to act on his behalf.

31. The Surveyor-General shall require every Dominion land 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 an oath or make and subscribe an affirmation, on the return of his surveys of Dominion lands, that he has faithfully and correctly, and in his own proper person, executed such surveys in accordance with the provisions of this Act and the instructions of the Surveyor-General; and, if it is proved 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.

Proceedings to be taken if false statement.

32. 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.

Surveyors' records.

33. 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.

Allowance to surveyors as witnesses.

CHAIN BEARERS.

34. Every chain bearer employed in the survey of Dominion lands shall, before he commences his chaining or measuring, take an oath or affirmation

Chainbearers to be sworn.

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 is employed; and any Dominion land surveyor may administer such oath or take such affirmation.

STANDARD OF MEASURE.

Measure of length.

35. The measure of length used in the surveys of Dominion lands shall be the Dominion measure of length defined by *The Weights and Measures Act*, and every Dominion land surveyor shall be in possession of a subsidiary standard thereof, which subsidiary standard, tested by the secretary of the Board under the supervision of the Surveyor General, and stamped as correct by the Surveyor General, shall be furnished to him by the secretary of the Board on payment of the fee fixed therefor by this Act; and, notwithstanding any thing to the contrary in *The Weights and Measures Act*, such subsidiary standard shall not require any test, stamp, inspection or verification other than is required by this Act; 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 lengths; and the said standard measure shall be returned to the secretary of the Board as often as it requires to be tested again.

Subsidiary standard.

Verification.

EVIDENCE BEFORE SURVEYORS.

Surveyors may examine under oath.

36. Every Dominion land surveyor acting in that capacity may examine witnesses on oath with respect to all matters relating to the survey of lands, and for better ascertaining the original corners or limits of any township, section, quarter-section, legal or other authorized subdivision, lot, parcel or tract of land, and may administer such oath to every person whom he examines in relation to such matters.

Procedure for compelling attendance of persons who have information as to boundaries.

37. Whenever any Dominion land surveyor is in doubt as to the true corner, boundary or limit of any township, section, quarter section, legal or other authorized subdivision, lot, parcel 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 the justice of the peace, as to 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.

38. A subpoena issued as in the next preceding section set forth shall be served on the person named therein by delivering a copy thereof to him, or by leaving the copy for him with some adult person at his residence and exhibiting to him or such adult person the original; and if the person required in such subpoena to appear (his reasonable expenses having been paid or tendered to himself or to such adult person), 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 a 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.

39. 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 evidence, and shall be signed by such person, or if he cannot write, shall be acknowledged by him as

Service of subpoena.

Penalty.

Evidence to be put in writing.

correct before two witnesses, who shall sign it, as shall also the Dominion land surveyor; and such evidence shall be filed and kept, 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 they relate are situate, subject to be produced thereafter in evidence in court.

Right to enter upon private lands.

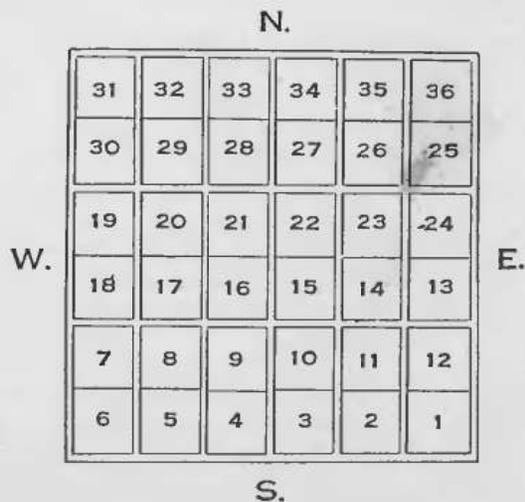
40. Any Dominion land surveyor, when engaged in the performance of his duties as such, may pass over, measure along and ascertain the bearings of any township or section line, or other governing line, and for such purpose may pass over the lands of any person whomsoever, doing no actual damage to the property of such person.

SURVEYS.

System of survey.

41. The Dominion lands shall be laid off in quadrilateral townships, each containing thirty-six sections of as nearly one mile square as the convergence of meridians permits, with such road allowances, and of such width, as the Governor in Council prescribes. Such sections shall be bounded and numbered as shown by the following diagram:—

Townships. Sections.



42. The lines bounding townships on the east ^{Township boundaries.} and west sides shall be meridians; and those on the north and south sides shall be chords to parallels of latitude.

43. The townships shall be numbered, in regular ^{Numbering and ranging of townships.} order, northerly from the international boundary, or forty-ninth parallel of latitude, and shall lie in ranges numbered, in the province of Manitoba, east and west from a certain meridian line run in the year one thousand eight hundred and sixty-nine, styled the principal meridian, drawn northerly from the forty-ninth parallel of latitude at a point ten miles, or thereabouts, westerly from Pembina; and elsewhere in ranges numbered from such other initial meridians as the Minister orders to be established, which meridians shall be styled the second, the third, the fourth meridian, and so on, according to their order in number westward from the principal meridian.

44. Townships shall be given their prescribed ^{Width of townships on base line.} width on the base line hereinafter mentioned; and the meridians between townships shall be ^{Meridians.} drawn across such bases, northward and southward to the depth of two townships therefrom, that is to say, to the correction lines hereinafter mentioned.

45. The said forty-ninth parallel, or interna- ^{Base lines.} tional boundary, shall be the first base line, or that for townships numbered one; the second base line shall be 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.

46. The correction lines, or those upon which ^{Correction lines.} the jog resulting from the convergence of meridians shall be allowed, shall be those lines running east and west between townships and midway between the bases, which lines are, the line between townships two and three, that between townships six and seven, and between townships ten and eleven, and so on.

47. Each section shall be divided into quarter ^{Division of sections.} sections of one hundred and sixty acres, more or less, subject to the provisions hereinafter contained.

Error.

48. The north and south error in closing on the correction lines from the north and south shall be allowed in the ranges of quarter sections adjoining, and north or south respectively of the said correction lines; except in the case of the north and south error in those townships between the first and second base lines, which error is to be left in the last quarter section adjoining the said first base line.

Deficiency or surplus.

49. In the survey of a township, the east and west deficiency or surplus shall be allowed in the range of quarter sections adjoining the west boundary of the township; but the Governor in Council may order such deficiency or surplus to be equally distributed among all the quarter sections involved.

Irregular quarter sections.

50. The dimensions and area of irregular quarter sections or other parcels of land shall, in all cases, be returned by the surveyor at their actual measurements and contents: Provided that in cases in which road allowances are not between but through sections, the area reserved for such road allowances shall not be included in the area returned for a quarter section, or other parcel of land.

Monuments to indicate corners.

51. Except as hereinafter provided, only a single row of monuments to indicate the corners of townships, sections or quarter sections, shall be placed on any survey line thereof; such monuments shall, on north and south lines, be placed in the west limit of the road allowances, and on the east and west lines, in the south limit of road allowances, and in all cases shall fix and govern the position of the boundary corner between the adjoining townships, sections, or quarter sections, on the opposite side of the road allowance.

Corners in correction line.

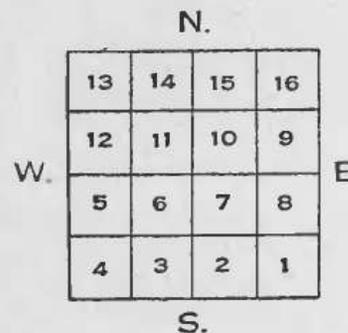
52. In the case of township, section and quarter section corners on correction lines, monuments shall, in all cases, be placed and marked independently for the townships on each side; and when a road allowance is laid out along such a line, the monuments shall be placed in the limit of the road lying alongside the lands which they are intended to define.

