REPORT OF PROCEEDINGS

OF THE

ASSOCIATION OF DOMINION LAND SURVEYORS

AT THE

SIXTH ANNUAL MEETING,

HELD AT

OTTAWA, FEBRUARY 19, 20 AND 21, 1889.

PRICE FIFTY CENTS

PRINTED FOR THE ASSOCIATION BY JOHN LOVELL & SON,
1889.

To Dominion Land Surveyors.

SHOULD you not be a member of the Association, it is respectfully urged that you at once become such, and by your earnest co-operation assist in making it a means of elevating the standard of the profession, and, by an interchange of ideas, of increasing the scientific knowledge of its members to as great an extent as possible.

Those who are not Dominion Land Surveyors by profession, but whose pursuits, scientific acquirements or practical experience fit them to co-operate with Dominion Land Surveyors in the advancement of professional knowledge, are qualified to join as Associate Members.

Should you be acquainted with any Dominion Land Surveyor who is not a member, or any gentleman qualified to join as an Associate Member, use your earnest endeavours to make him become such. "IN UNITY IS STRENGHT." Then let us unite together, and as a body be one man with one end in view,

"The Welfare of the Profession."

Any Dominion Land Surveyor may become a member of the Association upon payment of dues.

Application blanks for Associate Membership may be obtained from the Secretary-Treasurer.

INDEX.

LIST OF ADVERTISEMENTS.

ASSOCIATION OF DOMINION LAND SURVEYORS,

ORGANIZED APRIL 24th, 1882.

OFFICERS FOR 1889.

HONORARY PRESIDENT.

CAPT. E. DEVILLE, SURVEYOR GENERAL.....OTTAWA, ONT.

PRESIDENT.

J. S. DENNIS, D.T.S.....OTTAWA, ONT.

VICE-PRESIDENT.

WM. OGILVIE, D.L.S.....GLOUCESTER, ONT.

SECRETARY-TREASURER.

ARTHUR O. WHEELER, D.L.S.....OTTAWA, ONT.

EXECUTIVE COMMITTEE.

OTTO J. KLOTZ, D.T.S.....PRESTON, ONT.
THOS. FAWCETT, D.T.S.....GRAVENHURST, ONT.
JOHN McLATCHIE, D.L.S.....NEW EDINBURGH, ONT.

AUDITORS.

J. J. McARTHUR, D.L.S.....AYLMER, QUE.
W. S. DREWEY, D.L.S.....BELLEVILLE, ONT.

STANDING COMMITTEES

FOR 1889.

INSTRUMENTS.

G. B. ABREY *(Chairman)*, D. C. MORENCY, I. J. DUFRESNE.

GEODETIC SURVEYING.

O. J. KLOTZ *(Chairman)*, JOHN McAREE, GEO. MONTAGU-WHITE.

PUBLICATION.

T. D. GREEN *(Chairman)*, C. A. BIGGER, J. A. BELLEAU.

LAND SURVEYING.

JOHN McLATCHIE *(Chairman)*, G. E. McMARTIN, E. BRAY.

PERMANENT MARKING OF SURVEYS.

S. L. BRABAZON *(Chairman)*, P. T. C. DUMAIS, J. H. BROWNLEE.

NATURAL HISTORY AND GEOLOGY.

PROF. JOHN MACOUN *(Chairman)*, DR. R. BELL, THOS. DRUMMOND.

TOPOGRAPHICAL SURVEYING.

W. S. DREWRY *(Chairman)*, J. J. McARTHUR, J. A. KIRK.

CONSTITUTION AND BY-LAWS.

CONSTITUTION.

ARTICLE I.

Name of the Association.

"The Association of Dominion Land Surveyors."

ARTICLE II.

Objects of the Association.

The promotion of the general interests and elevation of the standard of the profession.

ARTICLE III.

Members.

1. The Association shall consist of Active Members, Honorary Members and Associate Members.

2. Active Members must be Dominion Land Surveyors, and only such shall hold office.

3. Any Dominion Land Surveyor may become an active member upon payment of the fees prescribed by Article IX.

4. Honorary Members must be nominated by two Active Members, and the nomination approved by a unanimous vote of the Executive Committee. The nomination with approval must be in the hands of the Secretary-Treasurer at least one month before the Annual Meeting. Persons nominated for Honorary Membership shall submit a Paper to be read at the Annual Meeting. They shall be elected by ballot in the manner hereinafter provided for the

election of officers of the Association. The number of Honorary Members shall not at any one time exceed twenty, and they shall be exempt from payment of dues.

5. (*a*) Associate members shall be those who are not Dominion Land Surveyors by profession, but whose pursuits, scientific acquirements, or practical experience qualify them to co-operate with Dominion Land Surveyors in the advancement of professional knowledge.

(*b*) Provincial Land Surveyors of any Province, and Articled Pupils of Dominion and Provincial Land Surveyors, shall be eligible as Associate Members.

(*c*) Associate Members shall be nominated by one active member in writing to the Secretary-Treasurer, and on approval of such nomination by the Executive Committee shall at once be admitted upon payment of fees prescribed by Article IX.

6. Associate Members shall not vote.

ARTICLE IV.

Officers.

1. The Surveyor General of Dominion Lands shall be Honorary President of the Association.

2. The Officers of the Association shall consist of an Honorary President, a President, Vice-President, Secretary-Treasurer, and an Executive Committee, all of whom, except the Honorary President shall be declared elected at the Annual General Meeting by letter ballot.

3. No member of the Association shall fill the office of President for more than two consecutive years.

4. Nominations for Officers of the Association shall be made to the Secretary-Treasurer in writing by two active members, at least two months before the Annual General Meeting. The Secretary-Treasurer shall prepare and forward ballot papers to the members of the Association, who shall return them marked in sealed envelopes to the Secretary-Treasurer before the date of the Annual General Meeting.

5. The letter ballots shall be opened at the Annual General Meeting, and the majority of the ballots cast in each case shall decide the election.

6. In case of an even or tie vote, the election shall be decided by the members present at the Annual Meeting voting by ballot.

7. Should the Secretary-Treasurer not receive three nominations for each of the offices of President, Vice-President and Secretary-Treasurer, or six nominations for members of the Executive Committee, the Executive Committee shall add to the ballot papers a sufficient number of names, to make up the number of three candidates for each of the offices and twelve for the Executive Committee.

ARTICLE V.

Meetings.

1. The Annual General Meeting shall commence on the third Tuesday in February, at Ottawa.

2 Special Meetings of the Association may be called by the President, or by the President when requested in writing by three or more members.

3. Eleven members shall form a quorum at any meeting for the transaction of business.

ARTICLE VI.

Amendments.

1. Any member of the Association, who may desire a change in the Constitution of the Association, shall give notice of such contemplated change to the Secretary-Treasurer, at least two months before the next Annual General Meeting, and the Secretary-Treasurer shall, in his notice of such meeting to the members, notify them of the name of the party proposing such change, and the nature thereof.

2. No by-law or rule shall be altered, or new one adopted, except at a General Meeting, and such amendment shall be voted upon at the said General Meeting, two-thirds majority of the votes cast being necessary for its adoption.

ARTICLE VII.

Executive Committee.

1. The Executive Committee shall consist of the President, Vice-President, Secretary-Treasurer, and three members; and shall have the direction and management of the affairs of the Association. Three members to form a quorum.

2. The Meetings of the Executive Committee to be held at the call of the President, or Secretary-Treasurer.

ARTICLE VIII.

Auditors.

Two Auditors, to be elected by ballot, shall audit the accounts of the Association annually, and present their report of the same at the Annual General Meeting.

ARTICLE IX.

Subscriptions.

1. The fee for membership for Active Members shall be five dollars, and an annual subscription of two dollars for each subsequent year; both payable in advance.

2. The fees of Active Members shall be forwarded to the Secretary-Treasurer with the ballot papers for election of Officers, and any ballot unaccompanied by the fees mentioned in sub-clause No. 1 shall not be counted in the Election.

3. Associate Members shall pay a fee of two dollars annually.

4. The names of members twelve months in arrears shall be struck off of the roll.

BY-LAWS.

ORDER OF BUSINESS.

1.

1. Reading of Minutes of Previous Meeting.
2. Reading of Correspondence and Accounts.
3. Propositions for Honorary Membership.
4. Balloting for Honorary Membership.
5. Reports.
6. Unfinished Business.
7. New Business.
8. Election of Officers.
9. Adjournment.

2. All motions must be in writing, and shall contain the name of the mover and seconder, and must be read by the Chair before being discussed.

3. Reports of Committees must be in writing, signed by the Chairman thereof.

4. No member shall speak on any subject more than once, except the introducer of the subject, who shall be entitled to reply; every member, however, shall have the right to explain himself, subject to the discretion of the Chair.

5. When a motion has been finally put to the meeting by the Chairman, all discussion thereon shall be closed.

6. The Chairman shall appoint two scrutineers when a ballot is taken.

7. Every member while speaking shall address the Chair.

DUTIES OF OFFICERS.

1. The President shall preside at all meetings at which he is present; in his absence the Vice-President; and in the absence of both the meeting shall appoint a Chairman.

2. The presiding officer shall only have a casting vote, not a deliberate one.

3. The Secretary-Treasurer shall keep an accurate record of all meetings, conduct all correspondence, announce all meetings, receive all fees and subscriptions and other moneys, pay no bills unless sanctioned by the Executive Committee and signed by their Chairman, make an annual report of all receipts and disbursements, and shall perform such other duties as may from time to time be assigned him by the Executive Committee.

PROGRAMME.

TUESDAY, FEB. 19, 9.30 A. M.

Meeting of Executive and Standing Committees for 1888; arrangement of Exhibits and other details.

TUESDAY, 2 P. M.

Reading of Minutes of Previous Meeting.
Reading of Correspondence.
Report of Executive Committee.
Report of Secretary-Treasurer.
Report of Auditors.
President's Address.

TUESDAY, 7.30 P. M.

PAPER—"A method of predicting Lunar Occulations."
W. F. KING, D.T.S., Ottawa, Ont.

PAPER—"Practical prospecting for Gold and Silver, and the preliminary developments of metalliferous veins."
JAS. BRADY, M.E., Grohman, B.C.

PAPER—"Reflection of the Electric Light."
OTTO J. KLOTZ, D.T.S., Preston, Ont.

LECTURE—"Supposed fossil-trees discovered at Kingston, Ont.," illustrated by Sciopticon Views, by H. N. TOPLEY, Photographer to the Technical Branch of the Department of the Interior, Ottawa, Ont.

WEDNESDAY, FEB. 20, 9.30 A. M.

Report of Standing Committee on Geodetic Surveying.
W. F. KING, D.T.S. (Chairman), Ottawa, Ont.

Report of Standing Committee on Publication.
T. D. GREEN, D.L.S. (Chairman), Brantford, Ont.

Report of Standing Committee on Land Surveying.
JOHN MCLATCHIE, D.L.S. (Chairman),
New Edinburgh, Ont.

Appointment of Scrutineers of Ballots.

WEDNESDAY, 2 P. M.

Questions, Problems and Formulas submitted to the Meeting.

PAPER—"The Status of our Profession."
J. W. HARRIS, D.L.S., Winnipeg, Man.

PAPER—"A Standard of Precision."
J. A. KIRK, D.L.S., Stratford, Ont.

PAPER—"Gunter's Chain."
S. BRAY, D.L.S., Ottawa, Ont.

PAPER—"Coal Mining."
C. A. MAGRATH, D.T.S., Lethbridge, N.W.T.

WEDNESDAY, 7.30 P. M.

PAPER—"Measurements."
J. H. BROWNLEE, D.L.S, Brandon, Man.

PAPER—"A Plea for Pioneers."
DR. ROBT. BELL, Assist. Director Geological Survey of Canada, Ottawa, Ont.

PAPER—"Hon. D. W. Smith, the first Surveyor General of Upper Canada."
JOHN MCAREE, D.T.S., Toronto, Ont.

PAPER—"Photo-Topography in Italy" (translated from the Italian). Transmitted by Capt. E. DEVILLE, Surveyor General, to whom it was communicated by the Italian Geographical Institute, through the Royal Italian Consulate for Canada.

LECTURE—"The Instruments used in the Profession."
W. F. KING, D.T.S., Ottawa, Ont.

Microscopical Exhibit of Biological and Rock Specimens.
Messrs. ADAMS & LAWSON, Geological Survey of Canada, Ottawa, Ont.

THURSDAY, FEB. 21, 9.30 A. M.

Report of Standing Committee on Natural History and Geology.
Prof. JOHN MACOUN, F.L.S. (Chairman), Ottawa, Ont.

Report of Standing Committee on Permanent Marking of Surveys.
S. L. BRABAZON, D.L.S. (Chairman), Portage-du-Fort, Que.

Report of Standing Committee on Photography as applied to Topographical Surveying.
W. S. DREWRY, D.L.S. (Chairman), Belleville, Ont.

Report of Standing Committee on Topographical Surveying.
OTTO J. KLOTZ, D.T.S. (Chairman), Preston, Ont.

Report of Scrutineers of Ballots.
Unfinished Business. New Business.
Arrangement of Committees for 1889.

THURSDAY, 2 P. M.

Meeting of Committees for 1889.

PAPER—"Irrigation."

THOS. FAWCETT, D.T.S., Gravenhurst, Ont.

PAPER—"Distance Measuring Micrometers."

W. F. KING, D.T.S., Ottawa, Ont.

LETTER—"Suggestions re Forestry."

A. T. DRUMMOND, Montreal, Que.

PAPER—"Settlement and Irrigation of the portions of the N. W. Territories West of the Eastern limit of the Missouri, Coteau, and South of Tp. 30."

WM. PEARCE, D.L.S., Calgary, N.W.T.

THURSDAY, 7.30 P. M.

PAPER—"Suggestions regarding Geographical Nomenclature."

A. T. DRUMMOND, Montreal, Que.

PAPER—"Government Surveys in Manitoba and the North-West."

J. S. DENNIS, D.T.S., Ottawa, Ont.

PAPER—"Surveys of the Province of Quebec."

G. E. MCMARTIN, D.L.S., St. Andrews, Que.

LECTURE—"How to preserve Natural History Specimens."

A practical illustration will be given of the best and easiest methods of preparing skins for future mounting.

Prof. JOHN MACOUN, F.L.S.,
Geological Survey of Canada, Ottawa, Ont.

Adjournment.

Full discussion after each Paper, open to all.

EXHIBITS.

INSTRUMENTS.

The exhibit of Instruments was large and comprehensive, and owing to the kindness of Capt. C. Deville, Surveyor General, Staff Commander Boulton, and Mr. G. B. Abrey, included many used only in the higher branches of Surveying. They were as follows :—

25 Inch Alt-Azimuth.
18-Inch Alt-Azimuth.
10-Inch Alt-Azimuth.
7 Inch Alt-Azimuth.
Prismatic Transit.
Astronomical Transit.
4 Inch Transit Theodolite.
Solar Compass.
Lagukol Micrometer.
Standard Steel Tape.
Reflecting Circle.
Artificial Horizon.
Exploring Theodolite.
4 Inch Prismatic Transit.
Reflecting Telescope.
Dip Circle.

Station Pointer (used by Staff Commander Boulton on Hydrographic Survey of the Georgian Bay).

German Rolling Planimeter (a description of this instrument as given by Mr. Abrey will be found further on).

Mr. Brownlee exhibited a simple clip for mending a broken steel band chain, and also field tools for applying the same. The box of tools required is about 4 x 2 x 1 inches, and weighs about a pound, being easily carried by the chainman along with the field-book.

PHOTOGRAPHIC VIEWS.

Mr. H. N. Topley had a large exhibit of Photographs, tastefully arranged about the hall, from negatives taked by Dr. Dawson, Dr. Bell and Mr. J. B. Tyrrell of the Geological Survey, and by Mr. William Ogilvie. Among the Views may be mentioned :—

Large Photographs of the Public Buildings in Washington, D. C.

Enlarged Photographs of scenery on the Yukon River.

Italian Topographical Photographs (loaned by Capt. E. Deville).

Medical Photographs, taken by Dr. Grey of the Army and Medical Museum, Washington, as follows:

The human hand in embryo, two and a half months old (enlarged 50 diameters).

Fimbriated papilloma of the bladder (enlarged 250 diameters).

Epithelioma of lip (enlarged 125 diameters), Ciliary Region of human eye.

Retina of human eye (enlarged 200 diameters), Human hair (enlarged 400 diameters.

Eggs of tricocephalus dispar in the liver of a mouse (enlarged 400 diameters). Bacillus aceti (enlarged 1250 diameters). Prof. Smillie of the National Museum of Washington also kindly sent Mr. Topley some photographs of fossil trees. These trees are now placed in front of the Museum, and are said to be the largest specimens exhibited in America.

MICROSCOPICAL.

A Microscopical Exhibit was given by Dr. A. C. Lawson, Mr. F. D. Adams and Mr. J. B. Tyrrell of the Geological Survey.

Dr. Lawson and Mr. Adams exhibited a full suite of rock hand, specimens of typical massive rocks, showing gradation from glassy or porphyritic surface rocks to coarse grained granular deep-seated rocks; also microscopical sections of these hand specimens, showing their characters under the microscope.

Mr. J. B. Tyrrell exhibited under the microscope *Foraminifera* from *Cretaceous* (chalk) formation in Western Canada.

The mechanism of the instruments used and the methods of petrographical research were briefly explained.

NATURAL HISTORY.

Mr. J. Edwards, Taxidermist, exhibited two deer heads and a brace of Ptarmigan (mounted).

MINUTES.

TUESDAY, Feby. 19th.

The morning was spent in meetings of the several committees, and in arranging the Hall and various Exhibits.

Afternoon Session.

The meeting opened at 2.40 p. m., the President, E. J. RAINBOTH, in the Chair.

The Secretary-Treasurer being unavoidably absent, on motion, Mr. T. D. GREEN was appointed to act *pro tem.*

The Minutes of the preceding Annual Meeting were disposed of by Resolution No. 2.

Moved by T. D. GREEN, seconded by J. H. BROWNLEE, and *Resolved*:—

That the minutes of the last meeting be adopted as printed in the 5th Annual Report, as they are shown very fully therein, and have been seen by all the members.

At the request of the President, Mr. J. S. DENNIS read the correspondence, the same having been placed in his hands by the Secretary-Treasurer.

Letters were received from the following:—

A. W. McVittie, D.L.S., drawing the attention of the Association to the probability of the British Columbia, and possibly the Dominion Government, appointing Government Assayers to mining districts, and to the advisability of that official being also a Government Surveyor, which would mean a D.L.S. in the office of Government Assayer, and thereby necessitating a more practical study of mineralogy for the degree of D.L.S.

Prof. Galbraith, S.P.S., acknowledging his election as an Honorary Member, and hoping to be able to find time in the future to write a paper for the Annual Meeting.

Wm. Murdoch, A. J. Brabazon and N. A. Freeman, Dominion Land Surveyors, applying for membership.

A. M. Burgess, Deputy Minister of the Department of the Interior, regretting that owing to the period of the year he would be unable to attend the Meeting.

Messrs. Keuffel and Essex, of New York, expressing an intention of exhibiting some of their Surveying instruments, tapes, scales, etc., provided they could do so without paying duty thereon. On consulting the Minister of Customs in the matter, the Secretary-Treasurer was informed that such an exhibit would be looked upon as samples of merchandise, and would be, therefore, dutiable.

Governor General's Secretary, acknowledging receipt of Fifth Annual Report, and conveying thanks on behalf of His Excellency for same.

Mr. DENNIS reported that a ballot had been handed to him that day, and asked whether it should be received. Discussion was closed by Resolution No. 3.

Moved by WM. OGILVIE, seconded by G. B. ABREY, and *Resolved*:

That all ballots presented at the Meeting, up to the time of the appointment of the Scrutineers, be received and counted.

The report of the Secretary-Treasurer and the statement of Receipts and Expenditures were read.

The PRESIDENT referred briefly to the deaths of Messrs. J. A. Snow and C. E. Wolff, both of whom were members of the Association, and of Messrs. Fisher and Duderidge, members of the Profession.

After discussion it was decided that the amount of work to be done would not warrant the Association in the purchase of a typewriter for the use of the Secretary-Treasurer.

The PRESIDENT then delivered his Annual Address.

PRESIDENT'S ADDRESS.

GENTLEMEN,

MEMBERS OF THE ASSOCIATION OF DOMINION LAND SURVEYORS,

As a member of this Association, it affords me much pleasure to meet again my fellow members in a gathering such as this—a gathering which cannot fail to be productive of the best results in its tendency to forget graver considerations, to promote harmony and good-will among the members of this organization, and in disarming any unfriendliness that might possibly be engendered by those contests and rivalries which are incidental to professional life. It is a pleasure in which I have always participated since our first or preliminary meeting at Winnipeg in 1882, and as the annual address of your president forms part of the programme for occasions such as this, I thought perhaps I could not do better, discharging this, to me, unaccustomed duty, than by briefly referring to the different stages through which our profession has passed in reaching its present efficiency, and attaining as it has within the past few years no insignificant place among the liberal professions of the country.

When I attended the meeting in Winnipeg, to which reference has just been made—a meeting attended but by very few, and of a somewhat casual nature—it was agreed upon to defer further proceedings until the following winter, and it was thought that Ottawa would be the most convenient place to assemble for the purpose of forming an Association of Dominion Land Surveyors. In accordance with this understanding, a meeting was duly convened at Ottawa with that object in view, and as most of you will readily remember it was attended by Surveyors from almost every part of the Dominion. At this meeting this Association was organized, an Association constantly increasing in importance, in which every Surveyor takes, as we know, a deep interest, and which has, I will venture to say, rendered most valuable assistance to our profession.