53. The township subdivision surveys of Dominion lands, according to the system above described, shall be performed under contract, either at a rate per township, per mile, or per acre, to be fixed, from time to time, by the Governor in Council, or by competitive tender, as the Governor in Council may, from time to time, direct; Provided that in special cases, where circumstances render it advisable, the Governor in Council may order the survey of a township or townships to be otherwise performed.

Exception.

54. To facilitate the description for letters patent of less than a quarter section, every section shall be taken to be divided into quarter quarter sections, each of forty acres more or less, which shall be styled legal subdivisions, and shall be numbered as shown in the following diagram:—

Legal subdivisions.



55. Notwithstanding anything in this Act contained, the Minister may direct—

Special provisions as to survey of certain lands.

(a) That lands bordering on any river, water course or lake, or on a public road, be surveyed, laid out and divided into lots of any certain frontage or depth, in such manner and with such roads as appears desirable;

(b) That lands be surveyed, laid out and divided into town or village lots, with such streets, lanes, places, squares and commons as are considered necessary;

(c) That roads, not exceeding sixty-six feet in width, be surveyed and laid out where such roads appear to be required;

(d) That lands in the Yukon Territory and in remote parts of the unorganized portions of the provinces of Manitoba, Saskatchewan and Alberta and the Northwest Territories be surveyed, laid out and divided into lots of such size and shape as may be found advisable;

(e) That lands in mountainous regions where the ordinary mode of survey is impracticable, be laid out into townships, sections, quarter sections and legal or other authorized subdivisions by fixing the corners of such townships, sections, quarter sections, and legal or other authorized subdivisions by reference to points determined by astronomical observations, or by triangulation or other geodetic process;

(f) That townships, sections, quarter sections, legal or other authorized subdivisions, settlement or river lots, town or village lots, or other lots or parcels of land, surveyed or laid out under the authority of this section, be described for patent by numbers according to plans of record, or by metes and bounds, or by both, as seems expedient.

OFFICIAL PLANS OF DOMINION LANDS.

56. Plans of Dominion lands surveyed or resurveyed under the provisions of this Act shall be plotted from the surveyors' field notes under the direction of the Surveyor-General; and such plans shall show the direction and length of the boundaries, the nature and position of the boundary monuments and the areas of the quarter sections or other parcels of land laid out.

2. The confirmation of any such plan by the Surveyor-General shall be held to be a confirmation of the survey or resurvey as the case may be, and the confirmed plan shall be the official plan; but no survey or resurvey of Dominion lands shall be confirmed unless made in conformity with the provisions of this Act.

3. No land shall be held to be surveyed, or resurveyed, until the official plan of the survey or resurvey has been confirmed by the Surveyor-General.

Description
of plans.

Confirmation
of plans.

When lands
are deemed
surveyed.

4. Where any plan of Dominion lands of record in the Department of the Interior is found to have been improperly or incorrectly plotted from the field notes of the survey, or where any omissions or clerical error or other defect is found in the plan, the Surveyor-General may cause a new plan to be plotted from the field notes of the survey or a new plan to be made showing such omissions or error or defect corrected, and such new plan shall, after confirmation by the Surveyor-General, become the official plan of the survey and shall be used for all purposes instead of the old plan: Provided that nothing in this section shall affect any rights claimed or set up under the old plan prior to the date of the confirmation of the new plan, and that all transactions prior to that date shall remain in force as if the new plan did not exist.

Correction
of plans.

RESURVEYS.

57. Wherever through an error in the survey, a boundary monument is not at the place where it should have been erected, the Minister may order that such monument be removed and that a new monument be erected at the proper place; but no monument defining the boundary of land for which letters patent have issued shall be displaced without the consent in writing of the owner thereof; nor shall a monument defining the boundary of land held as a homestead or under lease, license or agreement of sale be displaced without the consent in writing of the holder thereof, unless the error in the position of the monument is at least five chains, in which event the Minister may, without the consent of the holder, authorize the correction of the error, but the person or persons acquiring through such correction any improvements on the land shall be required to pay the owner of such im-

Resurvey of
land disposed of.

Arbitration
proceedings.

arbitrators, one to be named by each of the parties, and the third by the two so named: Provided, in the latter case, that, if either party refuses or neglects to name an arbitrator within one month after being notified so to do, an arbitrator may be named on his behalf by the agent of Dominion lands of the district.

Award.

2. The award of the single arbitrator or of a majority of the three arbitrators shall be final, and the proceedings upon the arbitration shall be governed by the laws in force in the province in that behalf.

Resurvey on petition.

58. The Minister may order a resurvey on receipt of a petition from owners of lands or from persons holding lands as homesteads or under lease, license or agreement of sale, representing that part or the whole of the monuments of the original survey have disappeared and cannot be found.

Notice.

2. Before commencing any such resurvey, public notice thereof shall be given once a week for a period of four weeks in *The Canada Gazette* and in some newspaper circulating in the neighbourhood of the lands to be resurveyed.

Evidence of original survey.

3. Any person who claims to know the position of one or more of the survey monuments defining the lands to be resurveyed, or to be in possession of information whereby the position of such monument or monuments can be established, may give notice thereof by registered letter addressed to the Minister before the commencement of the resurvey.

Production of evidence.

4. Before reestablishing any monument with respect to which notice has been given, the surveyor shall, by registered letter, request the person who has given such notice to appear before him at a time and place specified and to show the position of the said monument or to produce the evidence in his possession with regard thereto.

Finding of original monument after resurvey.

5. Notwithstanding anything in this Act contained, any monument reestablished under the provisions of this section to replace a lost monument shall define the boundary line which such monument is intended to mark, even though the monument of the original survey be subsequently found or its position be proved by other evidence.

59. Undisposed of Dominion lands may be re-surveyed when necessary. Resurvey of land undisposed of.

60. Any resurvey of lands authorized by the Minister under the provisions of this Act, whether for the purpose of removing a monument wrongly placed through an error in a previous survey and erecting a new monument at the proper place, or for the purpose of reestablishing the lines of a previous survey, shall, when confirmed by the Surveyor-General, become, and it is hereby declared to be, the original survey of the said lands, and upon such confirmation the boundaries established by the previous survey shall cease to have any force or effect, and any confirmed plan or plans plotted from the field notes of the previous survey shall cease to be the official plan or plans of the said lands. Resurvey to have effect of original.

SURVEY OF AUTHORIZED SUBDIVISIONS.

61. When 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 points established in renewal thereof, in accordance with the provisions of this Act relating to lost corners, giving, in either case, the quarter sections involved an equal breadth. Establishing line between sections.

2. In laying out a half section or a quarter section he shall connect the opposite quarter section corners by straight lines, but when the quarter section corner in any of the limits of the section has not been marked by a monument in the original survey, then such corner shall be established by giving to each half section its proportionate share of such limit according to the official plan of the township, and the half sections shall then be laid out by connecting the corner so established to the opposite corner. Laying out half or quarter sections.

3. In laying out other authorized subdivisions he shall give to every such subdivision its proportionate share of the frontage and interior breadth, according to the official plan of the survey, and connect the resulting terminal points by a straight line. Other subdivisions.

Lines in ground to be true limits.

4. The lines or limits so drawn on the ground in the manner above described shall, in the respective cases, be the true lines or limits of such section, half section, quarter section, legal or authorized subdivision, whether they correspond or do not correspond with the area expressed in the respective official plans or letters patent for such lands.

ORIGINAL BOUNDARY LINES.

Boundaries as defined by monuments shall be deemed the true boundaries.

62. All boundary lines of townships, sections or other authorized subdivisions, and of towns or villages, and all boundary lines of blocks, gores or commons, all section lines, and all limits of lots or parcels of land surveyed or resurveyed, as defined by monuments placed at the corners of any such townships, sections or other authorized subdivisions, towns or villages, or of any blocks, gores, commons, lots or parcels of land under the authority of this Act or of the Governor in Council, shall, after confirmation of the survey or resurvey by the Surveyor-General and subject to the provisions herein contained, be the true boundaries of such townships, sections, or other authorized subdivisions, towns or villages, blocks, gores, commons, 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 official plan or in any letters patent, grant or other instrument of or affecting any such township, town, village, section or other authorized subdivision, town, village, block, gore, common, lot or parcel of land.

Every division to comprise the area within its boundaries.

63. Every township, section or other authorized subdivision, town, village, block, gore, common, lot or parcel of land, shall consist of the whole width included between the several monuments placed as aforesaid, at the several corners thereof, and no more or less, notwithstanding any quantity or measure expressed in the official plan, letters patent, grant, or other instrument.

Aliquot part.

64. Any letters patent, grant or instrument purporting to convey any right or interest in any aliquot part of any section, or other authorized

subdivision, block, gore, common, lot or parcel of land, shall be construed to affect such aliquot part of the quantity it contains on the ground, whether such quantity is more or less than that expressed in such letters patent, grant or instrument.

65. In every town or village surveyed or laid out under the provisions of this Act, all allowances for roads, streets, lanes, or commons, laid out in the original survey of such town or village, shall be public highways; and boundary lines defined by monuments placed or planted in the original survey or resurvey of such town or village, to designate or define any allowance for a road, street, lane, lot or common, shall be the true 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, as far as such rules and regulations are applicable.

Road allowances in towns and villages to be public highways.

REESTABLISHMENT OF LOST CORNERS.

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

When original monument is lost.

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

If a township corner.

(b) If the lost monument is on one of the outlines of a township, or on one of the interior meridian section lines of a township, he shall connect by a straight line the nearest section or quarter section corners found on such outline or

If on the outlines or interior meridians.

dm

such interior meridian section line, and divide such straight line into such number of quarter sections as it contained in the original survey, giving to each a breadth proportional to the breadth shown on the official plan of the township;

copy
If on the outline, and other monuments are lost.

(c) If the lost monument is on the outline of a township and all the monuments between it and the corner of the township, together with the monument defining the said corner, are also lost, the township corner shall be reestablished, as provided in paragraph (a), previously to reestablishing the outline of the township;

If in the interior.

(d) When the lost corner is that of a quarter section on a section line running east and west in the interior of a township, the surveyor shall connect by a straight line the opposite section corners on the meridian boundaries of the section and give to each quarter section a breadth proportional to the breadth shown on the official plan of the township;

If on meridian boundary.

(e) When a corner on either of the meridian boundaries of the section is also lost, such meridian shall be reestablished previously to reestablishing the east and west line.

Road allowance to be taken into account.

2. Whenever a surveyor places a monument, as aforesaid, to reestablish a lost corner, he shall duly take into account any allowance for a road or roads; and the corner, or division or limit so established, shall be the true corner, or division or limit of such township, section or quarter section.

Exception.

3. Notwithstanding anything in this section provided, resurveys of Dominion lands may be made, on the order of the Minister, in such manner, not inconsistent with the other provisions of this Act, as he may direct.

Transmission of plans to local registrar.

67. The Minister shall cause to be transmitted to the registrar of every registration district or division or land titles district in the provinces of Manitoba, Saskatchewan, Alberta and British Columbia, and in the Northwest Territories and in the Yukon Territory, as soon as possible after the confirmation thereof, to be lodged or filed with him, a copy of the official plan of the survey or resurvey of each township, settlement, town or village site,

lot, plot or other survey or resurvey made under the authority of this Act, and of each plan amended or corrected under the authority of this Act, of Dominion lands in such registration district, or division or land titles district.

EVIDENCE.

68. Copies of any records, documents, plans, books or papers, belonging to or deposited in the Surveyor-General's office, attested under the signature of the Minister, or of the Surveyor-General, or of any chief clerk or officer authorized thereto, shall be competent evidence in all cases in which the original records, documents, books, plans or papers would be evidence. Copies as evidence.

69. Lithographed or other copies of maps or plans purporting to be issued or published by the Department of the Interior, and to have a lithographed or copied signature of the Minister of the Interior or of the Surveyor-General thereto attached, shall be received in all courts and proceedings as *prima facie* evidence of the original and of the contents thereof. Plans as evidence.

70. All affidavits, oaths, solemn declarations or affirmations required to be taken or made under this Act, except as herein otherwise provided, may be taken before the judge or clerk of any county or circuit court, or any justice of the peace, or any commissioner for taking affidavits, or any notary public, or any Dominion land surveyor, or any person specially authorized to take such affidavits by this Act or by the Minister. Before whom affidavits, etc., may be made.

71. The Minister may require any statement in relation to any land to which any Act relating to Dominion lands applies to be verified by oath, affirmation, declaration or affidavit. Minister may require sworn statement as to lands.

GENERAL.

72. The Minister, with the approval of the Governor in Council, may, whenever he deems it necessary so to do, vary any of the forms in the schedule to this Act, or to any Act amending it, or he may from time to time, with the like approval, Forms in schedule may be varied by Minister.

cause to be adopted such other forms to the like effect or such new forms as he considers applicable to or necessary in or for the purposes of any special case or class of cases.

OFFENCES AND PENALTIES.

Molesting a surveyor.

73. 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 an indictable offence, and liable on conviction thereof, either summarily or upon indictment, 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.

Destroying marks of original survey.

74. Every person who, knowingly and wilfully, pulls down, defaces, alters, or removes any monument erected, planted or placed in any original survey or resurvey, is guilty of an indictable offence, and shall be liable on conviction thereof, either summary or upon indictment, to imprisonment for any term not exceeding seven years.

Destroying other marks.

2. Every person who, knowingly and wilfully, defaces, alters or removes any other 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 is guilty of an indictable offence, and liable on conviction thereof either summary or upon indictment, 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.

Unlawful possession of monuments.

3. Every person who, not being a Dominion land surveyor, knowingly and wilfully has in his possession and custody, not for any lawful purpose in connection with a survey of Dominion lands, any such 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 indictable offence and is liable on summary conviction or upon indictment to imprisonment for a term not exceeding six months, or to a penalty not exceeding one hundred dollars, or to both, in the discretion of the court.

75. Nothing in this Act shall be held to prevent Dominion land surveyors, in their operations, from displacing any monuments or other boundary marks when necessary, after which they shall carefully replace them as they were before; or from removing a monument and erecting a new one when making a resurvey under the authority of this Act. Surveyors' privilege as to displacing monuments.

76. Sections 16 to 80 inclusive, 206, 212, and 221 to 224 inclusive, of *The Dominion Lands Act*, chapter 55 of the Revised Statutes, 1906, are repealed. Repeal.

SCHEDULE.

FORM A.

(Section 10.)

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 admission as articled pupils, for commissions as Dominion land surveyors or for certificates as Dominion topographical surveyors, according to law, without favour, affection or partiality.

Subscribed and sworn to
before me at , this
 day of ,
19 , }

FORM B.

(Section 16.)