The progress that has been made in the systems and practice of surveying in Canada may perhaps be most accurately comprehended, by contrasting the old methods and the instruments deemed sufficient for the execution of the work then required to be performed, with the methods that are followed at present, and the improved instruments that are now necessary for the satisfactory execution of a survey. In former years the surveyor was the chief and also the leader of his party in a very practical manner, sharing in all the manual labor, and to a stranger, hardly distinguishable from the laborers of his party, living as he did in the most indifferent way; he frequently returned to civilization, possessing it is to be hoped a refinement which his outward appearance would never have betrayed. His most, indeed his only, essential instrument was a magnetic compass, which was then thought by those who should have known better, to possess, in some mysterious manner, the highest degree of accuracy, and which it was believed that science could not improve nor modern instruments rival. In fact, he was very little above an ordinary laborer in name or remuneration, his profession was called his trade, and his instruments his tools. This age or period in surveying had almost entirely disappeared when I first began the study of the profession, and the traces of it that I observed and that are still observable are not such as would inspire one with admiration for the profession, or envy the duties and tasks its members were called upon to perform. Now happily, however, his position is wholly different, the accuracy now demanded in his work requires the careful and assiduous exercise on his part of all his scientific information, alike in his theoretical conception of the work and in the actual execution of it; this latter requires that he be thoroughly posted in the use of all modern and improved instruments that have been invented for the measurement of distance and location of position.

A surveyor is at the present day regarded and treated in the light of a professional man; those who secure his services understand that he expects to live somewhat at least in the manner becoming a professional man, and as such to conduct and manage his party; they are aware that the work he is to perform demands scientific information, and they engage him because he is supposed to possess it, and they expect to pay, and in most cases actually do pay, him something like an adequate remuneration for the services he renders. It is evidently the unquestionable and first duty of the members of our Profession, and especially of this Association, to jealousy guard against any innovation of a nature to diminish the efficiency of the profession, or to impair, in the slightest degree, the standing of its members, or the privileges they have lately been accustomed to enjoy; and it must also be evident that we can only maintain our present standing, and hope for still further advancement in the future, by striving to improve our methods of executing work, by adding

to our scientific and practical knowledge, and by encouraging a feeling of friendliness towards all our associates, and of independence and manliness in our transactions with the public. In this respect we must acknowledge that much of our advancement can be traced to the kindly interest that has been taken in our Association by some of the officials of the Interior Department, and the improved systems of surveying that have from time to time been devised by them, and I believe that when we reflect that the present Minister to his many other requirements possesses the technical information of the surveyor and engineer, we have every reason to hope that the amicable spirit that has characterised our dealings with the Department in the past will continue to distinguish all such dealings in the future, and I feel confident that any further efforts made by us in carrying out the aims of this Association will meet with their sanction and assistance, and commend themselves to the favorable consideration of the Minister and those of his Department whose approval may be necessary for their effective accomplishment.

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I may here refer to the question of incorporation. You are aware that it was once a live question before this Society, and you will recall how warmly it was advocated, and that it was the wish of this Association that the Dominion Land Surveyors should be legally incorporated. It is needless for me to state that all our exertions led to nothing. In the Province of Quebec, however, all admit that incorporation has been productive of the best results; but at the same time, it must be owned that its success is generally attributed to the large private business that is to be found there. Whether incorporation would at present bring about here—where there is scarcely more than one source of employment—a like result, is of course still debateable. Since the curtailment in surveying in the North-West, we see some surveyors turning their attention almost entirely to engineering in all its various branches, and it has occurred to me that perhaps the usefulness of this Association, as a factor in promoting the efficiency and raising the standard of our Profession, would be enhanced by enlarging the scope of the Society, and by not limiting its active membership to Dominion Land Surveyors. I entertain the opinion that the general absence of private practice for Dominion Land Surveyors will not enable us to keep up that interest in this Society, in the future, that has been so generously evinced for it in the past, and that distinguish its members at present, considering the intimate connection existing between the profession of the civil engineer and our own. The idea is impressed upon me, that if we admit others to our Association, changing its name say to that of the Dominion Association of Land Surveyors and Engineers, and having its deliberations cover a broader field, and take in, in their comprehensive scope, all subjects pertinent to both professions, in this way many would be induced to join us who are now ineligible, we would have in our ranks professional land surveyors from all the provinces, and also many engineers; in this manner a society might, I believe, be formed, in which the topics of discussion would interest others besides those actually engaged in the survey of Dominion lands, and which consequently would not be dependent for its existence on the continuance of government work. A programme of the proceedings proposed for the consideration of the present meeting of this Association has been carefully prepared and sent to each member

showing the work allotted for each day and sitting, and the subject of the different papers to be read, which will obviate the necessity of my dwelling in detail upon the nature of the subjects to be treated.

I have in conclusion to ask that you will give an attentive hearing to the various readings, which have all been prepared, I feel confident, with great care and labor. I have also to request that those whose names are not upon the programme will have no hesitation in expressing their ideas, not only on matters referred to in the programme, but also on all affairs concerning in any manner this Society in which we are all equally interested, and which we all wish to see prosper and increase in importance and usefulness.

E. J. RAINBOTH,
President.

Evening Session.

The meeting was called to order at 8 p.m., E. J. RAINBOTH, President, in the Chair.

A PAPER, "Method of predicting Lunar Occultations," was read by W. F. KING, and followed by discussion.

A PAPER, "Practical prospecting for gold and silver, and the preliminary developments of metalliferous veins," by JAS. BRADY, was read by T. D. GREEN, and followed by discussion.

A PAPER, "Reflection of the Electric Light," was read by OTTO J. KLOTZ, and discussed.

A LECTURE, "Supposed fossil trees discovered at Kingston, Ont.," was given by H. N. TOPLEY. Mr. Topley's lecture was illustrated by Siopticon views, including many outside the subject of the lecture. (A synopsis of Mr. Topley's lecture and exhibit will be found further on.) This closed the Evening Session.

WEDNESDAY, Feb. 20th.

Morning Session.

The meeting was called to order at 10.30 a.m., E. J. RAINBOTH, President, in the Chair.

No Report of Standing Committee on Instruments was presented, the Chairman, G. B. ABREY, stating that none had been prepared, as he felt assured that the lecture on "Instruments used in the Profession," by W. F. KING, would include all the Committee could say on the subject.

Report of Standing Committee on Geodetic Surveying.

Report of Standing Committee on Publication.

Report of Standing Committee on Land Surveying.

Resolution No. 4.

Moved by G. E. McMARTIN, seconded by W. S. DREWRY, and *Resolved:*

That the several reports of the standing committee be accepted.

Resolution No. 5.

Moved by WALTER BEATTY, seconded by EDGAR BRAY, and *Resolved:*

That the Secretary supply members of the Association who have not received blank forms of ballot, with the same.

Resolution No. 6.

Moved by WALTER BEATTY, seconded by W. S. DREWRY, and *Resolved:*

That Messrs. E. Bray, Snow and Crawford be appointed scrutineers of ballots for election of Officers.

Afternoon Session.

The meeting was called to order at 2 p.m., E. J. RAINBOTH, President, in the Chair.

A graphic method of dividing a Quadrilateral into any number of equal parts, by H. IRWIN, was adopted as read, as no proper means had been provided to follow out the geometrical figures.

A PAPER, "Gunter's Chain," was read by S. BRAY.

A PAPER, "The Status of our Profession," by J. W. HARRIS, was read, and followed by considerable discussion.

A PAPER, "A Standard of Precision," by J. A. KIRK, was read.

A PAPER, "Coal Mining," by C. A. MAGRATH, brought the afternoon session to a close.

Evening Session.

The meeting was called to order at 7.45 p.m., E. J. RAINBOTH, President, in the Chair.

J. H. BROWNLEE stated that owing to a misunderstanding having occurred, he had failed to prepare a paper, as per programme, but that he would consent to say a few words about improvements in Steel-band Chains, invented by A. J. Brabazon, D.L.S. (See further on.)

A large portion of the evening was taken up by a question of privilege, and several motions were passed in connection therewith.

MR. F. D. ADAMS and DR. LAWSON, of the Geological Survey, gave a microscopical exhibit of Biological and Rock Specimens, a description of which will be found under the heading "Exhibits."

Resolution No. 11.

Moved by OTTO J. KLOTZ, seconded by J. S. DENNIS, and *Resolved:*

That a sincere vote of thanks be tendered Messrs. Lawson and Adams for their kindness in exhibiting their Microscopes and Specimens.

THURSDAY, Feb. 21st.

Morning Session.

The meeting was called to order at 10 p.m., JOHN MCAREE, Vice-President, in the Chair.

A PAPER, "A Plea for Pioneers," by DR. ROBERT BELL, was read and discussed.

A PAPER, "Hon. D. W. Smith, the first Surveyor General of Upper Canada," was read by JOHN MCAREE.

A PAPER, "Azimuth by means of two Stars," by S. L. BRABAZON was read and discussed.

Report of Standing Committee on "Photography as applied to Topographical Surveying," W. S. DREWRY, Chairman, was presented and discussed.

Report of Standing Committee on "Topographical Surveying," OTTO J. KLOTZ, Chairman.

Remarks by J. S. DENNIS, regarding work of committee on "Geodetic Surveying."

Report of scrutineers of Ballots.

Resolution No. 12.

Moved by W. S. DREWRY, seconded by G. MONTAGU-WHITE, and *Resolved:*

That the report of the scrutineers be received and adopted.

Resolution No. 13.

Moved by W. S. DREWRY, seconded by WM. CRAWFORD, and *Resolved:*

That the list of exchanges be left in the hands of the Executive Committee.

Resolution No. 14.

Moved by WM. CRAWFORD, seconded by J. C. NELSON, and *Resolved:*

That a vote of thanks be tendered to Mr. Wheeler, Secretary of the Association, and that he be paid fifty dollars as a recognition of his services.

Resolution No. 15.

Moved by A. O. WHEELER, seconded by J. S. DENNIS, and *Resolved:*

That clause IX of the constitution be amended by adding the following sub-clause: "The names of all members, twelve months in arrears, shall be struck off the roll."

Resolution No. 16.

Moved by E. BRAY, seconded by WILLIAM CRAWFORD, and *Resolved:*

That the Executive Committee be authorized to strike the Standing Committee for the current year.

Resolution No. 17.

Moved by WM. CRAWFORD, seconded by J. C. NELSON, and *Resolved:*

That the Executive Committee be and are hereby authorized to retain a solicitor in Winnipeg and Victoria, to look after those practicing surveying in Manitoba, the North West and British Columbia, who are not duly qualified.

Afternoon Session.

The meeting was called to order at 3 p.m., JOHN MCAREE, Vice-President, in the Chair.

A PAPER, on "Irrigation," by THOMAS FAWCETT, was read and discussed.

A LETTER from A. T. DRUMMOND, of Montreal, containing suggestions relating to "Forrestry," was read and discussed.

Resolution No. 18.

Moved by OTTO J. KLOTZ, seconded by WM. CRAWFORD, and *Resolved:*

That a vote of thanks be tendered Mr. Drummond for the valuable suggestions contained in his letter.

A PAPER, "Settlement and irrigation of the portions of the N.W. Territories West of the Eastern limit of the Missouri Coteau, and South of the Tp. 30," by WM. PEARCE, was read and discussed.

A PAPER, "Government Surveys in Manitoba and the North-West," was read by J. S. DENNIS, and followed by discussion.

A PAPER, "Distance measuring Micrometers," was read by W. F. KING, and was followed by an explanation of the use of the micrometer by WM. OGILVIE.

A LECTURE on "The Instruments used in the Profession," by W. F. KING, brought the Afternoon Session to a close. (A synopsis of the lecture will be found further on.)

Evening Session.

The meeting was called to order at 8 p.m. JOHN MCAREE, Vice-President, in the Chair.

G. B. ABREY gave an explanation of the use of a Rolling Planimeter, exhibited by him, and an interesting discussion accompanied by some tests of its practical value took place.

A PAPER, "Suggestions regarding Geographical Nomenclature," by A. T. DRUMMOND, was read and discussed.

A LECTURE, on "How to preserve Natural History Specimens," by Prof. JOHN MACOUN, included practical illustration of skinning birds and deer heads, by J. C. EDWARDS, taxidermist.

Resolution No. 19.

Moved by G. B. ABREY, seconded by WILLIAM OGILVIE, and *Resolved:*

That a vote of thanks be tendered to Prof. Macoun for his instructive address.

Report of Auditors was presented and on motion adopted.

A PAPER, "Photo-Topography in Italy," submitted by CAPT. E. DEVILLE, Surveyor General, was read.

A PAPER, "Surveys of the Province of Quebec," was read by G. E. MCMARTIN, and discussed.

It was then moved by J. S. DENNIS, seconded by J. H. BROWNLEE, and *Resolved:*

That this meeting do now adjourn until the third Tuesday in February, 1890.

NAMES OF MEMBERS PRESENT.

Honorary Members.

W. F. King, D.T.S., Chief Astronomer to the Dept. of the Interior of Canada.

Prof. John Macoun, F.L.S., Naturalist and Botanist to the Dept. of the Interior of Canada.

Active Members.

Abrey G. B.
Beatty Walter
Belleau J. A.
Bigger C. A.
Bowman H. J.
Brabazon A. J.
Bray Edgar
Bray Samuel
Breen Thomas
Brownlee J. H.
Crawford Wm.
Dennis J. S.
Drewry W. S.
Dufresne I. J.
Dumais P. T. C.
Freeman N. A.
Green T. D.
Klotz Otto J.
Morency D. C.
Mountain Geo. A.
McAree John
McArthur J. J.
McMartin G. E.
McLatchie John
Nelson J. C.
Ogilvie Wm.
Rauscher Robt.
Rainboth E. J.
Snow J. F.
Webb A. C.
White Geo. Montagu.

Associate Members.

Brummell H. P.
McEvoy James
Smith W. H. C.
Symes P. B.
Topley H. N.
White James

Visitors.

A. T. Drummond, Montreal,
John Ogilvie, D.L.S.
Dr. A. C. Lawson, Geological Survey, Ottawa,
F. D. Adams, " " "
J. B. Tyrrell, " " "
A. P. Low, " " "
E. R. Faribault, " " "
Robt. Chalmers, " " "
W. McInnes, " " "
W. McL. Maingy, Dept. of the Interior,

M. Brady, Dept. of the Interior,
D. W. Lightfoot, Dept. of Public Works,
P. K. Hyndman, Dept. of Railways and Canals,
John Bobier,
J. H. Doherty,
R. K. Claire,
Wm. Canning.

NEW MEMBERS.

Active.

A. J. Brabazon.....Portage du Fort, Que.
T. W. Chalmers.....Battleford, N. W. T.
Joseph Cozens.....Sault Ste Marie, Ont.
J. L. Doupe.....Winnipeg, Man.
N. A. Freeman.....Milton, N. S.
Maurice Gaviller.....Collingwood, Ont.
H. Irwin.....Montreal, Que.
D. C. Morency.....Levis, Que.
Wm. Murdoch.....St. John, N. B.
A. L. Poudrier.....Donald, B. C.
T. J. Patten.....Little Current, Ont.
Arthur St. Cyr.....Ste Anne de la Perade, Que.
John Vicars.....Cannington, Ont.

Associate Members.

C. M. Odell.....Truro, N. S.
P. B. Symes.....Dept. of the Interior, Ottawa, Ont.
H. N. Topley.....Dept. of the Interior, Ottawa, Ont.

REPORTS.

REPORT OF SECRETARY-TREASURER.

OTTAWA, Feb. 16th, 1889.

TO THE PRESIDENT AND MEMBERS OF THE ASSOCIATION OF DOMINION LAND SURVEYORS.

GENTLEMEN,

I have the honor to make the following report of transactions during the past Association Year, extending from the 15th March, 1888, to the 18th February, 1889 (incl.)

As many of you gentlemen who were present at our last Annual Meeting will know, it was decided that a strong effort should be made to place the Association upon a better and firmer footing than heretofore, and to make the interchange of professional scientific works, thoughts and ideas the chain that was to bind us together in the future. I have great pleasure in informing you that the expectations of that meeting have been more than realized, and that we may consider our Association as holding one of the highest, if not the highest place amongst similar Associations and Societies in Canada or the United States.

Referring to the subject of Resolution No. 1, passed at the last Annual Meeting, I beg to state that the matter has been brought before the heads of the Department of the Interior, and is now under consideration,—and I think, I may say, favourable consideration. No action has been taken with any other Department, pending the decision of the Minister of the Interior, with regard to Interior and Geological Survey Reports and Maps.

As to Resolution No. 6, a copy of the 5th Annual Report, only, was sent to the Canadian Institute, and duly acknowledged; all other Reports being out of print.

By Resolution No 7, I was instructed to effect an exchange of Reports with the following Societies: Ohio, Michigan, Illinois, Connecticut, Colorado, and the P. L. S. Association of Ontario, to the extent of 50 copies to each. The first four gladly agreed to an exchange; Colorado would have been happy to do so, but published no Report last year. The Secretary-Treasurer of the last named Association writes, that in his opinion all D. L. S's who reside in

Ontario belong to the Association of P. L. Surveyors, and, therefore, that they get both proceedings; and for the *very few* outside of Ontario it would not pay to bother with them. In lieu therefore of the two last mentioned, arrangements were made for an exchange with the Societies of Indiana and Arkansas.

In every case it was found that a full exchange would be necessary, and consequently the following distribution was made: Ohio, 110 copies; Michigan, 100 copies; Connecticut, 90 copies; Illinois, 75 copies; Indiana, 75 copies; and to Arkansas, 40 copies; the most that could be spared as no previous arrangements had been made for such exchange. The total number, therefore, disposed of in this manner was 490 copies.

Seven hundred copies of the Annual Report were printed, at a cost of $1.10 per page for 157 pages. As stated above, 490 copies were received by our exchanges; 110 copies were distributed in a manner thought to be most beneficial to the Association, and the remainder, with the exception of half-a-dozen copies now in hand, went to supply the requirements of our own members.

In addition to the Report, two pamphlets were issued: one by the Executive, and one by a special committee, and were distributed to all the Dominion and Provincial Land Surveyors in Canada, whose addresses could be obtained with any degree of certainty. As the committees dealing with these will probably report concerning the same, I will only add that 1,000 copies of each were printed, with an accompanying circular, at a total cost of $26.55. Of this number between four and five hundred of each kind are now on hand.

Since the publication of the list of members in the 5th Annual Report, the following D. L. S's have joined the Association, viz.: Messrs. A. L. Poudrier, Maurice Gaviller, H. Irwin, T. W. Chalmers, Jos. Cozens, A. J. Brabazon, J. L. Doupé, Arthur St. Cyr and John Vicars, while the Executive Committee have admitted Messrs. H. N. Topley, C. M. Odell and P. B. Symes to Associate Membership.

363 letters have been received up to the 13th inst., and 518 letters have been written. While on this subject I may say that the work of the Secretary-Treasurer would be much lighter, neater and more business-like, did the Association possess a type-writer, and as a certain amount of work must always be done on a type-writer, that item of expense would be done away with were such the case. I would therefore strongly urge upon this meeting, that the Secretary-Treasurer be authorized to purchase one, upon the best

possible terms, provided that the same can be done without loss to the Association.

Within the past year several Reports of the Department of the Interior, neatly bound, have been presented, as a contribution towards a library, by Mr. J. S. Dennis.

Regarding the finances of the Association, I beg to submit the annexed statement of Receipts and Expenditures. In connection therewith I would draw your attention to the following facts.

Dues received during year, terminating March 8th, 1887—$58.00; during year terminating March 14th, 1888—$100.00; during year terminating Feb. 18th, 1889—$208.00; while dues paid in advance for year terminating in Feby., 1890—$89.00; or in other words, dues for 1886 amounting to $83.00; dues for 1887 amounting to $87.00, and dues for 1888 amounting to $187.00.

Income from advertisements in Fourth Annual Report—$30.00; income from advertisements in Fifth Annual Report—$39.00; income from advertisements for Sixth Annual Report, as far as known—$62.00.

Sale of Annual Reports in 1887—50c.; sale of Annual Reports in 1888—$2.52.

The above quotations require no comment.

In conclusion, I would remind you, gentlemen, that during the past year, two of our "Original Land-marks" have been removed by death: J. A. Snow, one of the oldest and best known surveyors in the Ottawa valley; and C. E. Wolff, one of those who risked their lives in 1885 on the behalf of peace and order. Let us hope that their "meridian" was "true," and that they have at length reached that point which should have been the "Pole Star" of their ambition.

I have the honor to be, Gentlemen,

Your obedient servant,

ARTHUR O. WHEELER,

Secretary-Treasurer.

RECEIPTS AND EXPENDITURES

FOR YEAR EXTENDING FROM MARCH 15TH, 1888, TO FEBRUARY 15TH, 1889 (INCL.)

RECEIPTS.

By Balance on hand	$243 26	
" Sale of Annual Reports	2 52	
" Refund of pre-paid duty on Exchs	5 00	
" Advts. in Fifth Annual Report	36 00	
" " for Sixth " "	5 00	
" dues for 1885	5 00	
" " 1886	11 00	
" " 1887	18 00	
" " 1888	174 00	
" " 1889	89 00	
		$588 78

EXPENDITURES.