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,
witnesseth as follows:—

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 date hereof, for and during and until the full end and term of three years from thence 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 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 to 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 profes-

sion, without fraud or delay, when and so often as he shall thereto be required; and shall readily obey and execute the lawful and reasonable commands of the said A. B., 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 each of them the said C. D. and E. F., 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 *The Dominion Lands Surveys 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 practise; that he 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.; that at the expiration of the said term, he will make the affidavit of service required; and that he will use his best means and endeavour, at the request, cost and charges of the said C. D. and E. F., or either of them, to cause and procure him,

first part to serve him from the date thereof for and during and until the full end and term of years from thence next ensuing and fully to be completed and ended subject to the several covenants therein contained;

And whereas the said party hereto of the third part hath served the said party hereto of the first part from the date of the said articles of clerkship to the date of these presents;

And whereas it has been agreed that the said party hereto of the first part shall assign to the said party hereto of the second part all benefit and advantage of him the said party hereto of the first part under or by virtue of the said articles of clerkship for all the residue now to come and unexpired of the said term of years; and it has been further agreed that the said party hereto of the third part shall put, place and bind himself as pupil to the said party hereto of the second part from the date of these presents for the remainder of the said term:

Now this indenture witnesseth that in pursuance of the said agreement, he, the said party hereto of the first part, at the request and with the consent of the said parties hereto of the third and fourth parts, testified by their being parties to these presents, hath assigned, transferred and set over and by these presents doth assign, transfer and set over unto the said party of the second part all benefit and advantage, interest, claim and demand whatsoever of him the said party hereto of the first part under the hereinbefore in part recited articles of clerkship and the service of him the said party hereto of the third part under or by virtue of the same; to have and to hold all right and interest whatsoever of him the said party hereto of the first part in and to the service of the said party hereto of the third part under or by virtue of the same, unto the said party hereto of the second part, his executors, administrators and assigns.

And this indenture further witnesseth that the said party hereto of the third part of his own free will testified as aforesaid (and with the consent and approbation of the said , the said party hereto of the fourth part, testified by his ex-

ecution of these presents) hath put, placed and bound himself, the said party hereto of the third part, and by these presents doth put, place and bind himself pupil to the said party hereto of the second part to serve him from the date of these presents for and during the remainder of the said term of year , and fully to be completed and ended, and for such further period, if any, as may be necessary to complete the full term of year under articles in accordance with the provisions of the statutes in that behalf.

And the said party hereto of the third part and the said party hereto of the fourth part do hereby, respectively, covenant with the said party hereto of the second part, his executors, administrators and assigns, that he, the said party hereto of the third part shall and will well, faithfully and diligently serve the said party hereto of the second part as his pupil in the practice and profession of a Dominion land surveyor from the date hereof during the remainder of the said term of year , according to the terms and conditions of the said hereinbefore in part recited articles of clerkship.

In consideration whereof the said party hereto of the second part, for himself, his heirs, executors and administrators, doth hereby covenant with each of them the said parties hereto of the first, third and fourth part, their executors, administrators and assigns that he, the said party hereto of the second part, will accept and take the said party hereto of the third part as his pupil, and also that he the said party hereto of the second part will observe and be bound by the terms and conditions of the said hereinbefore in part recited articles of clerkship, in so far as the same were binding on him, the said party hereto of the first part.

In witness whereof the said parties have hereunto set their hands and seals.

A.B. (Seal.)

C.D. (Seal.)

E.F. (Seal.)

G.H. (Seal.)

Signed, sealed and delivered }
in presence of }
Witnesses.

FORM F.

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 perform the duties of a 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 commissioned to practise as a surveyor of Dominion lands, under the provisions of *The Dominion Lands Surveys Act*.

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 _____

Surveyor-General, President of Board.

Secretary.

FORM G.

SURVEYOR'S OATH.

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.

Subscribed and sworn to }
before me at _____, }
this _____ day of _____, }
19 }

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 reestablished 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.

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 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 grades keep the time for weeks with sufficient accuracy for subdivision purposes; the 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.

STAR OBSERVATIONS IN DAYLIGHT.

In the western provinces and the Northwest 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 eyepiece is first focussed upon the diaphragm. 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 eyepiece is inconvenient and it is necessary to use the long diagonal eyepiece. A mark must therefore be made with a sharp knife on this eyepiece for placing it in focus.

To discover a star in the field in daytime 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 min-

ute 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° , 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° . 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

EXAMPLE No. 1

ASTRONOMICAL OBSERVATION.

Date *January, 19, 1909, 8.45 A.M. Mountain Time*Place *N. E. corner sec. 18, Tp. 27, R. 20, 2d, 3 Mer.*Reference line *East boundary of sec. 18*

Face.	H.C.R. on Reference line	H.C.R. on Polaris	Watch Time.
1 Right	<i>180° 05'</i>	<i>1° 21.9</i>	<i>16^h 22^m 57^s</i>
2 Left	<i>180 03</i>	<i>1 23.0</i>	<i>16 25 07</i>
Mean	<i>180 04</i>	<i>1 22.45</i>	<i>16 24 02</i>
3 Watch correction			<i>- 42</i>
Sidereal time			<i>16 23 20</i>
4 Tabular bearing for <i>16 h. 20 m. & Tp. 20</i>			<i>1° 15.5</i>
5 Difference for <i>3 m. 20 s.</i>			<i>+ 1.1</i>
6 Difference for <i>7 townships</i>			<i>+ 1.0</i>
7 Convergence for <i>2 sections</i>			<i>+ 2.2</i>
8 Bearing of Polaris			<i>1 19.8</i>
9 H.C.R. on Polaris			<i>1 22.45</i>
10 Correction to H.C.R.			<i>- 2.65</i>
11 H.C.R. on Reference line			<i>180 04</i>
12 Bearing of Reference line			<i>180 01.35</i>

NOTE.—The Reference line must be a section line or a line between two stations of a lake or river traverse.

the star is brought under the vertical thread or point by means of the lower slow motion screw. Setting now the vernier at 360° , 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. Explanatory Notes.

(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 observation 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 $1' \cdot 11$ per section. The point of observation being two sections away from the central meridian, the convergence is $2' \cdot 22$, say $2' \cdot 2$.

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 $180^\circ 05'$ 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.—Explanatory Notes.

(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

EXAMPLE No. 2
ASTRONOMICAL OBSERVATION.

Date *March 1, 1909 5.10 P.M. Mountain Time*Place *N. E. Corner Sec 24, Tp 35, R. 13, W 3 Mer.*Reference line *North boundary of section 24*

Face.	H.C.R. on Reference line	H.C.R. on Polaris.	Watch Time.
1 Right	<i>269° 56'</i>	<i>358° 49.5</i>	<i>3^h 34^m 35^s</i>
2 Left	<i>269 57</i>	<i>358 51.5</i>	<i>3 37 25</i>
Mean	<i>269 56.5</i>	<i>358 50.5</i>	<i>3 36 0</i>
3 Watch correction			<i>+ 39</i>
Sidereal time			<i>3 36 39</i>
4 Tabular bearing for <i>3 h. 30 m. & Tp. 20</i>			<i>359° 01.3</i>
5 Difference for <i>6 m. 39 s.</i>			<i>- 2.8</i>
6 Difference for <i>15 townships</i>			<i>- 1.8</i>
7 Convergence for <i>3 sections</i>			<i>- 3.4</i>
8 Bearing of Polaris			<i>358 53.3</i>
9 H.C.R. on Polaris			<i>358 50.5</i>
10 Correction to H.C.R.			<i>+ 2.8</i>
11 H.C.R. on Reference line			<i>269 56.5</i>
12 Bearing of Reference line			<i>269 59.3</i>

NOTE.—The Reference line must be a section line or a line between two stations of a lake or river traverse.

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 sub-

tracted 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 eyepiece, the star enters the field on the left: with the prismatic or an inverting eyepiece, 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, $61^\circ 45'$, gives for the altitude $66^\circ 15'$, at which the telescope is set.