To Rent of Hall for Annual Meeting	$ 5 00	
" Sec.-Treas. for services	20 00	
" Lithographing for Fifth Annual Report	10 00	
" Publishing, printing and prepayment of duty on exchanges by John Lovell & Son	200 00	
" Purchase of reduced railway fare certificates	1 00	
" Discount on American cheque	15	
" Advertisement for shorthand writer	1 00	
" Stationery	6 10	
" Telegraph and Telephone	1 25	
" Freight and Expressage	18 10	
" Type-writing	9 00	
" Cab hire and cartage	1 97	
" Duty on electros	1 26	
" Postage	36 26	
		$311 09
Balance on hand	$277 69	

OUTSTANDING LIABILITIES.

To Hope & Co., stationery and printing	$ 3 90	
" A. S. Woodburn, printing and stationery	39 25	
		$43 15

REPORT OF AUDITORS.

OTTAWA, Feb. 21st, 1889.

TO THE PRESIDENT AND MEMBERS OF THE ASSOCIATION,

GENTLEMEN,

We, the undersigned Auditors, have examined the accounts of the Association, and find them kept with care, and correctly. There is a balance to the credit of the Association of $277.69, and outstanding liabilities of $43.15; the Bank deposit of $294.44, as shewn by the bank book, agrees with the statement given us by the bank.

T. D. GREEN,
E. G. MACMARTIN.

NOTE:—As will be seen from the above, the bank deposit exceeded the balance shown by the Sec.-Treasurer's statement; this may be accounted for by the fact that sundry amounts were paid in subsequent to the closing of the accounts of the Association and the submitting of the same to the auditors.

SECRETARY-TREASURER.

REPORT OF STANDING COMMITTEE ON GEODETIC SURVEYING.

TO THE PRESIDENT AND MEMBERS OF THE ASSOCIATION OF DOMINION LAND SURVEYORS.

GENTLEMEN,

The Standing Committee on Geodetic Surveying beg to report as follows:—

The term "Geodetic Survey" may properly be applied to all surveys of precision of such extent that the curvature of the earth has to be taken into consideration. This distinguishes Geodetic Surveys from those made for the purposes of settlement merely, which come under the purview of the Standing Committee on Land Surveying.

Although the Dominion Lands township surveys have been made on a very large scale, more extensive in fact than have been many Trigonometrical and Geodetic Surveys; and although the Dominion Lands system is consequently based necessarily on consideration of the figure of the earth, yet the practical execution of these surveys in detail is a matter of simple surveying.

The Standing Committee on Geodetic Surveying are, therefore, restricted to surveys, such as are referred to in the Dominion Lands Act, as "extensive governing surveys." The Committee have to say

that no surveys of this kind have lately been made in Canada, and so they have nothing new to lay before the Association, and they have failed to induce members to contribute papers on subjects within their domain. Furthermore, they cannot extend their researches into the region of Exploratory and Topographic Surveys, &c., by the fact that the Standing Committees on Topographical Surveying and Photography bar the way.

Again, the one subject which has come before the Association, and which this Committee is in a position, as a Committee on Geodetic Surveying, to discuss, namely, the proposed Trigonometrical Survey of Canada, has been delegated by the Association to a special committee appointed for the purpose.

The Standing Committee on Geodetic Surveying feel, therefore, that, like Othello, "their occupation's gone," for the present year at least, and they beg to report that they have done nothing.

W. F. KING,
Chairman.

REPORT OF STANDING COMMITTEE ON PUBLICATION.

To the President and Members of the Dominion Land Surveyors' Association.

Gentlemen,

The Standing Committee on Publication have the honor to submit the following report of the printing and publishing performed since the last annual meeting.

As soon as a proper estimate of the number of pages and the number of Reports to be issued was ascertained, the Secretary-Treasurer solicited tenders for the printing thereof from the principal printing establishments of Canada, and when these tenders were received, a meeting of this Committee was called, and then decided to award the contract to J. Lovell & Son, of Montreal, on account of their prices, style, and experience in such reports. This firm, at the same rate, also printed the Memoranda of the different committees on Geographical Nomenclature and Orthography, and on the question of a Trigonometrical Survey of the Dominion.

On the whole, the printing and general construction of the Report and Memoranda are creditable; but, as it is desirable to produce as neat and compact a Report as possible, any suggestions regarding the improvement of the publication of the next Annual Report will be thankfully received.

Owing to our professional callings to the Northwest Territories, we regret to state that we have been unable to properly attend to our duties in this matter; and your worthy Secretary-Treasurer, with his customary zeal, has attended to the duties in connection with this branch of the Association during our absence, and we wish to take this opportunity of thanking him for his kindness.

The total amount of printing and publishing done since the last annual meeting is as follows:

125 Copies of a circular, issued for the purpose of notifying a member that his subscription was due, as well as a resolution of the reduction of 50 per cent. of the arrears, provided that reduced amount be forwarded before the 1st day of May.

200 Copies of forms for name, degree or degrees, occupation and address of the individual members.

225 Copies of a circular, giving a synopsis of the proceedings of the last annual meeting.

750 Sheets of official note paper.

1000 Official envelopes.

2000 Official wrappers.

250 Sheets for statements of accounts.

100 Circulars soliciting the presence of, and a paper from, the different members of this Association.

100 Nomination papers.

100 Ballot papers.

100 Envelopes for ballot papers.

400 Announcements, programmes, and invitations.

1000 Circulars soliciting any information which would tend to show the benefits of reliable maps compiled from data of a Trigonometrical Survey.

1000 Copies of the Memorandum submitted by the committee appointed to consider the question of a Trigonometrical Survey of the Dominion.

1000 Copies of the memorandum submitted by the committee on Geographical Nomenclature and Orthography.

700 Copies of the fifth annual report of the proceedings of this Association.

This concludes the printing and publishing for the past year, but will doubtless be increased the coming year, as it is deemed expedient to issue 1,000 copies of the next annual report.

In conclusion, we beg to suggest that the Association authorize and instruct the Secretary-Treasurer to procure a stamp, bearing the arms of the Dominion, supported by the lion and unicorn, and to have all papers and reports of this Association marked with the same. All of which is respectfully submitted.

Signed on behalf of the Committee.

T. D. GREEN,
Chairman.

REPORT OF STANDING COMMITTEE ON LAND SURVEYING.

To the President and Members of the Association of Dominion Land Surveyors.

Gentlemen,

The "Regulations for the government of survey parties in the field," submitted at the last annual meeting of the Association, by John MacAree, Esq., D.T.S., of Toronto, having been referred to the Committee on Land Surveying, they beg to report as follows, viz.:

That we believe rules or regulations will not make men more serviceable than they naturally are; that men employed on surveys should be engaged as laborers, and should do anything required of them. In our opinion it does not follow because a man wishes to engage to perform certain duties, that he will be able to fulfil his engagement more satisfactorily than some other member of the party that the surveyor may choose himself. Men employed on surveys are not usually overburdened with wealth, and when engaging are quite willing to agree to anything to get employment. The surveyor should make his own selection, from the members of his party, of those best suited to fill the different positions; and as men unacquainted with survey work will usually require some training, he should show every man what to do and how to do it. He should never allow loafing or shirking of duties. Should he not succeed in getting his men to do as he wants them, the sooner he dispenses with their services the better.

If on contract, a surveyor might engage his men at the highest rate of wages going, to perform certain work, should he be able to judge, according to the nature of the country, what would constitute a fair day's work. If not, he might engage his men at the common rate of wages; when they have become acquainted with their various duties, and have an idea how much work can be performed in a day, if all are good, willing men, offer them additional pay, say five or ten dollars per month, to keep up a daily average of a certain number of miles every day they work. Should any of the men be inclined to shirk their duties, offer 40, 60 or 80 dollars a month extra to the party, to be divided according to the actual value of each man's services in the party, so long as they keep up the same daily average every day they work. The men are then on contract as well as the surveyor, and are not only interested in the success

of the expedition so as to secure their wages, but are also interested in securing the bonus. There will then be no grumbling about long or irregular hours of labor, no trouble about getting up in the morning, and no calculations as to the depth or temperature of a swamp or pond of water they may have to wade; but instead of this, there is a willingness and determination to overcome difficulties, while advantage is taken of everything they can think of to further the work.

The surveyor finds everything made ready to his hand, is saved an endless amount of trouble and annoyance, and will make two dollars for every one he has thus so judiciously expended.

Regarding surveys for the Government, when men are employed by the day, the situation is somewhat different. Usually the surveyor will have to give the full amount of wages allowed by the Government, to procure men for the work. There is then no chance of giving a bonus to the men, as the Surveyor cannot afford to give it out of his own pocket.

On contract whether the men get an additional allowance or not, their pay, to a certain extent, depends on the success of the expedition, and consequently on their own exertions. Men also that would do a fair day's work on a contract survey are useless on Government work. There are very few honest men when engaged on a Government survey; they have no idea of giving a fair day's work for a fair day's pay. We believe that experience has taught nearly all surveyors employed on Government work that this is true; also that a Government survey is considered to be a summer picnic, where work should not interfere with the pleasures of the party.

The pay is sure, so it makes no matter how little or how much work is accomplished.

When the party gets to work, some of them do not find it so agreeable an occupation as they had anticipated, consequently they begin to grumble, shirk their duties, and cause a general disturbance in camp. The only thing the surveyor can do is to discharge those that are dissatisfied, and take chances of replacing them with better men.

What difference will it make if he has read over those Regulations when engaging them? Or if they have been included in the contract or agreement? None, whatever; because if you have to discharge a man, whether under contract or verbal agreement, you must pay him his wages due, or otherwise he is not discharged, and could claim pay to the end of the season.

Men engaged under written contract for the season, and paid by the day, must be settled with up to the day they are discharged. While men signing a contract, agreeing to work a specified time for a certain sum of money, can be discharged at any time for incompetence or disobedience of orders, without receiving any pay.

We believe some men may be frightened by signing contracts, but it will rarely make them more agreeable, willing or valuable workmen than what they otherwise would be. Men that have been warned about long or irregular hours of labor, wading swamps and ponds, fighting flies and mosquitoes, and have made little of such things as being of no consequence, when engaging on surveys, are often the first to make a noise about them.

Those who make light of hardships are often those who have not experienced any, and are less likely to endure them.

We do not believe in rules to govern survey parties in the field, nor do we believe when engaging men to have them sign an agreement or contract, but think that in the future, as in the past, it will be better for each survey party to be "a law unto itself;" and that the surveyor's own *ipse dixit* be his authority for promulgating such laws as he may think fit. It is sufficient that men be guaranteed board and pay; in return for which, whatever there is to do, they should do it with all their might.

We would, therefore, recommend that, although the Regulations pretty well cover the duties of the various members of a survey party, no action should be taken regarding them by the Association.

JOHN McLATCHIE,
Chairman.

REPORT OF STANDING COMMITTEE ON NATURAL HISTORY AND GEOLOGY.

To the President and Members of the Association of Dominion Land Surveyors.

Gentlemen,

Your Committee beg to report as follows:—

(1) Some attempt was made last Spring to enlist the various Dominion Land Surveyors in the Government employ, to make small collections of Natural History objects in the various localities where they were working, but as far as we are aware with only partial results.

(2) Since our meeting Mr. W. Ogilvie, D. L. S., one of your own members, and Mr. McConnell, of the Geological Survey, have returned from their explorations in the Arctic regions. Though these gentlemen did excellent service in every other branch, their Natural History collections were very meagre.

(3) The cause of this is not far to seek, and it would be unfair to these gentlemen not to state it. Natural History investigations were not included in the scope of their work, and their time and means were fully employed in other spheres of labor.

(4) Mr. J. M. Macoun accompanied Mr. Fawcett's party to the Athabasca and English River districts as naturalist; but having to perform the work of an assistant as well as naturalist, the results obtained were not so valuable as they would have been if his whole time had been devoted to Natural History work.

(5) I am happy to say that all the members of the Association were not neglectful of their opportunities, and I have much pleasure in mentioning the name of Mr. G.E.McMartin, who procured a fine specimen of the Rocky Mountain Long-eared Rat at Pincher Creek, and another of the Acadian Owl from St. Andrews, near Montreal.

In conclusion, allow me to express the hope that after the explanations of this evening, numerous gentlemen will emulate the example of Mr. McMartin, and send us numerous fine specimens next year.

Signed on behalf of the Committee.

JOHN MACOUN,
Chairman.

REPORT OF STANDING COMMITTEE ON PERMANENT MARKING OF SURVEYS.

Man's life is but a surveying bout,
And he's best engineer
Whose perfect transit ne'er is out,
Whose plan and lines are clear.

OLD POEM.

With regard to carrying out the suggestions in the paper "on the permanent marking of public Surveys in the field," published in the Report of the D. L. S. Association, in March of the year 1888, the undersigned would observe:

That there are two points which seem to demand special consideration: 1st. By what means can Surveys be marked in the

field, so as to perpetuate them; and. How can the results of those Surveys be published in a concise and convenient form, so as easily to give whatever information can be derived from them.

The plough in the field, fire in the bush, are powerful agents for the destruction of timber-posts. Trees are becoming too scarce to be spared for landmarks, and but for hard fighting with the fire every season, they would be even scarcer. Maps, to give accurate information, must be on a scale so large as to forbid their being published. Field notes are also difficult and expensive to publish, and occupy a good deal of space. If then Surveys are to be made permanent, and the information they furnish is to be given in such shape as to be easily packed away for future use, and yet to be always at hand, available for whoever wants it, there will have to be a departure from the wooden post and inscribed tree, and there must be some additional record of the work besides the usual plan and the report accompanying it. What then is to be substituted for the discarded landmarks, and what better method of recording shall we adopt?

It is hoped the accompanying table of co-ordinates, illustrated by a diagram of an imaginary Survey, will afford a satisfactory answer. Such a table is easily published, one page of a "blue book" would give enough for an extent of many miles. The diagram is nicely illustrative. A township plan showing the transit line of a Railway Survey being at hand, was taken advantage of, and a few hypothetical notes were added. A writer in one of the "exchanges" says: "if you leave plenty of marks, you have the Contractor (or whoever comes to disturb the Survey lines) by the throat, the lines can be restored if necessary." It is presumed the *modus operandi* is obvious. Lot corners, creeks, houses, intersections of roads, serve for points of reference, and though some may be lost, enough will remain to make the survey permanent.

In an extensive exploratory Survey like that of the Ottawa Ship Canal, it would be difficult to give precise rules—the Surveyor would have to do the best he could. Rocks in remarkable places, as for instance at the head of an Island, might be marked. Iron posts such as are used in the North-West would serve well for mile posts. They are light, imperishable, and useless for any other purpose, "Lo the poor Indian" lets them alone, so the chances in favor of their permanency are good.

It is unfortunate that the services of Messrs. Webb and Dumais, who were appointed with the undersigned to act as a Committee, could not be obtained. This unaided effort to meet the wishes of

the Association necessarily falls very far short of what might be expected from the better judgment and experience of those gentlemen; but it must be either this or nothing, and it is hoped its defects will be viewed with leniency. The endeavor is to show that Surveys may be made permanent at a trifling additional expense, and that the information forthcoming from them can be conveniently and concisely given, in a great measure if not entirely, independent of a map.

Submitted with deference by

S. L. BRABAZON,
Chairman.

PORTAGE DU FORT, 1st Dec., 1888.

P. S.—Since the above was written, the courses and distances of the transit line and the co-ordinates of the initial point of each course have been added to the table before mentioned. It is scarcely necessary to say that as long as one recorded mark can be found, any other can be established by means of it. Corners of lots, in a settled country, may be regarded as permanent marks, conflicting interests tending to preserve them. The data are more than sufficient for the utilization and permanency of the Survey, but the work would be more complete and valuable if permanent bench marks had been made and were recorded.

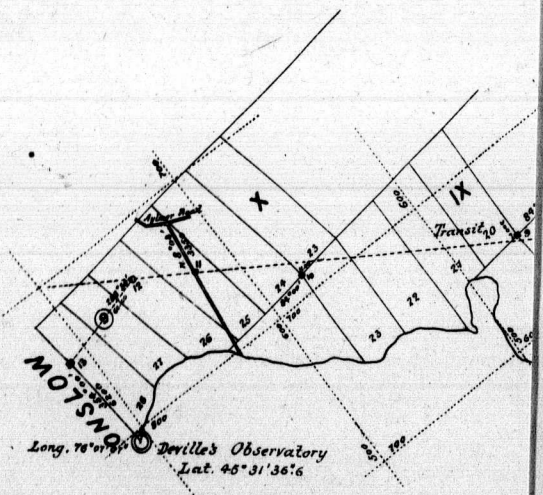
TABLE of co-ordinates of certain points in the Township of Eardley, County of Ottawa, Que., determined by the survey of the Montreal Northern Colonization Railway, the axis of X being the meridian, and that of Y a line perpendicular thereto.

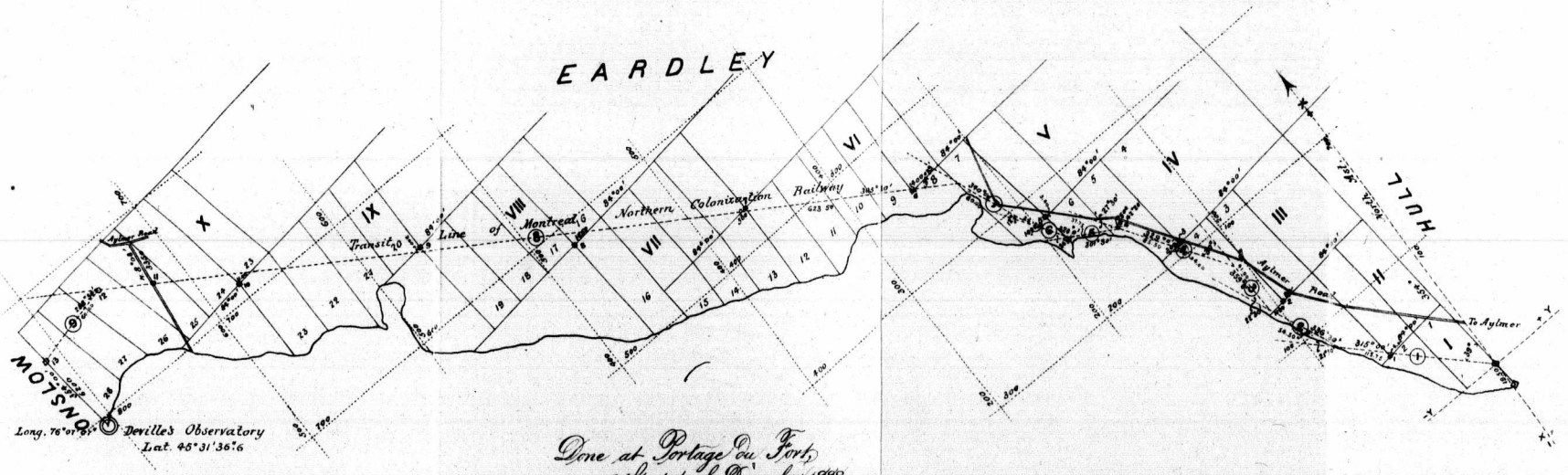
	Co-ordinates.	
	X.	Y.
Origin of co-ordinates on E outline of Eardley 19.5 chs. from S.E. boundary of Township on the bank of the River Ottawa.....	0.00	0.00
S. Boundary post between Eardley and Hull	—19.50	+2.00
1 S. W. corner of Lot 2, R. II.....	55.00	—58.50
2 S. W. corner of 3, R. III, 9 chs. W. of Aylmer Road.....	131.50	94.50
3 S. E. corner of 5, IV, 4 chs. W. of Aylmer Road.....	208.50	128.40
4 S. W. corner of stone foundation of M. N's dwelling house on Aylmer road.....	243.75	150.00
6 S. W. corner of 8, VI.....	283.00	191.00
7 S. E. corner of 13, VII.....	427.00	361.00
8 S. E. corner of 17, VIII.....	484.00	474.00
9 S. E. corner of 20, IX.....	553.00	564.50
10 S. W. corner of 23, X.....	613.50	676.50
11 Intersection of transit line with E. fence of road 33.50 chs. southerly from Aylmer road	650.00	723.50

	Co-ordinates. X.	Y.
12 Rock marked with a cross thus +.....	670.00	755.50
13 Intersection of transit line with W. outline, 62 chs. from S. W. corner.....	654.60	873.30
14 S. W. corner of Eardley, Latitude 45°, 31′, 36″.6 as determined by Deville....	593.50	806.35

No. of Line.	Transit Line. Course.	Distance chains.	Initial Point. X.	Y.
1	315° 00′	115 75.....	0.00	0.00
2	336 30	54 50.....	81.50	83.00
3	359 00	41 00.....	130.00	105.60
4	329 00	85 50.....	171.00	107.50
5	300 30	37 95.....	243.50	155.50
6	328 00	26 00.....	261.50	187.50
7	340 00	61 50.....	283.00	202.00
8	305 30	623 50.....	340.00	226.00
9	258 30	60 00.....	670.00	755.00

Convergence of Meridians say 1′ 4″ p. 100 chains.


X
IX
Transit
MONSLOW
Long. 76°01'
Deville's Observatory
Lat. 45°31'36"6



Done at Portage Du Fort,
on the 1st of December 1888.
S. L. Brabazon, D.L.S.
To accompany report of even date.

77 ft.
North Side
Level
N.E.