In example No. 4, the latitude of the place is $51^\circ 21'$ and its supplement $128^\circ 39'$; subtracting the polar distance of Regulus, $77^\circ 34'$, gives for the altitude $51^\circ 05'$. 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.. | $7^h 38^m 31^s$ |
| (2) Sidereal time " " " .. | $7^h 39^m 30^s$ |
| (3) Watch correction (slow) | + 39^s |

(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 | $10^h 03^m 59^s$ |
| (2) Sidereal time " " " .. | $10^h 03^m 18^s$ |
| (3) Watch correction (fast) | — 41^s |

(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 meri-

dian, 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 ^h 49 ^m 12.8 ^s
(2) " second limb	23 ^h 51 ^m 20.8 ^s
Mean	23 ^h 50 ^m 16.8 ^s
(3) Sun's R.A. at App. Noon, Green.	23 ^h 49 ^m 51.3 ^s
(4) Var. in 6 ^h .98 = 9 ^s . 1 × 6.98	1 ^m 03.5 ^s
(5) Sun's R.A. at observation	23 ^h 50 ^m . 54.8 ^s
(6) Watch correction (slow)	+ 38 ^s

(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^h.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^h.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 ^h 58 ^m 27 ^s
(2) " second limb	14 ^h 00 ^m 39 ^s
Mean	13 ^h 59 ^m 33 ^s
(3) Sun's R.A. at App. Noon, Green.	13 ^h 57 ^m 54 ^s
(4) Var. in 7 ^h .75 = 9 ^s .56 × 7.75	1 ^m 14 ^s
(5) Sun's Right Ascension at observation	13 ^h 59 ^m 08 ^s
(6) Watch correction (fast)	— 25 ^s

(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^h.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^h.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.

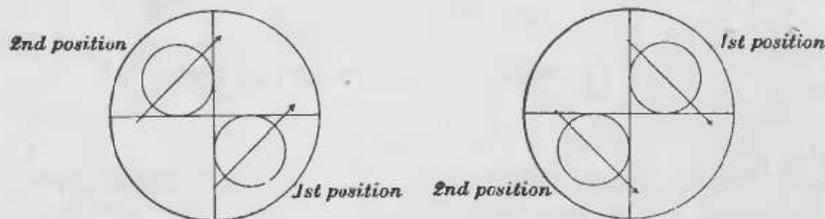


Fig. 39. Observation of the sun in the forenoon with an erecting eyepiece.

Fig. 40. Observation of the sun in the afternoon with an erecting eyepiece.

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 eyepiece. 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 eyepiece is not suitable for observing the sun; a diagonal eyepiece 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 eyepiece.

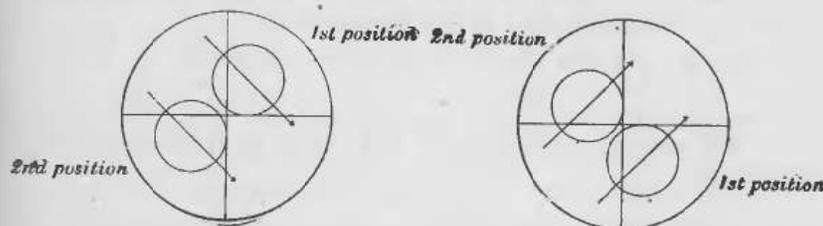


Fig. 41. Observation of the sun in the forenoon with a long diagonal eyepiece.

Fig. 42. Observation of the sun in the afternoon with a long diagonal eyepiece.

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 the 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:—

$$\cos \frac{Z}{2} = \sqrt{\cos S \cos (S - P) \sec L \sec h}$$

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 Z the azimuth of the sun. Reckoning the bearing from 0° to 360° from the north point through east, south and west, Z is the bearing in the forenoon and 360° minus the bearing in the afternoon.

The latitude and its secant are given in Table X. for the north side of every section.

On page 167 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° 26'	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° 39' 31"		sec. h = 0° 00' 294	
Local time = November 21	3h. 18m.	L = 49 20 58	sec. L = 0° 18' 612	cos. S = 9° 08' 168	cos. (S - P) = 9° 94' 966
Longitude	+7 12	P = 110 07 17	2S = 166 07 46	cos. $\frac{Z}{2}$ = 19° 22' 00	
Greenwich time = November 21	10 30	S = 83 03 53	S - P = 27° 03 24	cos. $\frac{Z}{2}$ = 9° 01' 030	
<i>Correction of Altitude.</i>		<i>Sun's Polar Distance.</i>		$\frac{Z}{2} = 65^\circ 56' 30''$	
Obs. altitude = 6° 47' 00"	Decl. at 0h. = 20° 01' 36"S			Z = 131 53 00	
Refraction = -7 38	Var. for 10h. 30m. = +5 42			Bearing = 228 07 00	
Difference = 6 39 22	Decl. at 10h. 30m. = 20 07 17			Convergence, $2\frac{5}{8} \frac{2}{8}$ sec. (§ 68 & 69) = +2 40	
Parallax = +9	P = 110 07 17			Bearing referred to central mer. = 228 09 40	
h = 6 39 31				H. C. R. on sun = 228 09 00	
				Correction = + 40	
				H. C. R. on line = 90 01 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° 10' 28"		sec. h = 0° 06' 324	
Local time = June 14	19h. 20m.	L = 51 26 45	sec. L = 0° 20' 633	cos. S = 9° 43' 64	cos. (S - P) = 9° 99' 629
Longitude	+6 57	P = 66 39 30	2S = 148 16 43	cos. $\frac{Z}{2}$ = 19° 70' 150	
Greenwich time = June 15	2 17	S = 74 08 21	S - P = 7 28 51	cos. $\frac{Z}{2}$ = 9,85' 075	
<i>Correction of Altitude.</i>		<i>Sun's Polar Distance.</i>		$\frac{Z}{2} = 44^\circ 50' 00''$	
Obs. altitude = 30° 12' 00"	Decl. at 0h. = 23° 20' 16"N.			Z or Bearing = 89 40 00	
Refraction = -1 40	Var. for 2h. 17m. = + 14			Convergence, $2\frac{5}{8} \frac{2}{8}$ sec. (§ 68 & 69) = -3 00	
Diff. 30 10 20	Decl. at 2h. 17m. = 23 20 30			Bearing referred to central mer. = 89 37 00	
Parallax = +8	P = 66 39 30			H. C. R. on sun = 176 17 60	
h = 30 10 28				Correction = -86 40 00	
				H. C. R. on line = 176 39 30	
				Bearing of line = 89 59 30	

APPENDIX C.

THE DETERMINATION OF THE MAGNETIC MERIDIAN.

Although the compass is not allowed for establishing lines of Dominion Lands Surveys, it is employed for other purposes and a knowledge of the direction of the magnetic meridian or of the magnetic declination is useful. For the determination of this direction, transit theodolites of the D.L.S. pattern are fitted with especially sensitive needles. As the observation can be made in a few minutes and with very little trouble, it is desired that all surveyors should observe when they can do so without inconvenience.

The observation and recording form are arranged for the determination of the bearing of the magnetic needle instead of the magnetic declination. The arrangement is made for the sake of simplicity in observing and recording, the bearing in question being, subject to instrumental corrections, the angle read on the horizontal circle of the transit. Moreover, it is not liable to errors of sign, as in adding or subtracting the declination.

DIRECTIONS FOR OBSERVING.

1. Place the instrument on a section line, and after adjustment, set the vernier to read the astronomical bearing of the line.
2. Release the lower clamp, direct the telescope on the line, and fasten the lower clamp.
3. Release the vernier clamp, and turn the vernier plate until the north end of the magnetic needle observed with a magnifying glass, is seen exactly opposite the zero mark. Tap the trough *lightly with the pencil* to be sure that the needle has taken the position of rest. Note the reading of the horizontal circle. Take several readings by repeating the operation.
4. Repeat operation No. 3 for the south end of the needle.
5. Enter in the notes the place of observation, date, hour of the day, weather and other remarks, if any. *It is important to record auroras occurring within 24 hours of the time of observation.*

REMARKS ON OBSERVATIONS.