REPORT OF STANDING COMMITTEE ON PHOTO-TOPOGRAPHY AS APPLIED TO TOPOGRAPHICAL SURVEYING.

MR. PRESIDENT AND GENTLEMEN,

I have the honor to present the Report of your Committee on "Photography as applied to Topographical Surveying."

In preparing our Report we have thought it best not to attempt a detailed statement and proof of all the constructions or problems involved, as we understand that a work on the subject by E. Deville, Esq., Surveyor-General, is now in press, and, as he is the father of the science (if I may so term it) in this country, it will necessarily be much more complete than anything we could hope to offer.

We will therefore confine this report to a short sketch of the history of the work, the method used in the field, and the explanation of one or two of the problems solved in plotting the topography from photographs.

The field work in this branch of our profession is very laborious, involving suffering from thirst, hunger, cold and extreme physical fatigue.

Every ascent and descent, together with the taking of the necessary photos and reading of angles, is performed in the same day; which sometimes necessitates from twelve to fifteen hours of the most severe physical exercise.

At the commencement of the work, on good climbing, a progress of 800 feet in elevation per hour is about the average; but toward the end of the season, when all superfluous flesh has disappeared, and a man's muscles are as hard as nails, a better rate is made, and sometimes 2000 feet per hour is accomplished.

Again, a "snag" may present itself, and 400 feet per hour is good time.

These are not all the hardships.

The great mental agony, caused by driving pack horses, can only be known to those who have tried it. If any man is in the habit of using "emphatic" language and wishes to cure himself, let him take half-a-dozen pack horses and start into the mountains.

In two hours he will have found out the ineffectiveness and foolishness of all the "cuss" words in the English vocabulary, and the *utter* insufficiency of all language to do justice to the occasion.

The application of photography to topographical work is no new idea, but has been tried more or less in several European countries

during the present century; but has *not* been developed and used in *any* country to the extent practised and contemplated in Canada.

In the spring of 1887 the Department of the Interior sent out two parties under special instructions from the Surveyor-General, who had developed the system of "Photogrammetry," and written a pamphlet on the subject for their guidance.

Both parties were equipped with cameras and prismatic transits, and were ordered to the Rocky Mountains for the purpose of carrying on a Topographical Survey; one party under J. J. McArthur, D.L.S., working in the summit range of the Rockies proper, and the other, in charge of the writer, in the Coast Range.

The astronomical traverse of the Canadian Pacific Railway was used as a base, and from this a triangulation was extended back into the mountains, the stations occupied being generally the highest peaks. The instruments used for triangulation purposes were 3½ inch prismatic transits reading to single minutes by two verniers.

Signals were sometimes used, but more often the readings were taken on the peaks themselves.

The height of stations was determined by reading angles of elevation or depression from station to station, allowance being made in the calculations for curvature of the earth and refraction.

The cameras used were "Eastman Detective" with drop shutters, using roll films. With these a series of photographs embracing the surrounding country were taken, by time exposure, from each of the instrument stations occupied.

From these photographs the topography was laid down on the plan. The work during that year was very largely experimental, as nothing of the kind had been attempted here before.

Owing to the unsuitability of the roll films, and delay from smoke the result was not as good as hoped for, but was sufficiently good to show the feasibility of the work, and the great advantage in cost over any other method. We consider that to make as accurate a survey of the same country by the ordinary methods would cost from ten to fifteen times as much; while much of it could be done by no other method, of which we have knowledge, than photography.

Accordingly, in the spring of 1888, the two parties were again sent out: one to the summit range of the Rockies in the vicinity of Banff, and the other to the Crow's Nest Pass. The same transits were used, but English cameras, with Dallmeyer lenses, using glass plates, were substituted for the Eastman cameras and roll films. The work was carried on in much the same manner as the preced-

ing year, with the exception that, in the triangulation, all angles were read twice on signals, the sides of the primary triangles varying from seven to twelve miles; as before, photographs of the surrounding country were taken from all instrument stations.

The results were satisfactory, the photographs turning out well, and about seven hundred square miles of the country being covered. No developing was done in the field, all negatives being securely boxed and forwarded to Ottawa, where they were developed and printed by Mr. H. N. Topley, photographer to the Department of the Interior.

This entailed a very large amount of work, as about six hundred and seventy-five plates were exposed. The negatives were all enlarged to four times the original area by the "Bromide" process, on the principle that plotting with a protractor of ten inches radius is more accurate than with one of five.

This brings us to the application of the photographs to topography.

We will state at the outset that the cameras were furnished with levels to insure the verticality of the plates, and the focal length was constant.

Now a photograph, apart from small errors arising from the lens, is a true perspective.

In perspective drawing we have the *object* or its *plan* to produce the *perspective;* here we have the *perspective* to produce the *plan*. So, if to the perspective we apply the reverse of the problems used in forming it, we have the means of making our plan.

To do this, we must know the focal length of the camera, which is the distance of the picture plane from the station point, and we must also know the distances apart and relative positions of the different stations.

This latter is found by plotting the triangulation, and the focal length is found by a simple process already described in works on the subject.

In connection with the taking of each view, zenith distances and azimuths are measured with the transit to two or more peaks appearing in that view. As we know the focal length, by a simple construction, the distance of the peaks above or below the horizontal plane can be laid off on the photograph on its scale, and the horizon or horizontal line drawn in its proper position.

The position of the centre of vision or point of sight on the horizontal line is found at the same time as the focal length; and the trace of the principal plane, in which it lies, is drawn on the photograph from marks, photographed in each view from fixed marks on

the plate holder, whose positions in regard to the principal plane are known. The intersection of the trace of the principal plane and horizontal line is the centre of vision or point of sight.

In our work, the projection on the plan of a straight line in space, through the station point and point of sight, is called the principal or centre line.

It may be projected on the plan in the following manner :—

From the azimuths measured with the transit, we know the direction from the station of some one of the peaks appearing in the photograph. A line in this direction is drawn on the plan. Next measure on the photo, with a pair of dividers, the distance of the perspective of the peak from the trace of the principal plane.

By using a scale of one hundred equal parts, the focal length and the distance measured on the photo, the natural tangent of the angular distance between the peak and point of sight may be found, and the principal or centre line projected on the plan.

Or, on the plan, find by trial a point at the distance of the focal length from the station, and, at the same time, at the distance taken from the photo (measured at right angles to the first distance) from the line drawn in the direction of the peak.

The point thus found is the projection on the plan of the point of sight.

Through this point draw a line from the station and also a line perpendicular to the first. These are respectively the projections on the plan of the principal and picture planes, and are the *centre line* and *picture line.*

Suppose the same operation gone through with a photo taken from an adjacent station, so that its centre line will intersect that of the first at an angle of, say, about 60°.

It is evident that many of the same points appear in both photos. Now if a number of these points be selected, and their distances from the trace of the principal plane laid off on their respective picture lines, then if lines be drawn through corresponding points from their respective stations, their intersections *must* be the projection on the plan of the several points.

The points thus established may be points on the crest of a ridge or spur, on a mountain side or on the bed of a stream. By using their projections on the principal plane, their distances from the picture plane and above or below the horizontal line, we obtain, graphically, their elevations in relation to the stations from which they were located.

The fact is thus revealed, that so far the application resolves itself into a graphical solution of triangles.

We can thus fix any number of points, and then have an accurate guide for sketching in contours, with the additional advantage of a photograph of the country before us.

The matter does not end here, however.

Suppose the points already laid down mark the direction of the crest of a ridge or the slope of a spur, and, as is most probably the case, that it is the same for some distance. Other laws of perspective being used as a basis, we are able to lay down on the plan the points of intersection of the several contour planes with the crest of that ridge of spur.

One law used in this problem is "All lines which in the object are parallel vanish in the same point."

The direction of the ridge, in regard to the centre line of the photo in which it appears, is obtained from the plan by aid of a protractor.

Now, suppose a vertical plane, cutting the contour planes, is passed through the length of the line marking the crest of the ridge. It is evident that the intersections of this plane with the contour planes are horizontal lines lying in the direction of the ridge, and therefore parallel; then, by the rule given above, they all vanish in the same point.

We will find this point.

Another law of perspective tells us that all horizontal lines, not parallel to the picture plane, vanish in the horizontal line; therefore the point in which the lines vanish is in the horizontal line.

The projection on the plan of the vanishing point is then found by drawing a line from the station point parallel to the direction of the ridge; its intersection with the picture line is the projection of the vanishing point sought.

We are now dealing with vertical distances, and must consider our construction in elevation, and will suppose the vanishing point projected on the horizontal line. The next step is to find the space on the photo which represents the distance apart of the contour planes.

Suppose a vertical plane passed through the station point and some one of the points (which we will call A) located on the crest of the ridge.

The intersection of this plane with the vertical plane passed through the crest of the ridge is a perpendicular line, as is also its intersection with the picture plane; and, from the nature of perspective, this last perpendicular is the perspective of the first, and must pass through the perspective of the point A (which we call A^1).

Now, if the perpendicular through A be divided into spaces equal to the distances apart of the contour planes on the scale of the plan, and in such a manner that the point A occupy its proper height in regard to a contour plane; then if straight lines be drawn from the station point to each of the divisions on the perpendicular through A, it is evident that their points of intersection with the perpendicular through A^1 will mark, on that perpendicular, the distances apart of the contour planes on the scale of the photo.

These points on the perpendicular through A^1 are evidently the perspective of the points on the perpendicular through A; we therefore have the perspective of two points in each of the lines, found by passing a vertical plane through the crest of the ridge, and cutting the contour planes, viz.:—the vanishing point and the points just found on the photo.

Now, if from the vanishing point we draw a line through any one of the points last found, it is evident that its intersection with the perspective of the crest of the ridge is the perspective of the point of intersection of the contour plane in which it lies. The above is the explanation of so much of the problem; but, as everything was considered in space, it is evident that a slightly different method must be adopted to make practical use of it.

It is done by considering the vertical plane, passed through the station point and A, as revolved about the perpendicular through A^1 until it coincides with the picture plane. Both planes are then revolved about the horizontal line, until they coincide with the horizontal plane—which may be considered as the surface of the drawing board.

The station point and point A appear on opposite sides of the point A^1 at their proper distances from it. The perpendicular through A^1 may then be divided, as before, by drawing lines from the station point through the points of intersection of the contour planes with the perpendicular through A.

Then from the vanishing point draw lines through the points of division on the perpendicular through A^1. The intersections of these lines with the perspective of the crest of the ridge are, as before, perspectives of the points of intersection of the contour planes with the crest of that ridge.

Having found these intersections, we next mark off their distances from the trace of the principal plane on a slip of paper, or measure them with dividers, and transfer them to their respective picture lines; lines being drawn through these points from their respective stations, their intersections with the line marking the

crest of the ridge are the projections on the plan of the intersections of the several contour planes with that ridge, and the problem is solved.

The reason for going at such length into the above problem is, that we know of no book, yet given to the public, in which it appears.

The solution of another problem enables us to lay down on the plan an accurate traverse of any lake or stream, the height of the station from which the photo was taken above the lake or stream being known.

There are many other problems, but those mentioned above are the ones most often used, and time and space prevent further trespass on your patience.

W. S. DREWRY,
Chairman.

OTTAWA, Feb. 21, 1889.

REPORT OF COMMITTEE ON TOPOGRAPHICAL SURVEYING.

TO THE PRESIDENT AND MEMBERS OF THE ASSOCIATION OF DOMINION LAND SURVEYORS.

GENTLEMEN,

As Chairman of the Committee on "Topographical Surveying," a Report is expected from me.

Being at present not actively engaged in that class of work, my Report will not be confined to any particular field of action, but will treat the subject in its widest scope.

Prefatorily I may state that we have no organized "Topographical Surveying" in Canada. The result of "Topographical Surveying" is a "Topographical Survey."

Let us see what a Topographical Survey means. It means that the face of the country has been accurately delineated in both horizontal and vertical measurements; it means that all the natural features of the country are accurately shown and drawn on maps; it means that the geologist is in possession of a plan, whereon he can with confidence show the accurate position of rock formations, deposits of economic minerals, can elaborate geological maps for the information of the public and those especially interested in the mineral industries—that industry to which, to a great extent, the future greatness and development of Canada depends; it means that the naturalist can more intelligently study the fauna and flora of the

country. Is not agriculture to a large extent a function of the Topography of the country? Will any one attempt to deny that our lately organized Experimental Farm at Ottawa, with branches in the various provinces, would not reap vast benefits in solving many problems in agriculture, horticulture, and arboriculture, were a topographical survey extant? It means that the engineer is afforded a reliable basis for computing the available basin from which to draw water supply, or where he can the most advantageously and economically project a railway; it means that the meteorologist will be assisted in solving the mysteries of atmospheric phenomena, especially of local storms.

It means in fine that every citizen of our beloved Canada would be benefited directly or indirectly.

Probably to no one is the value of a topographical survey, from a pecuniary point of view, so apparent and so directly valuable as to a person interested or engaged in mining operations. The elaborate plates of the mining regions in Pennsylvania and Colorado can bear witness to this.

We have not a great deal of scientific work prosecuted by the Government, and the Nation has not as yet learned to appreciate the results of national scientific work. I know that some people have the idea that we live in too "practical" an age to spend time and money in pursuit of "Science," which to them is synonymous with something "mysterious" and "impracticable."

The object of Science is the discovery of truth, and the practical man applies that discovery.

When a new important invention by Mr. Ingenuity is flashed over the world, who knows on how many men's brains the inventor has fed, until his skill could evolve that self-same invention, how many years of toil and labor had been spent in laboratory and field to furnish the necessary "truths" to make such invention possible.

As Darwin, Haeckel and Huxley have given us the theory of Evolution in life, so there is an evolution and development in the appliances for the amelioration of the condition of man.

Science and its practical application must go hand in hand, otherwise neither one bears its true usefulness.

What position would Germany occupy to-day in spite of the unification in 1871, were she not pre-eminently a nation of scientific attainments? There is not an industry in the Empire that does not keenly observe the researches of the devotees of Science, and quickly absorb any new discovery, and wisely does the Government encourage both.

Lest the subject become trite by further illustrations of the importance of a scientific basis for all work, I will revert to the subject proper.

To every one familiar with the subject at all, it must be patent that a topographical survey attains its full value only when it is based on a geodetic survey. As we have a special committee for that branch, I will leave any further reference to it for the Chairman thereof to report thereon.

Two questions present themselves to my mind in connection with a topographical survey: The first is what organization is to perform it, and secondly where shall the survey begin.

That such a survey must be a national undertaking, and hence under federal patronage, is certain. That at its inception it must be laid down in broad lines for future development is also evident, and furthermore that from the beginning the work be prosecuted with the thoroughness attainable by modern and refined methods.

Such survey should not be prosecuted as an isolated work, but should be in sympathy with allied surveys, so that they combined will supplement each other and blend into one harmonious whole, creditable as a work of Science, and beneficial to the people of Canada who pay for its execution.

I intentionally leave my two questions unanswered, in the hope that they may provoke discussion.

Of the methods of survey to be pursued I will leave for future consideration.

To me it would have been interesting to have dwelt somewhat on "Photogrammetry," an art which has of late years been extensively developed in Italy and Germany; but as our Association has a Committee on that subject, the prerogative of its Chairman is respected.

Before closing I take pleasure in giving the following extracts from Vol. I. of the Geological Survey of New Jersey, just issued:

"And now that the Geodetic and Topographical Surveys of the "State are completed, the final report of the Geography of New "Jersey is presented in this volume. At the beginning of the Sur- "vey no such work as is here given entered into our plans. But as "the successive reports appeared, and as the attempts at descriptive "Geology were made, it became apparent that for the study and "preparation of useful geological reports, it was necessary to have "accurate maps—maps which would show the location of all the "important geographical points, and also the outlines and elevations "of the hills and valleys, and their heights above the sea level. "There were no such maps of New Jersey in existence, nor indeed

"of any others of the United States. In the first attempts to pre-
"pare such, it was considered doubtful whether the expense could
"properly be incurred; but when they were issued, the approval they
"met, both from the people and the Legislature, gave assurance
"they supplied a felt want. . . . . The Geodetic Survey of
"the State was made, in order to fix accurately the latitudes and
"longitudes of points in the various parts of the State. They were
"necessary for furnishing correctly located points about which the
"Topographical Surveys could be arranged and located."

In conclusion, it is to be hoped that "Topographical Surveying" will become a permanent feature of the work prosecuted by the Department of the Interior.

May this meagre report on so extensive and so important a subject meet with your approbation.

OTTO J. KLOTZ,
Chairman.

OTTAWA, Feb. 21, 1889.

REPORT OF SPECIAL COMMITTEE ON GEODETIC SURVEY FOR CANADA.

OTTAWA, 16th February, 1889.

TO THE PRESIDENT AND MEMBERS OF THE ASSOCIATION OF DOMINION LAND SURVEYORS,

GENTLEMEN,

The committee appointed at the last annual meeting of the Association for the purpose of taking "such necessary steps as they deem advisable, in order to bring before the Government the urgent necessity of a Geodetic Survey of the Dominion," beg to report as follows:—

The committee prepared a memorandum on the subject, which was included in the Annual Report.

Furthermore, copies of the Memorandum were sent to every member of the House of Commons and Senate, and to all the Deputy Ministers.

The committee also communicated with a number of persons in the Dominion, of high professional attainments and competent to express opinions on the subject that have weight. In every instance the efforts of the committee as expressed in the Memorandum were highly approved of by these gentlemen, and their services offered to help to further the inception of the Geodetic Survey.

The committee has also brought the matter before the Government and are pleased to be able to report that the Government favorably entertains the Memorandum presented.

This is a brief outline of the work of the committee since the last annual meeting of the Association. In conclusion the committee beg to suggest that any further efforts that are to be made in this matter be assumed and done by the Standing Committee on Geodetic Surveying.

All of which is respectfully submitted.

OTTO J. KLOTZ,
Chairman.

REPORT OF COMMITTEE ON REDUCED RAILWAY FARES.

OTTAWA, February 19th, 1889.

MR. PRESIDENT AND GENTLEMEN OF THE ASSOCIATION OF DOMINION LAND SURVEYORS,

Your Committee to enquire and confer with the different Railway Companies with regard to allowing Dominion Land Surveyors reduced rates to and from the Association meetings, beg to report as follows:

The General Passenger Agents of the Grand Trunk Railway and the Eastern and Western Divisions of the Canadian Pacific Railway were communicated with to find out what could be done in the matter. In reply, memos. regarding Reduced Fares to Conventions, etc., were received from the Grand Trunk and Eastern Division of the C.P.R., which set forth that Reduced Rates would be granted to Delegates to our Association Meeting at the rate of one fare and one-third for return trip, provided there were twenty-five or more Delegates attending the said meeting who had paid Railway fares; if less than twenty-five, at one and two-thirds, which last amounts to the ordinary return rates.

In order to take advantage of these reduced rates it is necessary that a certificate, on a form supplied by the Companies, should be signed by the local agent who issues the ticket to the place of meeting, and that the Secretary-Treasurer of the Association should certify upon the back of the same form the number of delegates attending the meeting. Further communication elicited the fact that it is not necessary that twenty-five delegates should travel over the same road or that certificates should be held by that number;

all that is required to entitle holders of certificates to the reduction is that twenty-five delegates should have paid railway fares.

The General Passenger Agent of the Western Division of the C.P.R. made a similar proposition, but your Committee could not take advantage of the same as it was on the condition that twenty-five delegates should travel over that road West of Port Arthur, and no such number being available, arrangements could not be made.

Your Committee instructed the Secretary-Treasurer to obtain the necessary certificates and to transmit one to each member likely to make use of a railroad to reach the place of meeting, and this we understand has been done, as also to other parties applying for them.

Further information may be obtained by referring to the papers, in connection with this matter, on file with the Secretary-Treasurer. In conclusion your Committee would suggest that in future years a similar privilege be sought from the Intercolonial Railway, as also better terms from the Western Division of the C.P.R.

All of which is respectfully submitted.

Signed on behalf of the Committee.

G. B. ABREY,
Chairman.

REPORT OF SCRUTINEERS OF BALLOTS.

Feb. 21st, 1889.

To the President and Members of the Dominion Land Surveyors' Association,

We the undersigned scrutineers appointed to examine and count the ballots sent in for the election of officers for this Association for the current year, beg to report that we have performed that duty, and find the votes to be as follows:

Total No. of ballots received—45.

Votes for President.

J. S. Dennis	21 votes.
E. J. Rainboth	14 "
G. B. Abrey	9 "
	— 44

1 Blank.

For Vice-President.

William Ogilvie	27 votes.
John McAree	7 "
Thos. Drummond	6 "
I. J. Dufresne	5 "
	— 45

FOR SECRETARY-TREASURER.

A. O. Wheeler	44 votes.
S. Bray	1 "
R. Rauscher	0 "
	— 45

FOR EXECUTIVE COMMITTEE.

Otto J. Klotz	35 votes.
Thos. Fawcett	25 "
John McLatchie	19 "
G. C. Rainboth	18 "
T. D. Green	10 "
G. E. McMartin	8 "
A. C. Talbot	8 "
Thos. Breen	7 "
C. A. Biggar	4 "

FOR AUDITORS.

J. J. McArthur	20 votes.
W. S. Drewry	14 "
F. Driscoll	12 "
J A. Belleau	10 "

EDGAR BRAY,
J. FREDERICK SNOW,
WM. CRAWFORD.

Received and adopted.