For saving trouble and calculations, it is suggested that observations be made on section lines; they may, however, be made on any lines of which the bearing is known.

The direction of the magnetic needle is subject to a daily fluctuation called the diurnal variation. During the greater part of the night the direction is not far from normal. In the early morning, the north end of the needle in Canada moves towards the east, reaching its maximum deflection about 7 or 8 A.M. The motion is now reversed, the north end travelling westwards, and crossing the normal direction about 10 or 11 A.M. The extreme western position is reached in the afternoon and then the needle comes back to its normal position at some time after 5 or 6 P.M. This march is subject to wide variations during magnetic storms. The magnitude of the diurnal variation is not constant. In the inhabited parts of Canada, it may exceed 20 minutes. Observations at both eastern and western elongations of the needle on the same day, that is, between 7 and 8 A.M. and between 1 and 2 P.M., give the best results, and it is desirable that when convenient they may be taken then. This gives not only the best value for the declination, but also the diurnal variation which it is most useful to know. Failing this, however, the best time to observe is after 5 P.M., when the needle is about in its normal position. It is true that the normal position is crossed generally between 10 and 11 A.M., but the motion being very rapid and the time of crossing uncertain, the afternoon observation is preferable.

When an instrument is brought from England, it is usually found that the north end of the needle is dropping. To balance it without injuring the pivot point or cap, proceed as follows:

Raise the needle with the lifter, unscrew the end of the trough, withdraw the cover glass, take out the needle and shift the small brass counterweight. Then the lifter being still raised, place the needle upon it and lower the lifter gently. If the needle is not yet balanced, raise the lifter again and repeat the operation. The greatest care must be taken not to bend the needle in the slightest degree while shifting the counterweight, because the bending would change the direction of the magnetic axis.

If the needle is sluggish, the observation cannot be accurate. The sluggishness is generally due to a dull pivot or a

scratched cap. To keep both in proper condition, *the needle must always be lowered gently on its pivot and never be allowed to play, except when actually in use.*

There are instances of the polarity of the needle being reversed by transporting an instrument on an electric car. It is difficult to conceive that a needle may be brought into such an intense magnetic field as an electric car's without its magnetism being affected in some way, therefore, it is preferable to avoid this mode of transportation.

The place of observation must be at least three or four hundred yards away from wires carrying direct electric current. There must be no iron near the instrument. The observer must scrutinize his clothing and make sure that he has no iron or nickel on his person. Iron is found in buttons, as wire in hat brims, in some forms of neckties, in watches, chains and other articles of jewellery. The pivot in folding reading glasses is frequently made of iron. In case of doubt, the object may be tried close to the compass, measuring the distance at which an appreciable deflection is first produced. If the object during the observation for declination is not brought closer than 15 or twenty times the above distance, the effect on the needle is negligible in observations of this kind.

The needle may be deflected by static electricity developed in cleaning the glass cover of the compass trough or the rubber frame of the reading glass: this electricity is dissipated by breathing on the glass or rubber frame.

There is an index correction for each instrument. This is ascertained by comparison with a standard unifilar magnetometer at the Magnetic Observatory. When possible, it is well to determine the index error both at the beginning and at the end of a survey.

EXPLANATION OF SPECIMEN OBSERVATION.

(a) H.C.R. of compass north.

This is the average of the mean north and south end readings. The transit was adjusted to read correctly the bearing of the section line, so that the horizontal circle reading of compass north is the bearing of compass north referred to the astronomical meridian through the centre of the township. If the transit had not been so adjusted a correction to this reading would have been required.

(b) Correction for convergence.

The correction for convergence has for object to refer the bearing read on the horizontal circle to the astronomical meridian of the point of observation. The value of the correction is taken from the diagram in the Astronomical Field Tables. It is added when the point of observation is in the east half of the township, and subtracted in the other half. The rule of clause 69 of the Manual is inverted, the object in this case being to refer the bearing to the meridian of the point of observation.

(c) Bearing of compass north.

The bearing has now been referred to the meridian of the point of observation.

(d) Index error.

The index error is furnished with each instrument after comparison with the unifilar magnetometer.

(e) Bearing of magnetic north.

The bearing of magnetic north is the angle formed by the astronomical and magnetic meridians.

SETTING A TRANSIT BY MEANS OF THE COMPASS.

In connection with surveys of Dominion Lands, the most frequent use of the compass is for checking the courses of a traverse or for setting up the transit to read astronomical bearings.

In the first case, it is sufficient to make sure that there is no abnormal change in the reading of compass north: any sudden change indicates a probable mistake in some of the last courses.

The second case arises when it is desired to observe the pole star in day time at a place where there is no line of known bearing. The problem consists in setting up the transit so that it shall read astronomical bearings. If the surveyor has already ascertained the bearing of compass north with his instrument, he merely sets his vernier to read this bearing, releases the lower clamp, turns the whole instrument till the needle is exactly opposite the zero mark, fastens the lower clamp and releases the vernier clamp. With the instrument used for the specimen observation (Watts 2216) and anywhere near the place where the observation was taken, the vernier would be set to read $25^{\circ} 06' .9$, or rather $25^{\circ} 07'$.

It may be, however, that the surveyor has not ascertained the bearing of compass north with his own instrument and has to resort to the bearing of magnetic north taken from a

map or determined by another surveyor. Then the surveyor must, from the bearing of magnetic north, deduce the bearing of compass north by applying the index error of his own instrument after changing the sign. Starting with $25^{\circ} 01' .1$ for bearing of magnetic north in the case already cited, and the index error being $-5' .8$, the surveyor would add $5' .8$ to $25^{\circ} 01' .1$, which would give him $25^{\circ} 06' .9$ for the bearing of the compass north. He would then proceed as already explained.

All these corrections, it may be observed, are generally small and in practice are frequently disregarded.

OBSERVATION FOR MAGNETIC DECLINATION

Date *19th July 1908* Observer *G. J. Loneragan D.L.S.*
 Place *A0* Chs. *E* of the *S.E.* Cor. of Sec. *5*
 Tp. *50* Rge. *20* W. of *4th* Mer.
 Time *7¹⁵ P.M.* Instrument *Watts #2216* (Give No.)
 Bearing of reference line *89° - 59'*

H. C. R. FOR DIRECTION OF MAGNETIC NEEDLE.

NORTH END.		SOUTH END.	
(1)	<i>27 - 15'</i>		<i>27° - 17'</i>
(2)	<i>11</i>		<i>16</i>
(3)	<i>12</i>		<i>10</i>
(4)	<i>11</i>		<i>10</i>
(5)	<i>10</i>		<i>12</i>
Mean of North End. <i>27 - 11.8</i>		Mean of South End. <i>27° - 13.0</i>	
(a) H. C. R. of compass north		<i>27 - 12.4</i>	
(b) Corr. for convergence		<i>1.2</i>	
(c) Bearing of compass north		<i>27 - 11.2</i>	
(d) Index error		<i>5.8</i>	
(e) Bearing of magnetic north		<i>27 - 05.4</i>	

REMARKS.

A few clouds Windy
No aurora.

APPENDIX D.

INSTRUMENTS.

The instruments most generally used by Dominion Land Surveyors are kept in stock at the head office. Some of these instruments are of a special type developed as the result of years of experience to meet the special requirements of Dominion Land Surveys.

TRANSIT THEODOLITE FOR BLOCK SURVEYS.

The instrument for block surveys is a six-inch reiterating transit theodolite. The horizontal circle is graduated to five minutes and read by two microscopes to five seconds. A four-inch vertical circle read to minutes by a vernier, serves as a finder for stars in daytime and for measuring angles of elevation or depression.