JOHN McAREE,
Vice-President.

NOTICES.

SEVENTH ANNUAL MEETING.

The Seventh Annual General Meeting of the Association will be held at Ottawa, commencing on the third Tuesday in February, 1890.

It is earnestly hoped by the Executive Committee that members will do all in their power to assist in furnishing a suitable programme for the occasion, both by their own individual efforts, and by lending any assistance possible to the several Standing Committees working in the interests of the profession.

Professional information of any kind, whether sought or offered, will be duly reported upon, if referred to the Chairman of the Committee to which the same relates, or if forwarded to the Secretary-Treasurer of the Association, will be transmitted to its proper Committee.

SECRETARY-TREASURER.

NATURAL HISTORY AND GEOLOGY.

Members are specially invited to read Professor Macoun's Report on Natural History and to note the request contained therein.

Year after year the Professor has appeared at the Annual General Meeting and brought forward a similar request in more or less strong terms, fully realizing that the surveyor's opportunities are more numerous than those vouchsafed to the general man.

As Professor Macoun takes a deep interest in the Association and does all in his power to forward its ends, it is but fair that in return his request should be attended to, and that members of the Association in particular, and of the Profession generally, should make a strong effort to forward at least one specimen of Natural History or Botany during the year. I may say, from my personal knowledge of the Professor, that "all is fish that comes to his net," and even if the contribution be not valuable, the intention will be appreciated just as highly..

Dr. Bell, Assistant Director of the Geological Survey, has several times made a similar request on behalf of Geology and Mineralogy.

SECRETARY-TREASURER.

PUBLICATION.

It is proposed in future editions of the Annual Report, to set aside a few pages, under the title of "Member's Record," to contain in a few lines a synopsis of the work each member has been engaged upon for the past year.

It has been suggested that a Record of this kind would have several advantages: 1st. It would be an advertisement of each man's specialty in professional work. 2nd. It would enable a comparative stranger to find the man he wanted to do a certain kind of work in a certain locality. 3rd. It would make our Reports of additional interest to one another, for, though "curiosity" has, since time immemorial, been delegated to woman, there are few men, *even* surveyors, but would like to know what their neighbours have been doing. 4th. Each man whose name appeared in such Record would feel that to a certain extent he had a proprietorship in the Annual Report, and was therefore more closely connected with his brother members.

This notice has been inserted, in order to bring the suggestion before the members and obtain their opinions of the same; also as to whether they would be willing to contribute to such Record.

T. D. GREEN,
Chairman Publication Committee.

ELECTION OF OFFICERS.

For the first time since the inauguration of the Association, the Officers for the ensuing year were elected by general ballot. Out of sixty-five members, entitled to vote, forty-five recorded their ballots. This may be considered as a very fair proportion for an experiment, and it is hoped that at the coming election the members will exercise still more freely their privilege, and, that every one who has a vote, will cast it, and so by taking an active interest in the working machinery of the Association, make it a powerful combination to protect the rights and prerogatives of the Profession.

J. S. DENNIS,
President.

PROBLEMS AND SOLUTIONS.

SUBDIVISION OF A QUADRILATERAL FIGURE.

To divide a quadrilateral figure into any number of parts by lines parallel to one of the sides, the sides and angles of the quadrilateral being known.

Fig. 1.

Let the area of the first part be to the remainder as m to n.

Let EG be the required line.

Draw AQ parallel to BD, and let the angle EAQ be called θ, then $\theta = (A + B - 180°)$ and $EG = EQ + QG = EQ + AB$.

Also, $EQ : AE :: \text{Sin } \theta : \text{Sin } AQE$, but $AQE = EGB = (180° - B)$

$$\therefore EQ : AE :: \text{Sin } \theta : \text{Sin } B$$

$$\therefore EQ = \frac{AE \times \text{Sin } \theta}{\text{Sin } B}$$

$$\therefore EG = \frac{AE \times \text{Sin } \theta}{\text{Sin } B} + AB$$

From A draw AP perpendicular to EG, then $AP = AE \times \text{Sin } AEP = AE \times \text{Sin } (180 - A) = AE \text{ Sin } A$.

Now area of $ABGE = \frac{AB + EG}{2} \times AP =$

$$= \frac{AB + AB + \frac{AE \text{ Sin } \theta}{\text{Sin } B}}{2} \times AE \times \text{Sin } A$$

$$= \frac{2AB \times \text{Sin } B \times AE \times \text{Sin } A + AE^2 \text{ Sin } \theta \times \text{Sin } A}{2 \text{ Sin } B}$$

but area $ABGE$: area $ABDC :: m : (m + n)$

$$\therefore ABGE = \frac{m \times ABDC}{m + n}$$

$$\therefore \frac{2AB \times \text{Sin } B \times AE \text{ Sin } A + AE^2 \times \text{Sin } \theta \times \text{Sin } A}{2 \text{ Sin } B} =$$

$$= \frac{m}{m + n} \left\{ \tfrac{1}{2} AC \times AB \times \text{Sin } A + \tfrac{1}{2} BD \times DC \times \text{Sin } D \right\}$$

$$\therefore 2AB \times \text{Sin B} \times AE \text{ Sin A} + AE^2 \text{ Sin } \theta \times \text{Sin } A =$$

$$= \frac{2m \times \text{Sin } B}{m+n} \left\{ AC \times AB \times \text{Sin } A + BD \times DC \times \text{Sin } D \right\}$$

$$\therefore AE^2 + 2AE \times \frac{AB \text{ Sin } B}{\text{Sin } \theta} =$$

$$\frac{m}{m+n} \left\{ \frac{AB \text{ Sin } B \times AC}{\text{Sin } \theta} + \frac{BD \text{ Sin } B \times DC \times \text{Sin } D}{\text{Sin } A \times \text{Sin } \theta} \right\}$$

(1°) $$\therefore AE = -\frac{AB \text{ Sin } B}{\text{Sin } \theta} \pm$$

$$\pm \sqrt{\frac{AB^2 \times \text{Sin}^2 B}{\text{Sin}^2 \theta} + \frac{m}{m+n} \left\{ \frac{AC \times AB \times \text{Sin } B}{\text{Sin } \theta} + \frac{BD. \text{ Sin } B \times CD \times \text{Sin } D}{\text{Sin } A \times \text{Sin } \theta} \right\}}$$

This formula though somewhat long does not require very much calulation, as the quantity $\frac{AB. \text{Sin B}}{\text{Sin } \theta}$ occurs three times.

If, for example, it be required to divide the quadrilateral into three equal parts, then $m : n :: 1 : 2$ and $\frac{m}{m+n} = \frac{1}{3}$

Then (2°) $$AE = -\frac{AB \times \text{Sin } B}{\text{Sin } \theta} \pm$$

$$\pm \sqrt{\frac{AB^2 \times \text{Sin}^2 B}{\text{Sin}^2 \theta} + \frac{AC \& AB \times \text{Sin } B}{3 \text{ Sin } \theta} + \frac{BD \times \text{Sin } B \times CD \text{ Sin } D}{3 \text{ Sin } A \times \text{Sin } \theta}}$$

To find the next point, as F, the ratio of $ABHF$ to the remainder would be used, and the length AF found as above.

To find the points E and F graphically. Let it be required to divide $ABDC$ into three equal parts :—

Fig. 2.

First divide $ABDC$ into three equal parts, in the usual manner, viz. :—

Draw AJ parallel to BD, divide AJ into three equal parts at K and M, and trisect BD at L and N, join KC and MC; then the figures $ABLKCA$, $CKLNMC$ and $CMNDC$ are equal; draw KO and MP parallel respectively to LC and NC, then join LO and NP and the figures $ABLO$, $OLNP$ and $PNDC$ are equal.

It remains now to draw lines EG and FH through OL and PN parallel to AB, and so as to make $ABGE$, $EGHF$ and $FHDC$ equal to each other.

See Figure 3. Let it be required to draw a line PN cutting LO in such a manner as to leave the area of $ABNP$ equal to that of $ABLO$. Let PN intersect LO at R.

Fig. 3.

Draw LO and OF parallel to AB, then if PN be the required line, the triangles OPR and LNR are equal; also the triangles LOQ and LOF being between the same parallels are proportional to their bases LQ and OF; also the triangles LOQ and ROP are similar, as are also the triangles OLF and RLN ∴—

(1°) $\frac{LOQ}{LOF} = \frac{LQ}{OF}$, also,

$ROP : LOQ :: PO^2 : OQ^2$ and $RLN : OLF :: LN^2 : LF^2$

∴ Since $ROP = RLN$, $\frac{LOQ \times PO^2}{OQ^2} = \frac{OLF \times LN^2}{LF^2}$ or

$\frac{LQO}{OLF} = \frac{LN^2 \times OQ^2}{LF^2 \times PO^2}$ ∴ from (1°) $\frac{LQ}{OF} = \frac{LN^2 \times OQ^2}{LF^2 \times PO^2}$ (4°)

but since the lines LQ, NP and FO are parallel,

$OQ : OP :: LF : NF$ ∴ $\frac{OQ^2}{OP^2} = \frac{LF^2}{NF^2}$ ∴ from (4°)

$$\frac{LQ}{OF} = \frac{LN^2}{LF^2} \times \frac{LF^2}{NF^2} = \frac{LN^2}{NF^2}$$

$$\therefore LN^2 = \frac{LQ}{OF} \times NF^2 = \frac{LQ}{OF} \times (LF - LN)^2$$

$$\therefore LN^2 = \frac{LQ}{OF} \times (LF^2 + LN^2 - 2LF \times LN)$$

$$\therefore LN^2 \left\{ 1 - \frac{LQ}{OF} \right\} + 2LN \times \frac{LQ \times LF}{OF} = \frac{LQ}{OF} \times LF^2$$

$$\therefore LN^2 \left\{ \frac{OF - LQ}{OF} \right\} + 2LN \times \frac{LQ \times LF}{OF} = \frac{LQ \times LF^2}{OF}$$

$$\therefore LN^2 (OF - LQ) + 2LN \times LQ \times LF = LQ \times LF^2$$

$$\therefore LN^2 + 2LN \times \frac{LQ \times LF}{OF - LQ} = \frac{LQ \times LF^2}{OF - LQ}$$

$$\therefore LN = \frac{-LQ \times LF}{OF - LQ} \pm \sqrt{\frac{LQ^2 \times LF^2}{(OF - LQ)^2} + \frac{LQ \times LF^2}{OF - LQ}}$$

$$\therefore LN = \frac{-LQ \times LF}{OF - LQ} \pm \sqrt{\frac{LF^2}{(OF - LQ)^2} \left\{ LQ^2 + LQ \times OF - LQ^2 \right\}}$$

$$\therefore LN = \frac{-LQ \times LF}{OF - LQ} \pm \frac{LF}{OF - LQ} \sqrt{LQ \times OF}$$

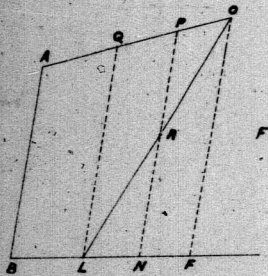


FIG. III

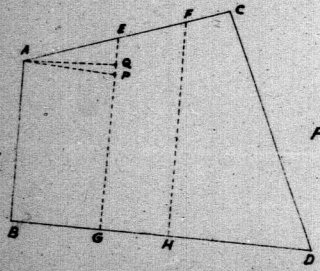


FIG. I

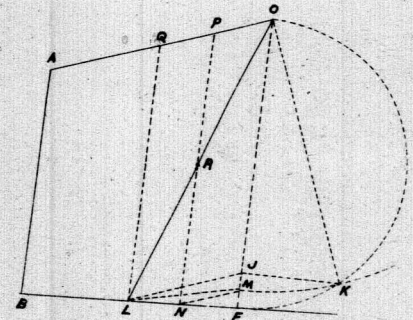


FIG. IV

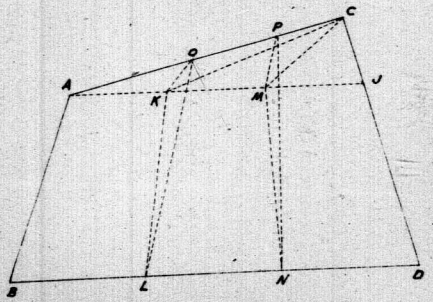
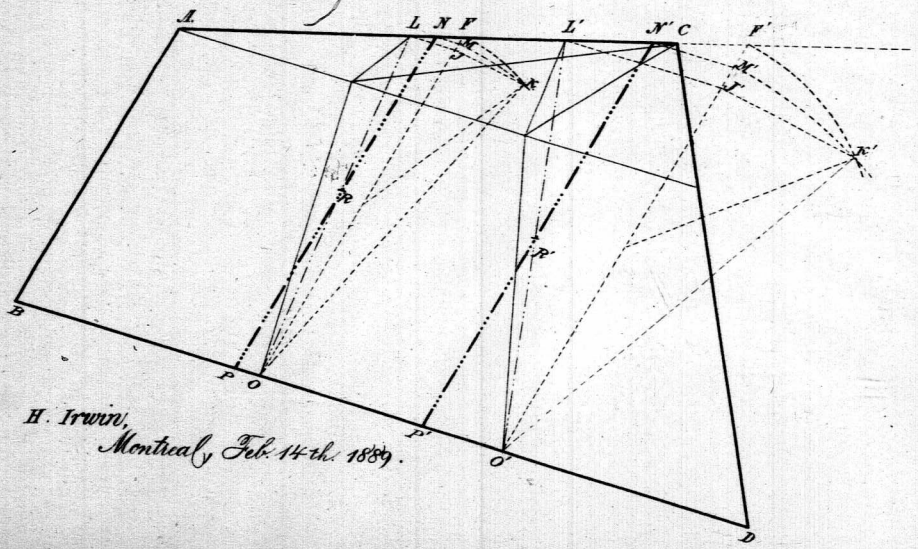


FIG. II

Diagram shewing Graphic method of dividing a [illegible] Intrest int

Diagram shewing Graphic method of dividing a Quadrilateral into any number of equal parts by lines parallel to one of the sides.
$ABQL = LQQ'L' = L'Q'DC$ and $ABPN = NPN'P' = N'P'DC$;
NP and $N'P'$ being parallel to AB.



H. Irwin,
Montreal, Feb. 14th 1889.

$$\therefore LN = \frac{LF}{OF - LQ}\left\{ -LQ \pm \sqrt{LQ \times OF} \right\} (6°)$$

From this equation the position of the point N can be determined graphically, as follows:—See Fig. 4.

Figure 4.

Having drawn LQ and OF parallel to AB, draw LJ parallel to AO, then $OJ = LQ \therefore OF - LQ = FJ$; also, $LQ \times OF = OJ \times OF = OJ^2 + OJ \times JF$ (5°).

Now if a semicircle be described on OF, and from J, JK be drawn perpendicular to OF then $JK^2 = OJ \times JF \therefore$ from (5°) $LQ \times OF = OJ^2 + JK^2$ but $OK^2 = OJ^2 + JK^2 \therefore LQ \times OF = OK^2$

$$\therefore \sqrt{LQ \times OF} = OK$$

Now with O as centre and OK as radius, describe an arc of a circle cutting OF in M, then $OM = OK$

$$\therefore OM = \sqrt{LQ \times OF},$$ we have, also,

$$OF - LJ = FJ$$ as above, and $$LQ = OJ$$

$$\therefore LN = \frac{LF}{FJ}\left\{ \pm OK - OJ \right\}$$ from (6°)

$$\therefore LN = \frac{LF}{FJ}\left\{ OM - OJ \right\} = \frac{LF}{FJ} \times JM$$

$$\therefore LN : LF :: JM : JF$$

The point N can therefore be found by drawing from M, MN parallel to LJ and the required dividing line, NP is drawn from N parallel to AB.

To recapitulate, the final graphic method is as follows:—See Figure 4. Draw OF parallel to AB, draw LJ parallel to AO, on OF describe a semi-circle, from J draw KJ perpendicular to OF, with O as centre and OK as radius cut off $OM = OK$, from M draw MN parallel to AO and, finally, from N draw the dividing line NP parallel to AB, the area $ABNP$ will then be equal to the area $ABLO$.

See accompanying Fig. 5 for a diagram drawn to scale.

H. IRWIN.

MONTREAL, 14th February, 1889.

PROBLEM.

Suppose there was a model of this planet, made, say, of pasteboard, and that part of it—the triangle ABC—having been injured, was removed. Required the radius of that sphere of similar material, from which a spherical triangle could be cut, to mend the injured spheroid that would most nearly coincide in curvature with the part of the spheroid that was removed.

S. L. BRABAZON.

N.B.—As the problem originally stands, BC is supposed to be nearly east and west, covering about 3° of Longitude—Latitude about 50°.

The solution, however, to be general, in terms of the semi-axis major (a) and the eccentricity (e) and the latitude. (See Fig.)

PROBLEM.

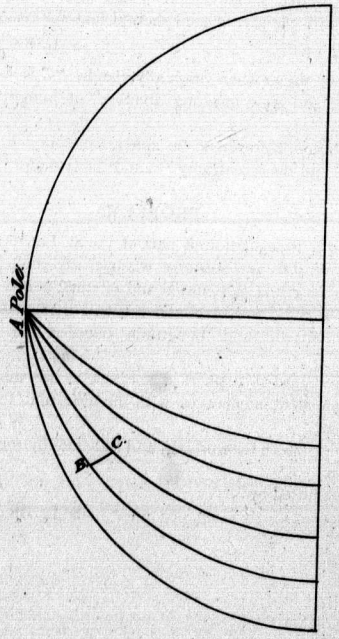
Suppose a triangulation of part of the St. Lawrence, where the course is easterly and westerly triangle, say three or four miles in average length of side, initial and terminal points say 150 miles apart; how would you obtain from such a triangulation the difference of Latitude and Longitude between the first and last stations?

Having regard in a spherical solution to use that sphere most nearly coincident in curvature with the terrestrial surface involved in the case.

Deduce formulæ for working, and illustrate by rough diagram or projection.

Submitted by

S. L. BRABAZON.


A Pole
B
C

LECTURES.

SYNOPSIS

OF A LECTURE ON INSTRUMENTS USED IN SURVEYING, BY W. F. KING, CHIEF ASTRONOMER TO THE DEPARTMENT OF THE INTERIOR OF CANADA.

The lecturer began by saying that as the time at his disposal was short, he would confine his attention to instruments used for measuring angles, particularly horizontal angles. A large number of instruments of different sizes—from the small three inch prismatic transit to a twenty-four inch alt-azimuth—being on exhibition, he used them to illustrate the various points considered.

The essential part of the angle-measuring instrument being the graduated circle, this was first spoken of. Under this head were treated the nonagesimal and centesimal divisions of the right angle, and the sexagesimal and decimal divisions of the degree, also the various modes of numbering the degrees, whether round the whole circle from 0 to 360, the half circle, or the quadrant, and the relative advantages for different purposes of the different modes. The relation between size of circle and fineness of graduation was also treated of.

A short description was also given of the machines used for graduating circles, and the necessity of a number of equidistant verniers, for the purpose of cutting out eccentricity and errors of graduation, was pointed out. Two vernier and three vernier instruments, being those in most common use, were compared, as well as single plate and two-plate or reiteration and repetition instruments. The microscopes used in large instruments, instead of verniers for reading the graduated arc, were described. The manner of supporting the graduated circle was then considered. Under this head comes the question of three or four foot screws, and the kind of instrument on which each is suitable. The graduated circle is held in place in nearly all small instruments, by means of a vertical spindle or axis, which carries all the weight of the upper part of the

instrument, no part of the outer rim of the upper plate resting upon the lower plate. Attention was here directed to the twenty-four inch altazimuth, in which the weight of the upper part of the instrument is carried by three small wheels running on the rim of the lower plate, while the central axis is very short, serving only to keep the instrument centred. The tripod was then discussed, and the advantages of the split-leg tripod indicated. Next in importance to the graduated limb came the sights by which the attention is fixed on the object. On the compass plain sights are generally used; but on instruments of more precision, the telescope. The construction of the achromatic object glass and the eye-piece were touched upon, and the arrangement of the threads in the common focus, there being generally parallel threads in astronomical instruments, while for terrestrial work threads meeting in a V are generally preferred. The great importance of the focussing tube of the object glass moving parallel to the line of collimation, and especially moving without wobble, was shown.

A description was given of the manner in which levels are ground in the workshop. The requisites of a good level were stated. Special attention was drawn to the striding level as being invaluable for the best work.

The vertical circle was then spoken of briefly, and some errors of adjustment peculiar to it pointed out, as occurring in instruments where the vernier arm of the vertical circle is attached to one of the standards.

The advisability of having an instrument as symmetrical as possible was shown, especially with reference to unequal expansions of unsymmetrical parts under changing temperatures. A further error in heavy instruments arising from this cause was the flexure of the parts, this being a serious objection to the prismatic transit, which is otherwise a very convenient and compact instrument. This was illustrated by reference to the twenty-four inch altazimuth, in which there is a very large flexure of the horizontal axis due to the telescope being attached to the extremity of this axis, beyond the standards. The lecturer then pointed out that an instrument should be chosen with reference to the work it had to do, and that if a plate of a certain size were chosen the other parts of the instrument should be in proportion, the size of the object glass, the magnifying power, the length and stiffness of the standards, the size and fineness of graduation of the plate, the distance apart of the foot screws, and the strength of the tripod. For instance, it would be foolish to set a finely graduated seven or eight-inch instrument

having a powerful telescope upon the ordinary round tripod, and again the split-leg tripod would be unnecessarily cumbrous for use with a small instrument, and a ten second graduation does not suit a half-minute telescope. The lecturer concluded by exhibiting a solar compass, and explaining the manner of using it, and the various errors of adjustment to which it is liable.

SYNOPSIS

OF A LECTURE "SUPPOSED FOSSIL TREES DISCOVERED AT KINGSTON, ONT.," BY H. N. TOPLEY, OF THE DEPARTMENT OF THE INTERIOR OF CANADA.

Mr. Topley first entertained the members of the Association with a series of sciopticon views, consisting of portraits, landscapes and prominent churches and public buildings of Europe. The portraits included the Queen, our Governor-Generals—Lord and Lady Dufferin, Lord and Lady Lansdowne, Marquis of Lorne and Princess Louise, our present Governor, Lord and Lady Stanley of Preston, Sir John A. Macdonald, Sir Hector Langevin, Sir Adolphe Caron, and all the members of the Cabinet. He also exhibited late portraits of the Hon. Edgar Dewdney, Minister of the Interior, and Mr. A. M. Burgess, Deputy Minister, which were greatly admired. The landscape views of Ottawa, Northwest, Yosemite, and along the Canadian Pacific Railway, were generally appreciated. The last mentioned series were from negatives taken by E. Deville, Surveyor-General. Two amusing pictures concluded the above, entitled Topographical Surveyors endeavoring to plot their maps on ice; the second one depicted showed their ludicrous situation, having struck a snag, they went through the ice head first, leaving nothing but their contour lines above. His description of the supposed fossil trees at Kingston was very interesting, being illustrated from photographs. The first picture described was that of a column of red sandstone, fifteen feet high and two feet in diameter. The rock is of pure sandstone, "Potsdam formation," with thin layers of white sandstone intermixed.

The interest taken in these supposed trees is on account of their peculiar formation; the laminations are horizontal, while the column itself is composed of perpendicular circular rings, which has led people to believe that they were fossil trees. The second picture described included a portion of the first, and a large supposed tree, having fallen from its original bed in the rock. This one measured about twenty feet high and five feet in diameter. It had fallen with its outer covering firmly adhering to the shaft, but

was broken into three pieces. The third view was that of the sandstone resting on conglomerate. Also drawings of the face of the cliff, showing the erosion which had taken place by the action of an ancient sea after the formation of "the supposed trees." Some maps describing the country in which they were found; one in particular, showing Mr. P. Blake's farm, on which these trees were photographed.

Then followed the four different theories as to their formation. The first theory is that they are fossil trees, but this could not be substantiated according to the science of geology. "The general redness of the sandstone is sufficient evidence that organic remains are very scarce, and so indeed we find it. Two or three fishes, a few leaves, the most perfect is a species of fern, a fir cone, and a few small fragments of thin, hollow bones which may have belonged to either birds or reptiles, are all that have yet been found;" as there is not the slightest indication of either bark, grain, roots or branches, with the naked eye or microscopically, it is quite evident they are not organic or petrified trees.

Second theory.—Pot Holes.—This theory was not sustained from present indications, as none have been found to assume the proper shape, although diagrams and sketches were shown describing their true formation. This theory was also rejected.

Third theory.—"Spring Holes," caused by the pressure of water from the height of land, as the Rideau lakes at present are about one hundred and fifty feet above where these are found.

Fourth theory.—"Spring Holes," caused by indirect volcanic action.—This in connection with the above theory seems to be the true cause of their formation, afterwards becoming filled with the sand, and petrified. In one portion of the rock is to be seen a large supposed tree, about eight feet in diameter, worn away by the action of water, also glacier markings and glacier polished sandstone.

SYNOPSIS

OF A LECTURE ON HOW TO PRESERVE NATURAL HISTORY SPECIMENS, BY PROF. JOHN MACOUN, NATURALIST AND BOTANIST TO THE DEPARTMENT OF THE INTERIOR OF CANADA.

Professor Macoun gave a very interesting description of a method of preserving plants, when in the field, to bring home for future reference. He said that he was on the programme for a lecture, but owing to ill health he was unable to say much, in fact should not have been present at all, but was unwilling to altogether disappoint the meeting. He had brought Mr. Edwards here, who was going to show practically how to skin a bird and preserve a deer's head for future mounting, but before Mr. Edwards began he would like to show a new method of preserving plants.

He then produced two boards, and said they were made of ash, of three thicknesses, the grain of the inside board running the opposite way to that of the outside two. To one board two straps were attached, filled with holes for tightening purposes. The way to preserve plants with these boards was to take thick sheets of paper and place the plants on them, covering again with other sheets of paper, then strapping the boards together, and they could be thrown about anywhere, in the baggage cart, or on the pack saddle.

In reply to a query as to whether it was necessary to get the roots, Professor Macoun said, that with all herbaceous plants you should get the roots, and in all plants you should get the flower, the fruit, and the seed if possible.

In conclusion, Professor Macoun thought it was the duty of every surveyor to bring home a few specimens; he said that it was in that manner that Museums were filled, by each gentleman bringing, say, two birds of a kind, one for himself and the other for the Museum, and it would be not much trouble for them to bring a couple of deer heads; the only thing was that they should know how to preserve them, until they got them home to have them properly mounted, and he hoped that the audience would profit considerably by what they would see from Mr. Edwards, as he was a practical taxidermist, and would be very glad to tell them anything, if they would ask him.

Mr. Edwards then proceeded to give a practical illustration of skinning birds and deer heads, and preparing them for further mounting; he also submitted the following in relation to the same:

HINTS ON SKINNING AND PRESERVING DEER AND OTHER ANIMAL HEADS, FOR THE PURPOSE OF MOUNTING.

MALE DEER.

1st. Make an incision along the centre of the upper part of the neck to about three inches from each antler, then cut across from this incision to the base of each antler, removing the skin carefully from around the horn. When the skin is opened out, a V-shaped cut will be observed.

Separate the ears at the base, being careful to only slit the ear on the *inside* part of the way down, and remove the flesh or grizzle from the base of the ear. Now sever the skin from around the eyes, being very careful not to cut through at the cavities near them. Then pull the skin down over the muzzle, and trim away the flesh from around the lips. It is very desirable that all superfluous flesh should now be scraped from the skin, and when this is done you have it ready for curing. With female deer, or other animal heads having no horns, the cutting need only be made at the base of the neck, and the skin drawn over the head, the same care to be taken in removing it around the eyes, cavities and muzzle.

It must be understood that the longer the hide of the neck is left, or the closer it is cut off to the base, the better and more valuable the head will be.

To cure or preserve the skin, rub the whole on the flesh side with powdered alum and saltpetre; in the absence of these the skin may be rubbed with a liberal quantity of salt, after which roll it up—hair side out—and put away in a dry place for four or five hours when it will be ready to put in place.

In removing the head from the carcass, cut off at the base of the skull, and if any means are at hand to boil the skull, the flesh will be more easily removed than by paring off.

The brains should be removed.

The bones of the under jaws, when cleaned, should be tied together and put in place on the upper jaws. The head is now ready for covering.

Before covering, however, the skin should be sewn up at the mouth and eyes, care being taken to sew from the flesh or inside.

Pull the skin over the head, and before sewing up at the base of the horns or end of the neck, beaver hay, hay or dried grass should be filled in, in such quantity as to allow the skin when dry to resume

about its natural shape—especially about the mouth, as in paring off the flesh, the lips invariably stretch, consequently too much packing around the mouth should not be used.

Never cut the skin down the front of the neck, the seam when sewed is sure to show and be distasteful to the eye.

EXPLANATION OF A ROLLING PLANIMETER.

Mr. ABREY said the best thing he could do would be to read an extract from a description of the instrument written by himself, published in the Report of the Association of Ontario Land Surveyors, for 1888.

Mechanical Integrators are constructed on the assumption that if a wheel is moved over a smooth surface, in the direction of its axis, it will slide without revolving, and if moved at right angles, it will revolve without sliding, and if moved in any other direction it will both slide and revolve.

The instrument here exhibited is mounted on rollers of equal size and equally weighted, and when moved over a figure the fulcrum of the tracing arm moves in a straight line, and differs from the Polar instrument in general use. It possesses great advantages over Polar Planimeters, inasmuch that it will measure at one operation a figure of considerable width and of unlimited length. It is also more easily manipulated than a Polar.

In moving the instrument around a figure, the arm is always in a line nearly at right angles with the axis of the rollers, and very little difference in force is required to move the tracer over one part than another, whereas with a Polar, it is required over some parts to move nearly in line with the anchor point, and then, from the greater force required, the tracer goes by a more or less jerky motion.

The instrument is also what is called suspended, and possesses greater precision than any yet constructed, and although a large instrument it is very precise in measuring small figures. Of course, like all planimeters, it requires great care, and every part must go smoothly and without shake in any part.

In describing the theory of this Rolling Planimeter, it is convenient to develop it by a system of rectangular coordinates. The tracing arm is at right angles to the plane of the recording wheel, and the axis of the recording wheel is parallel to the tracing arm. In moving the instrument it will be observed that the speed of the record-

ing wheel increases as the tracing arm moves away from the line, drawn through its fulcrum, at right angles to the axis of the rollers, and reverses its motion in passing the said line, therefore with tracer on the said line, the recording wheel generates no motion; it will also be seen that if the rollers remain still, the moving the tracer to either side does not cause the recording wheel to revolve, as it simply slides on the disc in the direction of its own axis.

For the mathematical proof of the theory of the instrument, see the above Report for 1888.

Its theory is explained a little differently in Professor Johnston's Surveying, and if I have understood what is there stated, his explanation is not exact. He uses the expression end ordinates, whereas it should be equal end ordinates; for, to simply pass the tracer over the irregular path of the boundary would give the area of a figure with curved outlines, and not that bounded by the Y ordinates.

From the theory, it will be seen that the distance of the recording wheel from the tracing arm is immaterial, and is not a function of the area, but the axis of the recording wheel must be parallel to the axis of the tracing arm, else the area generated by the tracer on one side of the axis will be greater than on the other. The instrument is fitted fully for testing and correcting its errors.

The instrument measures the area of the plotted figure drawn to scale; this record then requires a suitable multiplier to get the area of the field or section of which the plot is the diagram. In practice it is desirable that the point from which we start to trace be taken, so that the tracing arm shall be at right angles, or nearly so, to the axis of the rollers, as a small error in bringing the tracer back in closing is then a minimum; also, if possible, an approximately equal area should lie on each side of the tracing arm when so placed at starting, to eliminate any remaining error in the axis of the recording wheel.

The figure should be traced slowly and by an easy motion forward, too great a speed or a jerky motion may cause the recording wheel to slip.

The accuracy and precision of this instrument may be seen from the published tests.

In repeating the tracing of a figure the difference should not be more than about 0.002 of each other.

With an Amsler Polar, I found the difference of two readings might be about .02 on the vernier, and was not satisfied with anything greater than that.

This error would be about the same independently of the size of the figure. With this instrument the error is nearly some per cent. of the size of the figure.

In the instrument there is a counting wheel, having a differential motion counting revolutions of the recording wheel up to 420.

The vernier of the recording wheel sub-divides its circumference into 1,000 equal parts. The tracing arm is divided into half millimeters. For English measures the makers have given the value of a single division of the vernier for .0025 sq. in., .002 sq. in., .0015 sq. in., .00001 sq. ft., .001 sq. in., .0005 sq. in., as corresponding to divisions on the tracing arm of 830.4, 671.7, 513.3, 493.8, 354.6, and 195.3 half millimeters. With care in tracing the instrument should give a true area of the figure to within the 1:1000 to the 1:10000, depending on its size.

DESCRIPTION OF AN IMPROVED STEEL BAND CHAIN.

Mr. BROWNLEE said that with the permission of the President he would give a short description of an improvement in a steel band measure, invented by A. J. Brabazon, D.L.S., of Portage du Fort, Que. The improvement consists in double-jointed, flat swivles, at 20 feet, 25 links, apart on the coil, as the case may be.

The claims for the swivle are as follows:—

1. Reduction of liabiltiy to breakage from kinking.

2. Facility in measuring up or down hill, when shorter measures than full length of chain are required.

3. The reduction of wind pressure on chain, as at least one half the length of chain will adjust itself edgewise to direction of wind.

Mr. Brownlee also exhibited a simple clip and field tools for applying same over the severed or broken edges of a steel band.

This invention does away with the use of rivets, and is a simple and effective method of repairing a chain in the field, the box of tools required is about the size of 4 x 2 x 1 inches, weighing about 1 pound, and is just the thing for chainmen to carry along with field books.

PAPERS.

OCCULTATIONS OF STARS BY THE MOON.

It is frequently desirable, in explorations, to be able to determine the longitude of a place within a reasonable degree of accuracy. The independent methods of doing this, *i.e.*, methods requiring only astronomical observations, are few. The method of occultations is one of the most accurate of these. The observation requires no instrument, except a good telescope. Of course, for longitude, the correct time must be known, which will necessitate an instrument for that purpose, but the observation of the obscuration of the star by the moon, or its reappearance, may be made with any telescope.

In the lists of occulted stars published in the Nautical Almanacs, stars down to the sixth magnitude are given. Occultations of these small stars by the dark limb of the moon are readily observed, but they cannot be observed on the bright limb, except with a very good telescope. However, stars of the third magnitude or higher, and especially the larger planets, can be observed with small telescopes.

The time at which the moon's centre and the star, as viewed from the centre of the earth, have the same right ascension, is given in the almanac. This is not the time of immersion or emersion, since the semi-diameter of the moon must be allowed for, as well as its parallax, which last has a very great effect, and varies according to the altitude of the moon.

On this account, the actual time of the immersion or emersion may differ from the tabulated time of geocentric conjunction by an hour or more. Hence for the purpose of preparing for the observation, a calculation of the approximate time of the occurrence is necessary.

This calculation, if made in figures, according to the methods given in the text books, is tedious and intricate.

My object in writing this paper is to give a method by graphical construction, by which calculation in figures is almost altogether avoided, as well as the intricacy of the process, and the liability to error is consequently obviated. The method consists in drawing the projection on the plane through the centre of the earth at right angles to the direction of the star, of the path of the observer in space as he is carried along by the diurnal rotation of the earth, and

of the path of the moon. If a time can be found at which the observer and the moon's centre are separated by a distance equal to the radius of the moon, the immersion or the emersion will take place at that instant. The example below will serve to make the process clearer.

The latitude of the place must be known, and also the approximate longitude. From the latitude must be first found the geocentric coordinates of the place by adding to, and subtracting from, the logarithmic cosine and sine of the latitude, the logarithms of F and G respectively, given in the following table :

Lat.	Log. F.	Log. G.
40	0.00062	0.00239
45	0.00075	0.00226
50	0.00088	0.00213
55	0.00101	0.00201
60	0.00113	0.00189
65	0.00124	0.00178
70	0.00133	0.00169

The two results thus obtained must be multiplied, the first by the sine of the star's declination, and the second by the cosine.

As an example of the method of working, I will suppose that an observer, at Ottawa, on the 25th Jan., 1888, wishes to observe occultations for longitude.

Looking at the list of occultations in the American Ephemeris at 25th Jan., 1888, we find that nine occultations occur that day, visible somewhere on the earth's surface, but we see that the first two on the list occur during day-light. The third occurs after sunset, its hour angle is only about 2½ hours from the meridian, and the limiting parallels of latitude are + 58° and 0°, between which limits falls the latitude of the place 45° 23′, so that we may infer that this occultation may be visible. It should be stated here that it does not necessarily follow that because the limiting parallels include the latitude of the place that therefore the occultation will be visible. The visibility depends also on other conditions which will appear in the working. When some practice in this method is acquired, the computer can frequently decide as to the occurrence of an occultation by the tabulated value of Y, together with the hour angle. The fourth star, χ_4 Orionis, is right as regards time of occurrence and hour angle, but not as to limiting parallels. The next two stars also fulfil these three conditions, but the remaining three are ruled out by the limiting parallels,

Thus for this night, we have to compute χ_2 Orionis, 68 Orionis, 71 Orionis.

For an example of the prediction we take 68 Orionis.

We have now for the place of observation (Ottawa), latitude = 45° 23′, longitude 75° 42′ west of Greenwich, or 5.4 m. east of Washington.

For the star we have from the Almanac.

δ = Declination = + 19° 48′.8

Washington mean time of conjunction = 10h 45m.7

Then we have :—

	log cos ϕ = 9.84659	log sin ϕ = 9.85235
From table given above	log F = 0.00076	log G = 0.00225
	log ρ cos ϕ' = 9.84735	log ρ sin ϕ' = 9.85010
δ = + 19° 48′.8	log sin δ = 9.53014	log cos δ = 9.97350
	9.37749	9.82360

whence

ρ cos ϕ' = 0.7036

ρ cos ϕ' sin δ = 0.2385

ρ sin ϕ' cos δ = 0.6662

From Ephemeris :—

	H. M.
Washington Hour Angle at Geocentric Conjunction	+ 0 59.9
Difference of Longitude, Washington to Ottawa	— 0 5.4
Ottawa Hour Angle at Geocentric Conjunction	+ 1 05.3
	= 16°.325

In the figure AB and AH are drawn at right angles to one another, each equal to ρ cos ϕ' = 0.7036. AP = 0.2385, AC = 0.6662.

Any convenient unit may be used for these lines. For instance, 10 inches will be found a sufficiently large unit to give good results, at least when the star's hour angle at occultation is not more than three or four hours. With this unit AB or AH would be 7.04 inches, AP 2.38, and AC 6.66, and all lengths of lines throughout the calculation must be multiplied by ten to give the lengths in inches to be measured on the diagram.

C is then the centre of the earth, and B and P the extremities of the major and minor axes of the elliptic path of the observer.

The star being above the equator, the part of the ellipse below the line AB is taken.

The angle HAH_0 is made equal to 16°.3 to the *east* of AH, since the hour angle is positive and the place is therefore east of the star.

The angles H_0AH_1, H_0AH', $H'AH''$, are each made equal to 15° or one hour.

More correctly these angles should be 15°.04, or the sidereal equivalent of one mean solar hour, since the mean solar hour is the unit of the quantities x', y', below, but 15° is sufficiently close, since the angles are laid off with a protractor.

From H_1, H_0, H', H'' perpendiculars are drawn to AB, meeting it in A_1, A_0, A', A''.

The proportional compasses are now set to the ratio $AH : AP$, and the perpendiculars from H_1, &c., are divided in the points P_1, P_0, P', P'', by means of the compasses, in this ratio.

These latter points are points on the ellipse. P_0 represents the observer's position at the time of geocentric conjunction, P_1 at one hour before, P' at one hour after, and P'' at two hours after.

From the Ephemeris are found $Y = +0.3659$, $x' = 0.5686$, $y' = +0.0358$.

CM_0 is taken equal to .3659, M_0 being above C, because Y is positive.

M_0D is drawn equal to $y' = +0.0358$, still upwards because positive.

DM' is drawn at right angles equal to $x' = .5686$, always to the right, being always positive.

M' is then the position of the moon's centre at conjunction, M_0 position one hour after. On M_0M' produced take M_0M_1 and $M'M''$ each equal to M_0M'. Then M_1 is the moon's position one hour before conjunction, and M'' two hours after conjunction.

Hence the points M_1, M_0, M', M'' correspond to P_1, P_0, P', P'' respectively.

Now at the instant of the star's disappearance under the moon's limb, or reappearance therefrom, the distance between the projections of the observer's position P_1 and the moon's centre M_1 must be exactly equal to the moon's radius, which is .2723 (or 2.723 inches with the supposed unit of 10 inches).

By measurement we find :—

$P_1M_1 = .5944$ $\qquad$ $P_0M_0 = .2130$

$P'M' = .2096$ $\qquad$ $P''M'' = .6264$

Hence the two points at which $PM = .2723$ lie one between P_1

and P_0, and the other between P and P', and the time of immersion is found by:—

$$\tau = \frac{2723 - 2130}{5944 - 2130} \text{ of an hour} = 9.6 \text{ minutes.}$$

and of emersion by

$$\tau = \frac{2723 - 2096}{6264 - 2096} \text{ of an hour} = 9.0 \text{ minutes.}$$

Hence we have for a first approximation:—

Immersion at 9.6m before the moon arrives at M_0, *i.e.*, at 9.6 minutes before conjunction.

And the emersion takes place 9 minutes after the moon arrives at I', *i.e.*, at $1^h\ 09^m.0$ after conjunction.

For a closer approximation we may now plot in two points, one 10 minutes before conjunction, and the other 1h. 10m. after conjunction, making the angles H_0Ah, $H'Ah'$ each equal to 2½°, and proceeding as before, p and p' being the corresponding points on the ellipse, m and m' are the corresponding points on the moon's path, $m M_0$ and $m'M'$ being each one-sixth of M_0M'.

Then we have by measurement:

$$M_0P_0 = .2130 \qquad mp = .2750$$

whence we get

$\tau_1 = 9.6$ minutes agreeing with the former result. $M'P' = .2096$ $m'p' = .2776$ whence $\tau_2 = 9.2$ minutes.

Hence the immersion and emersion respectively take place 9.6 minutes before and 1h. 09.2m. after conjunction.