The telescope has an object-glass of one and seven-eighths inch aperture and fourteen-inch focus. It has an eyepiece micrometer, the drum of which is divided into one hundred parts, each representing one and one-half seconds. The diaphragm and micrometer can be revolved around the axis of the telescope so as to place the movable thread either horizontal or vertical. A small magnetic needle attached to the instrument serves to place it approximately in position. Precise level bubbles, electric lamps and special attachments are provided for astronomical observations.

The tripod is of the shifting head pattern for adjusting the instrument accurately over the station. Advantage can be taken of this feature for eliminating the effect of periodic errors of graduation in measuring angles, the instrument being shifted in azimuth so as to use different parts of the graduated circle.

This instrument was designed for the production of lines, the measure of horizontal angles and the determination of latitudes and azimuths, which are the measures to be made by block surveyors. These measures are effected with great precision and convenience with this type of instrument.

TRANSIT THEODOLITE FOR SUBDIVISION SURVEYS.

The instrument for subdivision surveys is a repeating four-inch transit theodolite, now listed by several firms as "D.L.S." or "Canadian" pattern.

The horizontal and vertical circles are four inches in diameter and are read to minutes by verniers.

The telescope has a clear aperture of one and one-half inches and a focal length of ten inches. Four eyepieces are supplied: two ordinary inverting, one prismatic and one long diagonal. The diaphragm has platinum iridium points. 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 permanent index of sufficient stability to last in perfect adjustment as long as the instrument lasts in wear. There are five points altogether, two of them being for stadia measurements. A spare diaphragm ruled on glass is supplied; it has the disadvantage in star observations of absorbing considerable light.

A trough compass is attached to the standards of the instrument; the needle is very sensitive and it can be adjusted with great precision. It serves for placing the instrument approximately in position for star observations in daylight, for checking the orientation in traverses and for the determination of the magnetic meridian.

A mahogany framed tripod is the regular equipment. Sliding tripods or other patterns can be supplied but they are not recommended.

The instrument fits in a leather covered case with shoulder straps, the outside dimensions being $18\frac{1}{2} \times 7\frac{1}{4} \times 6\frac{3}{8}$ inches. The weight of the case with the instrument inside is $18\frac{1}{2}$ lbs. The tripod weighs $8\frac{1}{2}$ lbs.

SIDEREAL WATCH FOR SUBDIVISION SURVEYS.

The sidereal watch is an 18 size 19 jewel movement in an open face nickel case. The dial is divided into twenty-four hours. The movement is adjusted to the following specifications:

Deviation from mean daily rate not to exceed two seconds. Mean rate: pendant up to differ less than five seconds from rate dial up, and from the other positions by less than ten

seconds. Temperature rate not to exceed 0.3 seconds per degree fahrenheit.

Although the watches are adjusted to these specifications at the factory, there may be slight changes by the time they reach the surveyors, but their accuracy is ample for subdivision surveys.

No timepiece 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. A watch must be cleaned and oiled every second year. 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 entrusted. When any repairs are required, it is best to have them made through the head office.

ANEROID BAROMETER.

Two kinds of aneroids are kept in stock. One is a pocket aneroid, two and a half inches in diameter, in a soft leather case, very portable; the other one is a regular surveying aneroid, three inches in diameter, in a hard leather case. They are graduated to 6,000 or 12,000 feet; the divisions in those graduated to 6,000 feet are naturally larger than in those graduated to 12,000 feet and the readings more accurate.

In requiring Dominion Land Surveyors to use aneroids, the object is to ascertain approximate elevations on the survey lines. If the index error is known, a fair idea of the elevations above sea-level may generally be obtained by comparison with the daily isobar maps of the Meteorological Service. As the instrument is very delicate and a slight jar is sufficient to alter the index error, no opportunity should be neglected of obtaining this error as frequently as possible, either by comparison with a standard barometer at any of the meteoro-

logical stations or by recording the aneroid reading, date and time of day, at all places of known elevation, such as railway stations. With these data, the index error can be calculated at the head office. A change in index error can often be deduced from readings recorded at one place on different dates, even when the altitude of the place is unknown.

The aneroid is at best an unsatisfactory instrument. The surveying pattern, although a little cumbersome, is recommended. It is a good plan to have one of each kind, the smaller one serving as a check against disturbances of the index error of the larger one.

STEEL TAPES.

The tapes kept in stock are flat wire tapes, four, five and eight chains in length, and quarter inch steel bands five chains in length. The wire tapes are one-eighth of an inch wide and very strong; they are divided into chains, the first and last fifty links being divided into links. The graduation marks are on brass sleeves. The quarter inch steel band is divided into links, the graduations being etched.

Steel tapes are very liable to break; this fact cannot be impressed too strongly upon the chainmen. In case an accident should happen, the surveyor ought to be provided with means of repair. Fairly good repairs can be made in the field with brass sleeves prepared with everything necessary for soldering. The broken ends of the tape are cleaned and inserted into the sleeve and a lighted match is held under it until the solder is melted, when the repair is completed. The central hole in the sleeve is to enable the user to see when the broken ends are in contact and the other two holes are to indicate when the soldering material is melted, which takes place either when it bubbles in or runs away from these holes.

Prepared sleeves for flat wire tapes and for quarter inch tapes are kept in stock.

STADIA RODS.

The stadia rods kept in stock are fourteen feet long and three and a quarter inches wide. They fold in the middle. They are graduated in links and tenths. There are no figures on the rod, the colour scheme being so arranged that they are unnecessary. A folding circular level is attached to the back of the rod for holding it vertical.

Attention is called to the fact that the stadia points of the transit theodolite and the stadia lines of the glass diaphragm having no means of adjustment, the stadia can only be used in connection with a table of corrections. This table is obtained by chaining a base on level ground and measuring with the stadia the distance of a number of points on the base; the difference between the two measurements gives the correction for each distance. The table is completed by interpolation. The measurement must be made when the air is quite steady and the conditions favourable.

CLINOMETER.

The clinometer usually kept in stock is of the pattern known as Abney Level. The angle of elevation or depression is read with a vernier and magnifying glass.

PACKING AND TRANSPORTATION.

Instruments must not be shipped without being packed in outside boxes. If shipped otherwise there is great risk that they will be injured in transit, and, moreover, the express companies charge three rates.

Aneroids and watches do not stand well transportation by mail or express; if this cannot be avoided, the packing should be such as to minimize the evil effects of rough handling.

APPENDIX E.

FORM OF AGREEMENT FOR LABOURERS AND COOK.

ARTICLES OF AGREEMENT made and entered into at *the city of Hamilton*, in the *province of Ontario*, this *sixteenth* day of *March*, A.D. 1909, between *John Brown*, of the *city of Hamilton*, Dominion Land Surveyor, hereinafter called the employer, and *William Smith*, labourer, of the *same city*, hereinafter called the employee.

Witness that the employee hereby agrees to enter into the service and employment of the employer and to faithfully and diligently serve him and his assistant or assistants, or any person under whose charge the 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 upon which the party shall organize at *the city of Calgary*, in connection with the surveys to be performed in *the province of Alberta*, or such shorter period as shall prove sufficient for 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 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 service; and also not to leave the service of the employer or enter into the service or employment of any other person during such period without the written consent of the employer.

And the employer in consideration of such service agrees to pay to the employee the wages of *ninety cents* per day for the first *three months* of such service, and *one dollar and five cents* per day thereafter, and to board him so long as the employee continues to serve under this agreement.