From the ephemeris we have

	H.	M.			H.	M.
Washington M. T. of conjunction	10	45·7				
And difference of longitude	= −0	5·4				
Ottawa M. T. of conjunction	= 10	51.1	H.	M.	H.	M.
Therefore Ottawa M.T. of immersion	= 10	51.1	—	09.6	= 10	41.5
And Ottawa M.T. of emersion	= 10	51.1	+ 1	09.2	= 12	00.3

The angle of position of the star at immersion measured from the north point of the moon's limb towards the east is the angle between the direction $\mu\pi$ and HA or, 74°, μ and π being the final positions of the moon and the observer at the calculated instant of immersion.

Similarly for emersion the angle is that between the directions $\mu'\pi'$ and HA or 283°.

The angles of position from the vertex of the moon's limb are the angles between $\mu\,\pi$ and $C\pi$ and between $\mu'\,\pi'$ and $C\mu'$ or 52½° and 243° respectively.

The determination of the angle of position enables the observer to know at what point of the moon's limb he is to watch for the star. The angle from the north point is required when the instrument is mounted equatorially, and that from the vertex or highest point of the moon's limb, when an ordinary altitude and azimuth mounting is used.

The time of immersion or emersion is obtained by this method easily within a minute, which is quite close enough for the purpose of preparing for the observation. The exact time of immersion is, of course, of less importance than that of emersion.

The second approximation as given above is unnecessary in the present case, and is in general not required when the time of occurrence comes within 15 minutes of one of the points plotted. But when the star passes far from the centre of the moon, this limit of 15 minutes must be reduced. In fact, when the moon merely grazes the star, careful measurement is necessary to tell whether the occultation will occur at all or not. However, in such cases, the observation is not of much use for longitude.

It is easily perceived at or near the beginning of the work, when the moon's centre passes at a greater distance from the projected place of observation than the moon's radius, so that the occultation cannot occur, and much trouble will thereby be saved.

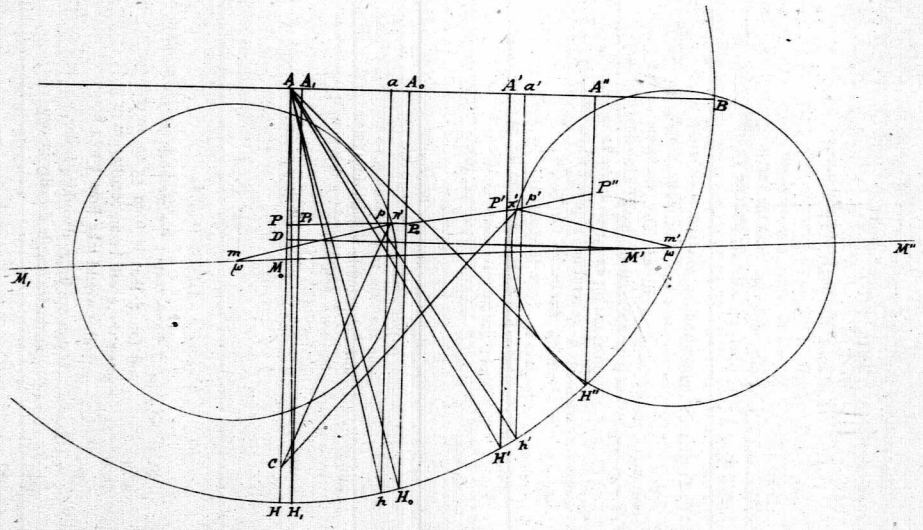
With a little practice, it requires but a few minutes to predict an occultation by this method.

W. F. KING.

DISCUSSION.

O. J. KLOTZ.—I have tested the methods as set forth in Mr. King's paper, and found that in from 15 to 20 minutes it can be ascertained whether there will be an occultation or not; by the old logarithmical method it would take from 3 to 4 hours.

A MEMBER.—If you are in good working order, you can ascertain this by the old logarithmical method easily in two hours.


A
A1
a
A0
A'
a'
A''
B
P''
P'
p'
P
P1
D
E2
m
m'
M1
M0
M'
M''
H''
H'
h'
C
H
H1
h
H0

PRACTICAL PROSPECTING FOR GOLD AND SILVER, AND THE PRELIMINARY DEVELOPMENT OF METALLIFEROUS VEINS.

Surveyors in the practice of their profession have many opportunities of examining the rock formation, and ascertaining to some extent the mineral resources of various parts of the country, and, although many members of the Profession and of this Association are quite as well posted as I am on the above subjects, others may not have given them much attention, and will not object to a few hints that may assist them in determining when they are in a country that may be expected to produce gold, silver, or other ores; how to search for the same in an intelligent manner; and how veins may be opened up in a preliminary way, so as to ascertain, as cheaply and quickly as possible, the character, value per ton, and probable production of ore, thus determining the nature of reduction works required, and being enabled to estimate the cost of mining and reduction plant necessary to work the mine to its full capacity, and of the returns and profits that may be anticipated.

It is said that most of the great mines of the world were found by chance, and not by regular prospectors. This is probably true as regards lodes and veins; but it must be remembered that until within very recent years the average miner or prospector had little or no knowledge of the rock formations in which gold, silver and other metalliferous veins were likely to be found, and simply roamed over the mountains in a haphazard way, and was as likely to look for gold quartz in cretaceous limestone as in metamorphic slates, or to follow the wrong formation longitudinally as to cross it and get into a better one.

One instance, however, may be mentioned, where intelligent observation and persevering search led to the discovery of immense gold fields and the settling up of a great continent, namely, the discovery of gold in Australia by Hargraves in 1851.

Nothing will build up a new country so rapidly as the discovery of gold and silver mines. Agricultural and manufacturing enterprises are of slow growth, no matter how fertile the soil or how excellent the facilities for successful operation, unless they are given an impetus by something such as the discovery of gold or silver, which will cause an immediate influx of population.

When such a rush occurs, as is generally the case on the first opening up of a new mining country, the work of exploring and development goes on rapidly, and all the resources of the country are developed in a proportionally rapid manner. Lumbering, farming, and stock raising enterprises spring at once into existence, as the mines furnish a ready market and good prices for their products.

The old pioneer prospector is rapidly disappearing, and organized prospecting and exploring parties, under the direction of competent mining engineers and experts, are taking his place; and this manner of acquiring mineral properties will be largely adopted in the future, as being the cheapest and in every way the most satisfactory manner of gaining possession of valuable mining rights.

The head of such a party, starting out to prospect any particular range of country, would first acquaint himself with all the geological and other information to be had from the reports of the Geological Survey, and other parties who had visited the region of his intended explorations. Failing such sources of information he would take such reports and evidence, as he could find, relating to the mineral resources, etc., of other districts on the same geological belt or mineral zone, and thus get some idea of where to look for the particular class of ore or mineral desired.

The following extracts from an article, on "Mineral Zones and Mountains" from the "Mining and Scientific Press," will help to explain this point.

"One of the plates accompanying King's Exploration of the 40th "Parallel is a section of the Warren Map of the U. S. Engineer "Department. The section given includes the main central region "of the Great Basin, with a part of the coast system of California, "and the outlying chains of the Rocky Mountains. A brief study "of this map will teach the *one great and prominent law of "arrangement of Cordillara Mountain chains*, namely, *that they "trend from North to South, or from Northwest to Southeast.*

"In strict subordination to this longitudinal direction of ranges, "says King, are grouped all the structural features of local geology. "The average strike of the great areas of upturned strata is "generally with the meridian. All the larger outbursts of granitic "rocks conform to it as well, since their rents are most commonly "the axial lines of actual folds; and lastly, when the tertiary uplift "occurred, its ranges bordered the older mountains in parallelism, "and the volumes of lava accompanying it found exit through "longitudinal rents, and either built themselves up along the

"ancient line of structure, or through new fissures piled up chains "of volcanoes conforming in trend with the general north and "south plan.

"*Over these mountains are found localities* of the *precious "metals*, and it is not surprising to observe that, following its "leading structural idea, *they appear to arrange themselves in "parallel longitudinal zones.*

1. "The Pacific coast ranges on the West carry quicksilver, tin, "and chromic iron.

2. "The next belt is that of the Sierra Nevada and Oregon "Cascades, which upon their west slope bear two zones; a foot-hill "chain of copper mines, and a middle line of gold deposits. These "gold veins and the resultant placer mines extend far into British "Columbia and Alaska.

3. "Lying to the east of this zone, along the east base of the "Sierras, and stretching southward into Mexico, is a chain of "silver mines containing comparatively little base metal, and fre- "quently included in Volcanic rocks.

4. "Through Middle Mexico, Arizona, Middle Nevada and "Central Idaho, is another line of silver mines, mineralized with "complicated association of the base metals, and more occurring "in older rocks.

5. "Through New Mexico, Utah, and Western Montana lies "another zone of argentiferous galena lodes.

6. "To the east again the New Mexico, Wyoming and Montana "gold belt is an extremely well defined and continuous chain of "deposits."

From this it can be seen how any information relating to the geological structure, and rock formations of a district, or the character of its ores, will assist in determining what may be expected at other points, in similar respective positions, on the same range. As an illustration of this, I may mention the fact that on the Selkirk Range, in Kootenay District, B.C., large and valuable lodes of silver-bearing lead and copper, associated with other base metals, have lately been discovered. The ores of this district correspond in character with those of Idaho and Western Montana, immediately south and on the same range, and with those of mineral zones 4 and 5.

It being a fact that nearly all the valuable gold-bearing veins of the world have been found in metamorphic slates and schists of different ages, from the Silurian in Australia to the Jurassic in California; it is more resonable, and one is more likely to prove

successful, in searching for gold, to confine one's explorations to metamorphic rocks. In like manner, all the great gold placers, being chiefly composed of sand, clay, gravel and boulders derived from these and allied rocks, it seems reasonable to prospect for gold placers on the lower slopes and benches of mountains and hills composed of such rocks (particularly where traversed by many quartz veins), and on the rivers and streams draining a country of the above character.

Gold-bearing lodes may be looked for in quartz veins traversing, nd interstratified with the softer metamorphic crystalline rocks such as argillaceous, chloritic, talcose and hydromica slates and schists; also, to a much less extent in granite, gneiss and the harder metamorphic rocks.

The minerals or ores commonly associated with gold, in quartz veins, are iron, copper, lead and zinc sulphurets, and sometimes tellurium; the presence of one or more of these being considered a good indication in a gold country, and their entire absence as unfavorable to the permanency and regular yield of the lode—even though free gold may be visible in the quartz. The most permanently productive gold quartz mines have been those in which free gold was seldom or never seen, and the above sulphurets were more or less represented.

The quartz is frequently rusty or cellular, and discolored brown, yellow, reddish, blue, etc., by the decomposition of the base ores accompanying the gold.

The most certain and reliable way of finding out if a quartz vein carries gold, in paying quantities, is to pound up pieces from different parts of the vein and pan them out. If the quartz is pounded very fine, and then carefully washed down in a pan or horn, fine particles of gold will be found, and can be seen with the naked eye, if there is sufficient in the quartz to pay for working; and it is not worth while spending much time over a vein (as a gold vein), unless colors can be found in that way. Of course gold is found in paying quantities associated with ores of silver and other metals, as in the Comstock Lode, where its presence cannot be ascertained by simply panning out; but this really comes under the head of silver ore, and will have to be assayed in a similar manner.

Veins and streaks of solid arsenical and other pyrites often carry gold, in what would appear to be paying quantities; but such mines have seldom been worked successfully.

Silver and its ores are so intimately connected with many of the

ores of lead, copper, antimony, zinc, etc., that in indicating the rocks in which we may expect to find silver-bearing veins, we necessarily include the others.

Native silver, Ruby silver, and silver ores proper, and such as are mixed with base metal ores to only a limited extent, are found most frequently in Syenite, Trachyte, Andesite, Porphyry,—Gneiss and allied metamorphic rocks,—and in shaly sandstone, conglomerates, etc., in the vicinity of eruptive rocks, and generally in a quartz gangue. Argentiferous galena, and carbonate of lead carrying silver, argentiferous grey copper ore, etc., in argillaceous shale and schists, crystalline limestone, etc., and porphyry. And low grade argentiferous galena and carbonates in carboniferous and other limestones.

The vein matter, or gangue, may be quartz or calc-spar, or both, and may be mixed with heavy-spar, flour-spar or pearl-spar; and in some of the largest and most productive lodes the vein matter is chiefly yellow and brownish clay, with boulders of iron maganese rock, and horses of the country rock, and in this character of gangue the largest chimneys of galena and carbonates, carrying silver, have been found.

The character and value of silver ores cannot be accurately determined, except by regular assay. They are mixed with so many other ores and minerals, that in many cases they cannot be distinguished from the ordinary ores of the base metals. After long experience a man may be able to form a fair estimate of the ores of the particular district in which he has been working; but take him into a new district where the combinations are different, and his opinion as to the value of an ore, from simple inspection, is quite worthless.

A collection of small specimens of different metallic ores, which can be obtained in New York, and readily carried along, will be of some assistance; and with a blow-pipe outfit, tests which will determine at least the presence or absence of silver, and many of the other metals, can be made. These with "Danas' Manual of Mineralogy," an elementary treatise on geology, and a book of instructions for the use of the blow-pipe—a gold pan or horn, and a bottle of Nitric Acid—will enable one to get a fair idea of any ore, rock, or mineral we may come across.

A pick and shovel, hand-crushing machine, or pestel and mortar, and one or two rock hammers and small prospecting poll picks should be carried along; and on regular prospecting expeditions, where such things can be packed or carried, a small bellows and

anvil, drills, striking hammers, powder, fuse, caps, etc., should form part of the outfit.

In prospecting a given belt of country, it is best to cross it as often as possible, and where the rock formation is most exposed; following up the beds of the streams, where practicable, and making lateral excursions at convenient points, and where the formation seems favorable.

At, or near, a change of formation, say from slate to granite or limestone; and near porphyritic or other igneous rocks, in stratified and metamorphic beds, large and productive lodes may be looked for.

Large veins are generally split up, or divided into several branches, in the valleys and crossings of streams; but the large and solid outcrops can generally be found on the high ridges on either side, by taking the general direction of the veins at the crossing, and it is usually on these ridges or hills that the largest and most valuable deposits of ore are found.

Preliminary Development:

The first thing to be done in opening up a lode is to ascertain the extent of the ore-body on the surface, so as to determine the best place for a shaft or tunnel. This can be done by sinking to bed rock at several places along the general line of the lode, where it is not already exposed, and making cross-cuts at these points. If the mine is to be opened up by means of a shaft, it may be located about the centre of this ore-body, and should follow the vein down. The dip of a vein is so liable to change near the surface, that a perpendicular working-shaft cannot be properly located until prospecting works have been carried to a depth of at least 200 or 300 feet. Drifts or levels should be run about every 60 feet, and, where the vein is wider than the drift, cross-cuts should be made at about the same distances apart. The extent to which this work should be carried, and the size of shaft, etc., must be determined by the nature of the vein and its ore, the developments made in sinking and drifting, and the amount of money the manager has at his command for this purpose. A shaft from 200 to 300 feet deep, and drifts as above, say 120 feet on each side of the shaft, with cross-cuts about every 60 feet, will generally be considered sufficient to decide the probable value of the property, and the cost of mining and reduction works for permanent operation.

The ore taken out of the shafts and drifts will help to pay for

the work, and the mine will be in a condition to put on men enough to stope out ore while reduction works are building, to keep them running while the permanent working shaft is being put down.

If the vein crops out on a side hill, or bluff, so that a tunnel can be run *along the vein*, at a sufficient depth from the outcrop on top, much time and money can be saved, and both hoisting and pumping works dispensed with. But if the strike of the vein is such that the tunnel must be run any distance *through country rock*, before encountering the vein, it must be prospected and proved to a sufficient depth, before a tunnel can be attempted without great risk of miscalculation and disappointment.

In lodes that are not too wet, rock and water can be hoisted for the first 100 feet by windlap, and from 200 to 300 feet by a whim; but where much water is encountered an engine will be required.

The following points in relation to Mining Claims should be carefully noted:—

1. Location or position on the Map.
2. How to reach it, and condition of roads, trails, &c.
3. Course, or strike, width and dip of vein or lode.
4. Class of ore or mineral, as nearly as can be ascertained.
5. Quality " " " and samples, if possible.
6. Length and width of ore-body exposed.
7. Gangue or matrix of vein.
8. Character of walls.
9. Country rock.
10. Water-power, if any, fall, No. of inches, &c.
11. Quality and cost of wood, timber and lumber.
12. Cost of labor and board.
13. Price of provisions, grain, hay, &c.
14. Rate of freight from nearest railway station, steamboat landing, or town.
15. Distances from do.
16. How lode is situated for development by tunnel or shaft.
17. Distance and freight to nearest smelter or reduction works; rates paid for ore, or charge for reduction.
18. Remarks on climate, labor, supplies, grass, &c.
19. Sketch of claim and surroundings.

In closing this paper I will quote the following from a Report to the Legislative Council of Victoria, Australia, March, 1854:—

" The discovery of the Victoria gold fields has converted a remote

"dependency into a country of world-wide fame; it has attracted a "population, extraordinary in number, with unprecedented rapidity; "it has enhanced the value of property to an enormous extent; "it has made this one of the richest countries in the world; and in "less than three years it has done for this colony the work of an "age, and made its impulses felt in the most distant parts of the "world."

Knowing the immense results that have followed the opening up of mines in Australia, California, Nevada, Montana, &c., one would suppose that our government (both Provincial and Dominion) would offer every inducement to prospectors and miners to prosecute their work of exploration and development, instead of hampering them with unnecessary and harassing rules and regulations. The mining laws of all the Provinces and the Dominion should be assimilated, and many alterations made; and mining machinery, which cannot be or is not manufactured in Canada, should be admitted free of duty, at least until such time as we can manufacture it ourselves.

JAMES BRADY.

VICTORIA, B.C., Feb. 11th, 1889.

REFLECTION OF THE ELECTRIC LIGHT.

The following short series of observations was taken with a view of determining approximately at least the range of elevation at which reflections from the electric light are visible. The reflections observed and considered are only those of the atmosphere and not those of clouds.

The place of observation was Preston, the electric lights being in Galt. The distance of the point of observation from the centre of the lighted area is in round numbers two hundred and fifty chains, and the direction south-east. There are 32 lights of 2000 candle power each; there are two dynamos of the Thomson spherical machine design; one dynamo is used for street lighting, the other for private lights. An 80 H. P. engine supplies the power. The area in which the lights are distributed is 110 chains north and south, by 65 chains east and west. There are twelve miles of circuit.

It is self-evident that in observations of this kind, where there is no sharp line of demarcation between artificial light and stellar light, the telescope is inapplicable.

At first a graduated rod with a draughtsman's square was used for obtaining the angular elevation, the line of sight passing over the square (which was slid up and down the rod), and the ridge of a building nearly at right angles to the line of sight. It was soon found however that this method gave too small a range of elevation, so it was changed to that of using a variable base. On a level piece of ground were marked off various distances, then having measured with the instrument at the height of the eye at the distant point, the angle of elevation of the ridge above referred to, the elevation at the other points immediately follows, and sufficiently accurate by a graphical solution.

The light of these 32 electric lamps was however not distributed equally in all directions. Twelve of the lights have two sets of carbons, but not burning at the same time; these lights are covered by a hood ten and a half inches in diameter. When the current first passes, the carbon points are on a level with the hood, so that no direct upward illumination is possible; during the process of combustion, the lower point or negative pole is lowered, while the upper one follows it by automatic arrangement. This lowering continues for six inches when the current is made to pass over the adjoining fresh set of carbons. We see therefore that on account of the hood the minimum direct upward illumination is nil, and the maximum of these 12 lights is only three-eighths of the whole.

The remaining 20 lights carry only one set of carbons, and are without a hood; the points at lighting being 14 inches beneath a rectangular box 5 by 6½ inches, carrying the adjusting magnetic mechanism, the points being lowered during combustion six inches as in the previous case. These latter lights give a direct upward illumination of nearly one-half of the whole.

Now of the direct upward illumination for observation by reflection, it is seen that the 12 lights furnish very little light, as at the maximum the rays are sent out at an angle of 45 degrees to the horizon; the inclination of the rays of the 20 lights at their maximum being about 81 degrees to the horizon.

Light either emanates from a luminous body or is reflected from illuminated bodies. In our observations we have to deal exclusively with reflected light. The intensity of light varies as the square of the distance, whereas the brightness remains practically the same within wide variations of distance.

The air is composed of gases and aqueous vapor, both reflect light; but in consequence of the lowness of the refractive index of the former, both the reflection and refraction thereof are feeble.

The gases of the atmosphere, we may assume as constant, but not the aqueous vapor or hygrometric condition of the atmosphere, and as it is mostly from this vapor under various conditions that we receive the reflections, it will be seen that our observations must to a very great extent follow the fluctuations of the percentage of aqueous vapor in the upper regions of the atmosphere. Another factor from which reflections may be received is the microscopic dust floating in the higher regions; but as the observations were taken in the winter when the ground was covered with snow, it is assumed that the effects of this factor are inappreciable.

A cloudless sky is the best condition under which to take observations for the purposes of this paper, for only then are we certain that the maximum height observed is situate directly over the lights. Knowing the length of the base line of our right angle triangle, the linear height of the visible reflected light is readily found. It sometimes happens that a cloud is floating somewhere above the illumined upper area, and from its more compact form of accumulated aqueous vapor possesses higher reflective powers, and will hence show more reflected light than is otherwise visible. But as one observer cannot by angular measure fix the position of a cloud, it is impossible to deduce the linear height of reflections as seen emanating from a cloud. I have on several occasions seen on clear nights with a single cloud hanging over the illumined area

reflections from the cloud, when many degrees beneath it no reflections from the atmosphere were visible.