And if the employee shall complete such period of service hereunder, or if he shall sooner quit such service with the consent in writing of employer, and if he shall have conducted himself honestly, faithfully and properly in the course of such service and shall have otherwise in all respects observed the provisions of this agreement the employer agrees to pay him a bonus, sufficient together with the wages already agreed

upon, to make up the wages at the rate of *forty dollars* per month from the date upon which the employee reports for duty at the city of Calgary until the completion of such service.

Provided that if the employee shall be guilty of any misconduct in his service or shall commit any breach of this agreement, he may at any time be discharged by the employer, and in such case shall forfeit all wages which may then be due him, and also the said bonus without prejudice to the employer's other remedies.

In Witness whereof the parties hereto have hereunto set their hands the day and year first above written.

Signed in the presence of }
Robert Jones. }

John Brown,
William Smith.

APPENDIX F.

RATION LIST.

Figures for 100 rations or subsistence for one man for 100 days.

Articles.	Alaskan Parties U. S. Geological Survey.	National Transcontinental Railway.	Canadian Militia.	C. P. R. Land Department.	Canadian Pacific Railway.	Grand Trunk Pacific Railway.
	(1)	(2)		(5)	(6)	(7)
Allspice..... lbs.	0.10	0.10			0.12	0.07
Apples, evap..... "		5.80		16.60	11.00	8.33
Apricots, evap..... "		4.16			5.95	
Bacon..... "	71.60	50.00	12.50	66.70	23.80	41.66
Bacon, Long Clear..... "						27.77
Baking Powder..... "	2.90	0.83		3.30	2.38	2.77
Barley..... "		1.66			2.38	(8)
Beans..... "	14.30	26.60	12.50	16.66	11.90	27.77
Beef, corned..... "		26.60				20.83
Beef, extract..... "		1.66				
Beef, dried..... "	2.70				5.95	(8)
Beef Tea Capsules..... "	0.20					
Biscuits..... "		20.00	(3)			
Bread..... "			100.00			
Butter..... "	14.00	15.80	12.50	20.80	14.28	16.66
Cabbage..... "						(8)
Candles..... "		6.66		3.33		
Celery Salt..... "	0.04					
Cereal..... "	17.90					
Cheese..... "		6.80	6.25	9.15	5.95	5.55
Cherries, canned..... "					9.60	
Chocolate..... "	1.80					
Cinnamon..... "	0.04				0.12	0.14
Coal Oil..... gal.					1.10	
Coffee..... lbs.	5.40	3.33	2.08	5.00	9.52	5.55
Codfish..... "		5.00			5.95	0.69
Corn, canned..... "		2.60			19.20	(8)
Corn Meal..... "		5.00		10.00	7.14	8.33
Corn Starch..... "		3.33			2.38	(8)
Cream, condensed..... "		5.83				
Currants..... "		3.33			2.38	2.77
Curry..... "	0.04					
Eggs, crystallized..... "	3.00					
Fish, dried..... "						8.33
Flour, wheat..... "	100.00	125.00		133.20	95.24	166.00
Flour, Buckwheat..... "					11.90	13.88
Fruit, evap..... "	22.30					
Ginger..... "	0.04	0.08			0.12	0.27
Ginger, essence..... "		0.08				
Ham..... "		33.30		28.30	23.80	
Hops..... "		0.20				
Jam..... "		5.00	12.50			(8)
Lard..... "		6.60			9.52	8.33
Lemon Extract..... "		0.08		0.31	0.21	0.13
Lime Juice..... "	0.08	2.10				
Lye..... "					0.48	0.27
Macaroni..... "		0.83			1.20	(8)
Marmalade..... "		1.66				(8)
Matches, small boxes..... "		4.50	(4)	2.50	2 12-14	2 28-36
Meat..... lbs.			100.00			
Milk, condensed..... "		6.60			6.24	6.05
Molasses..... pts.		10.00				(8)

RATION LIST.—Continued.

Figures for 100 rations or subsistence for one man for 100 days.

Articles,	Alaskan Parties U. S. Geological Survey.	National Transcontinental Railway.	Canadian Militia.	C. F. R. Land Department.	Canadian Pacific Railway.	Grand Trunk Pacific Railway.
	(1)	(2)		(5)	(6)	(7)
Mustard..... lbs.	0.42	0.04		0.21		0.55
Nutmegs..... "	0.01	0.05			0.06	0.07
Oatmeal..... "	16.60			10.00	9.52	13.88
Onions..... "	0.54	6.60			4.62	
Peaches, canned..... "		6.60			24.00	(8)
Peaches, evap..... "					11.90	
Pears, canned..... "						(8)
Peas, split..... "			3.125		4.76	(8)
Peas, canned..... "		10.00				(8)
Pea Sausages..... "	3.20					
Pepper, black..... "	0.20	0.36	0.17	0.36	0.24	0.27
Pickles..... gals.		0.31		0.62	1.43	(8)
Potatoes..... lbs.			100.00		95.24	(8)
Potatoes, evap..... "	16.10	6.60				
Prunes, evap..... "		6.60			11.90	16.66
Pork..... "		43.30				
Raisins..... "		3.30				7.49
Rice..... "	8.50	5.83			5.95	16.66
Salt..... "	5.30	5.50	3.125	8.00	4.75	5.55
Sago..... "					2.38	
Sauce, Worcestershire..... bct.		1 20-30			1 19-21	1 20-30
Soap..... lbs.		5.00		6.66		5.55
Soap, toilet..... cakes		3.00				
Soda..... lbs.		0.20			0.71	
Soup, veg. evap..... "	1.80	0.26		1.20		
Soup, condensed..... "		1.66				
Strawberries..... "						(8)
Sugar..... "	25.10	33.33	12.50	31.60	35.71	41.65
Syrup..... gal.		0.40		1.25	1.19	
Tapioca..... lbs.		2.66			2.38	(8)
Tobacco, chewing..... "		2.50				
Tobacco, smoking..... "		5.00				
Tomatoes, canned..... "		8.30			36.00	(8)
Tea..... "	3.60	6.66	1.56	3.30	3.55	5.55
Vanilla Extract..... oz.		0.10			0.12	
Vegetables, fresh..... lbs.			3.75	5.00		(8)
Vinegar..... gals.	0.18	0.20		0.20	0.24	0.27
Yeast, cake..... lbs.		1.60		1.40	1.50	1.66

(1) The amounts of some articles will, of course, be reduced if fresh meat, eggs and vegetables can be bought in the country, and also if transportation permits the carrying of canned vegetables, fruit and milk.

(2) Calculated from the figures for one man for one month.

The following named articles may be selected by the District Engineer in quantities varying from the above list, but retaining the same relative amount of meat and vegetable food as given in the list:

Bacon, Pork, Corned Beef, Ham, Peas, Rice, Oatmeal, Cornmeal, Buckwheat Flour, Condensed Soup, assorted Jam and Marmalade.

(3) When bread or biscuit is not available an equivalent in weight of wheat flour or oat or cornmeal, instead of the ration of bread or biscuit, may be issued.

(4) When fresh meat is not available salted or dried meat, as can best be obtained, may be issued instead.

(5) Calculated from the figures for one man for thirty days.

(6) Calculated from the figures for fourteen men for thirty days.

(7) Calculated from the figures for twelve men for thirty days. Eggs, fresh meat and vegetables may be supplied as required if they can be obtained from the farming community.

(8) The article may be supplied instead of similar articles opposite which weights or measures have been shown.

Lat. of Ottawa $45^{\circ} 25' 28''$ N
Long. " " $75^{\circ} 02' 50.2''$ W.

At Ottawa

Ast. bearing of magnetic north
is about $347\frac{1}{2}^{\circ}$ i.e. mag
decl. is about $12\frac{1}{2}^{\circ}$ west of true
north.

Corr. made by hand Page 100
" 167

7

3