Now besides the direct rays that illumine the upper regions, rays from the lower strata of the atmosphere are also reflected upwards, and in a large measure go to illumine the upper strata upon which observations are made.

On a clear night with little moisture in the atmosphere, it will be noticed that the illumination by the electric light on surrounding objects, such as buildings, is especially bright, shadows sharply defined, and places such as lanes or side streets where the direct rays do not fall especially dark. But if it rains, a marked difference will be noticeable, the above bright illumination of buildings will be more subdued, and on the other hand lanes and side streets where no direct rays fall comparatively bright. This results from the reflection from the innumerable drops of rain. The same phenomenon is produced by falling snow.

But when it is snowing it is more difficult, in fact often impossible, to make satisfactory observations of elevation than when raining, because the snow does not transmit rays of light as drops of water do, as each snow-flake is composed of many crystals, and the light is lost by repeated reflections.

It may be stated that by reason of reflection of light, a cloud projected against the sun appears dark or black, because few rays are transmitted through the cloud, that is there is an absence of light in that part of the sky, and hence appears dark; a cloud so situate, however, that the reflections can reach the eye will for similar reasons appear white.

Date.	Elevation.	Elevation in Feet.	Relative Humidity.	Thermometer.	REMARKS.
1889.					
Jan. 19	10°	2900	83		Clear sky.
" 20			99		Snowing, no light visible.
" 21	18°	5400	83	22°	Some light, fleecy clouds.
" 22	7°30′	2200	82	23°	Starlight. No clouds. Light diffused.
" 23	2°40′	800	89	35°	Sky overcast. No stars visible. Light spread more laterally than vertically.
" 24	2°35′	700	85	28°	Starlight, no clouds. Light faint.
" 25	2°35′	700	75	31°	" " " " "
" 26			93	26°	Starlight overhead, but heavy haze on horizon. No light visible.
" 27					
" 28			91		Snowing. No light visible.
" 29			78		Absent from home.
			78	11°	Starlight; a very light haze on horizon and no light visible.
" 30	45°	16500	89	22°	Light snow; sky overcast, yet here and there stars dimly seen. Light not bright but widely diffused.

Date.	Elevation	Elevation in feet.	Relative humidity	Thermometer.	REMARKS.
1889.					
Jan. 31	21°	3500	73		Starlight, but hazy on horizon. Light diffused, but a light cloud showed the reflection higher than could otherwise have been judged.
Feb. 1	35°	11600	83	14°	Starlight; hazy; spiculæ of snow in air. Light diffused. Illumination in sky lens-shaped.
" 2			76	26°	Overcast; no stars visible. Clouds apparently immediately above Galt, so that little or no light was visible, but from 20° upwards a bright and diffused band of light extended to the zenith and a little beyond. Laterally the band extended fully 90° on the horizon. At the same time in the northwest of the sky was visible at an elevation of 7° a band of illumined clouds, being reflected light from the electric lights in Berlin, seven and a half miles distant.
" 3	31°30'	10200	95	10°	Light clouds; stars visible. Light bright on clouds.
" 4			99		Snowing heavily, no light visible.
" 5			83	—2°	Moonlight; prevented observations for succeeding nights.
" 23			87	—6°	Bright starlight to within 5° of horizon. No clouds. Light so faint as to be indefinable in height.
" 24	37°	12400	88	8°	Sky overcast; fine snow; some stars dimly seen. Light diffused.
" 25	7°	2000	74	—2°	Starlight, but not very clear; no clouds, fog or mist on horizon although stars visible to within 10° of horizon. Light scarcely visible.
" 26			94		Heavy snow. Light invisible.
" 27			87		Too clouded.
" 28	32°	10300	90	31°	Misty.
Mar. 1	6°	1700	92	31°	Snowing. Light, a narrow band on horizon.
" 2	24°	7300	83	35°	Overcast; no stars. For 5° above horizon scarcely any light visible, then came a bright band which was diffused upwards, being more sharply defined beneath.
" 3	11°	3200		27°	Clear starlight, no clouds. Light faint and diffused, not much brighter than Milky Way.
" 4	12°	3500	82	32°	Sky overcast, but here and there a star visible. On horizon little or no light visible. From about 5° a bright band extended upwards, terminating rapidly; not much diffusion. Berlin lights, fairly bright band on horizon, elevation about 4°.
" 5			84	25°	Bright clear starlight. Aurora borealis in north, steady illumination, no streamers. Light almost invisible, just barely so on horizon; no elevation.
" 6	40°	13800	83	30°	Overcast. Immediately above horizon up to 4° no light visible. Above that to 7° was a cumulus cloud with rents; cloud, bright illumination, rents dark; above cloud diffused light up to 40.° Berlin lights visible on horizon upwards of 3° or 4°.
" 7			76	27°	Overcast. Moonlight, and hence no observations on succeeding nights.

NOTE.—In the above the word light is used for reflected light. Elevations given are never on clouds, and heights to the nearest hundred feet.

We have from the observations, therefore, the greatest height measured as something over three miles, and find that the fluctuation of elevation is very great, due mostly as before stated to the amount of moisture in the atmosphere. In every observation the reflected light must have travelled over at least three miles, passing obliquely from the higher strata of the air to the eye, so that we are correct in saying that the initial upward rays must have penetrated vertically more than three miles in every case.

But knowing that a ray of light penetrates at least a certain distance, and having an ocular demonstration thereof, are two very different things. A ray of light can itself not be seen, it is simply a direction of motion and has no material existence. Hence these upward rays would be invisible to us but for the existence of the air, with its aqueous vapor reflecting or turning some of these upward rays in such a direction as to fall upon our eye. If the image formed upon the retina of the eye is sufficiently bright, the impression of light is made upon the brain; if the reflected rays are not sufficiently numerous to make that impression, no light will be visible.

This shows that two observers would probably not adjudge the same elevation in taking similar observations as the above, it depending upon the sensibility of the retina.

The more reflecting surfaces that we have the more light we will receive; but when these do exist in the upper strata, they are in a measure also distributed through the lower strata, through which the ray must pass in order to reach us; so that when the reflection increases, the transmission decreases, but in a less ratio up to a certain limit.

Through the kindness of the Director of the Meteorological Service, the figures in the column Relative Humidity were obtained They are for Toronto at 10 p. m. of each day. The comparative proximity of the place of observation to Toronto permits us to assume that the hygrometric curves of the two places are similar. Comparing the fluctuations from day to day of elevation and relative humidity, a foregone conclusion is substantiated, and that is, that although the elevation of reflection is dependent upon the amount of moisture in the upper regions of the atmosphere, that amount is not obtained by observing the relative humidity at the *surface* of the earth, nor is there a constant ratio connecting the two. The writer is not aware of any observations or tables that show the ratio of relative humidity for different temperatures, for different elevations above the surface of the earth at a given point.

In the summer-time during the heat of the day, the moisture is carried to higher regions increasing the relative humidity there, while decreasing the same near the surface of the earth; during the night when the air is being cooled off, the reverse takes place. In the winter it is not probable that the variation in a day of the relative humidity of the upper and lower regions is as great as in summer.

From a series of observations extending say over a year at least, we might hope to deduce a curve from the elevation observations, representing fairly well the hygrometric curve of the upper regions.

Should the above observations be compared with those at other localities, due consideration must be given to the number of lights, and their construction.

The greater the number of lights within a given area, the greater the illumination, and the higher the visible reflection.

OTTO J. KLOTZ.

GUNTER'S CHAIN.

MR. PRESIDENT AND GENTLEMEN,

I think that anything I may advance regarding Gunter's Chain will be quite familiar to you all; I would not have chosen it as the subject of an address, however short, to this Association, were it not that my attention was drawn to consider the great utility of this standard of measurement by some paragraphs in an article published in an exchange we received from one of our sister associations during the past year.

The article is entitled "Decimal *versus* The Metric System." As the Metric System is a Decimal System, the title appeared to be peculiar; on reading the article, I found that the writer wished to prove that it was advisable not to adopt the Metre, but to retain the Foot, decimally divided, as the Standard for American Engineers and Surveyors, and to discard the use of all other standards of measurement whatever, including Gunter's Chain.

The foot, decimally divided, is almost invariably used by Civil Engineers in our various surveying and levelling operations, and has been so used for a great number of years; I am of the writer's opinion that for this class of work it would not be advisable to make any change; I also agree with him in that it would be a great benefit if the foot, divided decimally, were in general use by architects and artisans, similarly with regard to the advisability of using the cubic foot also divided decimally. I am one of, I believe, a large majority who are of opinion that it would be a public boon to cease using the different weights and measures now in use, and to adopt decimal measurements of volume and weight of which the foot might be the base; but for measurements of areas it is different. I am of opinion that as long as a mile is a standard of length and an acre a standard of area, so long will Gunter's Chain be preferred by Surveyors for nearly all their measurements, and of areas especially.

The paragraphs to which I refer, are these:

"I wish to make a few comparisons, and will start with the state-
"ment that we must have a new system of notation in weights and
"measures. We all remember our childhood school-days, trying
"to memorise the complicated duodecimal system of weights and
"measures, that made mathematics, the grandest and most exact
"of all arts and sciences, a dread to the majority of scholars,

"a dislike that can be overcome by improving our system of nota-
"tion. I will take the Gunter's chain to start with:

"PROBLEM:—How many acres in a tract of land of the follow-
"ing dimensions: Gunter's chain, 6 rods, 1 link, 4.08 inches, by
"26 rods, 10 links=? Decimal, 100 feet, by 435.6 feet=43,560
"square feet=1 acre? Please note the chain measurement, use
"decimals of an inch, and the entire measurement will have to be
"reduced to decimals before multiplying, and then divided by 160 to
"get answers in acres. If you ask what is a rod, nine out of ten,
"if they know, will answer, sixteen and one-half feet, instead of
"twenty-five links. I think this simple experiment will prove to
"you all, that to use the foot instead of the Gunter's chain is not
"introducing a foreign element to anyone's detriment."

Please note especially that the writer takes Gunter's chain, which is in itself a decimal system, pure and simple, to illustrate the advisability of adopting a decimal system, and that he quotes the measurements taken with it in *rods, links, inches and decimals of an inch!* This is the first instance in my experience of a measurement taken with Gunter's chain being expressed in rods, links, inches and decimals of an inch. I think that eminent Astronomer and Mathematician, Mr. Edward Gunter, would have been astonished at such a liberty having been taken with the chain that he had the wisdom to divide decimally.

As we all know Mr. Gunter's invention or discovery consisted in having observed that the result of 5,280 feet, that is the length of one mile, divided by 66, is exactly 80, or as now expressed, 80 chains make one mile, and that 10 times the square of 66 feet exactly equals one acre, or, as now expressed, 10 square chains make one acre; there remained nothing therefore to do but to divide decimally the standard of 66 feet, thus discovered, which Mr. Gunter wisely did, dividing it into 100 links, and each link into tenths and hundredths, therefore the problem given in the paragraphs I have quoted, instead of being stated 6 rods, 1 link, 4.08 inches, by 26 rods, 10 links, should have been stated 1.5151 chains by 6.60 chains. But this problem, to put it mildly, is unfair and misleading, as one multiplier is made to express 100 feet exactly, and is therefore necessarily a repeating decimal, and obviously cannot be a measurement made with Gunter's chain. A fair problem is any one in which the multipliers are even such as:

2.25 chains × 5.50 chains = 1.375 acres and the equivalents in feet.

165 feet × 363 feet = 59895 square feet ÷ 43560 = 1.375 acres.

The measurement with the chain manifestly possesses the advantage of not requiring the division by 43560, which is quite an advantage when there are a large number of areas to be ascertained. Both of these answers are expressed in acres and decimals of an acre, as in this Dominion the expression of areas in acres, roods and perches has happily become obsolete.

We must not forget also that maps or plans, constructed with the scale referring to measurements made with the chain, possess a decided advantage over those made with the scale referring to measurements made with the foot as a standard; for instance, in a map or plan with a scale, stating that 10, 20, 40, or 80 chains equal one inch, we know at a glance that 8, 4, 2, or 1 inch, as the case may be, on the map or plan, is exactly a mile, and we also know that the map has been constructed decimally, whereas the equivalents in feet, 660 feet, 1,320 feet, 2,640 feet, or 5,280 feet, to an inch, are very inconvenient scales, and preclude the possibility of constructing the map or plan decimally; and if the map is constructed with a scale of even 100 feet, we still have the fraction of 280 feet in every mile to enter into the measurement of any distance on the map or plan to be expressed in miles.

In conclusion, I think there is no doubt that the Surveyors' chain, commonly called Gunter's Chain, which was invented by Mr. Edward Gunter about 250 years ago, is still at this date too valuable a link between the standards of a mile and an acre, and too convenient a standard itself for measurements generally and of areas in particular, to be lightly set aside for any other standard whatever, that is, as long as a mile is retained as a standard of length and an acre is retained as a standard of area.

S. BRAY.

OTTAWA, 1st February, 1889.

THE STATUS OF OUR PROFESSION.

This is emphatically an age of improvement. Since the commencement of the Nineteenth Century what wonders have been accomplished! The very elements have been made to do the bidding of man. He has harnessed the lightning—compelled the slumbering properties of matter to do his bidding. "He has made the wave a willing slave, to plow its own blue deep, and over the land, the rock and desert sand, with fiery train to sweep." Yet the man who acted as fireman on the first Railway Locomotive is still living, and is now a resident of Ontario! The uses to which electricity has been applied, within the last decade even, is simply marvellous. Had the announcement been made ten years ago that a person in New York City could hold converse with another in Chicago, whose voice and tone he could distinctly recognize, the man who made it would by common consent be considered a fit subject for the insane asylum; yet Edison has demonstrated this, and even more astounding discoveries, and yet the scale of progression increases in intensity at every new development. So eminently successful has been this victory of mind over matter, that the last leaf in the vast volume of research and discovery is in perfect keeping with the developments of the first.

Such thoughts are inevitable in glancing back through the long vista of past ages, in search of the object which has been most prolific upon this vast, almost uncontrollable, system of progression, and for the purposes of this paper the author hesitates not to assert that the science of the Surveyor has contributed its quota to this gratifying result, from the date Adam "surveyed the Garden of Eden roundabout" to the present time.

In complying with repeated requests, that I would prepare a paper to be read before the sixth annual meeting of the Dominion Land Surveyors Association, I may here premise that I do so with extreme hesitation, from the fact that the subject demands more time and attention than I can bestow upon it at present. I will, however, introduce the subject, leaving it for more extended treatment at the hands of the Association. The question to be considered at the very outset is what position should we occupy among the professions of the day? Do we occupy the place to which we are entitled? If not—why not? If imperfection exists

and is admitted, the thing to be done is to ascertain the cause, and apply the remedy if possible.

That the profession of the Surveyor is entitled to rank among the first can be demonstrated by argument, as conclusively as it can be shown that we do not, at present, occupy the high position to which we are by right entitled, and which it is the aim of our Association to secure to us. The question of standing must necessarily be considered by comparison with the other learned professions—the Ministry, Law, Medicine, &c.—all of which have their several fields and special missions. It can be reasonably claimed that the theoretical portion of our profession affords a wider field for thought than can be found in any other profession. We have for a basis the most exact and absolutely correct foundation. The principles and correct applications of mathematical science admit of no uncertainty. No exceptions are necessary to prove the rule as in some other departments of science. In this respect we can fairly claim to be in possession of the only indisputably accurate profession; for do not ministers differ widely in their views, concerning even the fundamental principles which underlie the teachings and doctrines of the true Church? Doctors frequently differ on vital points pertaining to their profession; and in law, unless there are two sides, the interest in that profession would be greatly diminished. Thus we can readily see that while differences of opinion exist in other leading professions, ours, being governed by the unvarying principles of mathematics, must, when properly applied, produce correct results. The nearest approach to an apparent uncertainty in the study of our profession which I remember having met is the following:—"An asymptote of an hyperbola is a straight line drawn through the centre, which approaches nearer the curve the further it is produced, but being extended ever so far can never meet the curve." This may appear, at first sight, contradictory, but a principle similar to that upon which this depends is contained in the 47th Prop., 1st Book Euclid, from which it is shown that the square of the 2nd side subtending the right angle must be added to that of the other side, to equal the square of the hypothenuse. Now, to apply this principle, we will suppose the base to be one mile long, and the perpendicular to be one foot in length, the length of the base will be so nearly equal to that of the hypothenuse as to be practically the same; and the further the base be extended, while retaining the same unit of measure for the perpendicular, the more nearly will the base and hypothenuse approach to equality; yet, in the calculation we cannot ignore the perpendicular, however

small the ratio, in order that a correct result may be obtained. Thus is demonstrated the absolute correctness of the fundamental principles enunciated. This principle also holds true when applied to calculations in spherical trigonometry and astronomy. By the aid of such principles we are enabled to explain why the moon, which is comparatively near to us (being about 30 diameters of the earth distant), appears as large as the sun, which is 400 times farther away. Were the moon to recede from the earth a distance equal to that of the sun, its diameter would be contained within an angle, which, at the distance of a mile, measures one inch and a half—half of which corresponds to the perpendicular or semi-diameter of the object viewed; nevertheless, this factor must play a very important part in calculating the sizes of the various planets, and all objects presenting a defined disc. This serves to give some idea of the care and skill that must be exercised, not only in the observations and calculations, but in making the instruments by which we are enabled to read such results.

Thus by the application of the principles of our science we not only measure the distances to the planets which compose the solar system, but are enabled to ascertain their relative size, position, velocity and weight. In illustration of this may be instanced the accuracy of the calculations involved in determining the exact time, locality and duration of the eclipse of the sun, which occurred on the first day of the present year. Not only was the moment of time accurately predicted, but so finely defined was the belt of totality, that its limits could have been marked out upon the earth by lines drawn across the continent. Astronomers made no mistake as to the location of points from which to make observations to the best advantage. This is but another illustration that the principles of mathematics, when properly applied, work out correct results, whether in the prediction of an eclipse of the sun or moon, transit of Venus, or other calculations in astronomy, spherical trigonometry, &c.

While the instruments and appliances for the prosecution of such extended investigations may not be within the reach of all, it is none the less requisite and necessary that we should be capable of putting to their proper uses the results obtained through these intricate appliances. By the teachings of our calling we are privileged to see, as "through a glass darkly," the operation of Nature's laws, and should be inspired by a desire to investigate still further this interesting and important branch of our profession.

In concluding this branch of our subject, it may be remarked that

the mind can with difficulty conceive the extent and accuracy of the calculations involved. We quote figures without an adequate conception of their meaning. The distance to our nearest neighboring planet (Venus) is so great, that were we to travel by an imaginary railway train at an average rate of 30 miles per hour without stopping for wood, water or way-stations, we would only reach our destination at the end of one hundred years. The trip would thus prove a failure within the years allotted to the life of man. So much for the "all rail route" to our neighbors, the planets. Now let us consider for a moment the movements of light and electricity. The former comes from the sun in eight minutes, or 186,000 miles per second, and although travelling at that immense velocity we learn with astonishment that, had most of the fixed stars we view with the unaided eye been blotted out of existence at the date of our birth, we would be still able to observe them as if they had not been obliterated, as the light from them which now strikes the eye started on its course before we were born. It is only by such illustrations as these that we can gain anything like a comprehensive understanding of the immensity of the distances represented by the figures we employ, and with which we have to deal in the higher branches of our profession, to which every student should aspire.

In view of the nature and extent of the attainments necessary for those who would worthily uphold the dignity of our profession, it is reasonable to assume that our standing and influence should be second to none. But is it so? We have to admit that it is not, for reasons that lie upon the surface, and which we will consider briefly. We have allowed the profession to drift, as a craft without rudder or master, at the mercy of wind and wave. We have too long been without organization or association for the preservation or promotion of our interests. A few years ago, it is gratifying to note, leading members of our profession in the Dominion and in many of the States to the south of us, roused themselves, and a laudable effort was made culminating with us in the organization of the Association of Dominion Land Surveyors, which is doing good work in a right direction, and should receive the encouragement and active support of every member of the profession. The Surveyor, of all men, should recognize the fact that nothing in Nature can remain at rest, from the revolutions of the planets and heavenly bodies down to all animate and inanimate matter. Nature abhors a vacuum, and as well might we expect that a hole made in the waters of the ocean would remain unoccupied, as that our place among

the professions can be kept and preserved for our use and occupation without active attention upon our part. Active and constant exercise is required, both of mind and body. The arm carried in a sling for a few months only will lose its cunning; the profession or association whose members are inactive will similarly become weakened and incapable of effective action. To keep abreast of the times, we require a more constant and thorough interchange of ideas, and it is only by united action that we can hope to maintain our position, or prove to the world that we are worthy of recognition. At present in popular parlance, the Surveyor's whole staff, including the cook, is referred to as a "party of Surveyors," and what wonder, considering that from want of organization we ourselves scarcely know who are members of our profession qualified to practice. It is not surprising therefore that the public generally have fallen into the habit of considering as a Surveyor every person who can set up an instrument, read an angle, and chew tobacco, and occasionally strike the mark—with the tobacco juice. We owe it to the public as well as to ourselves, and the students who in good faith undergo the necessary courses to become surveyors, to weed out those parasites, whose monumental cheek enables them to usurp positions for which they have never become qualified, and who, being under no bonds, have the double advantage of assuming no responsibility. We require and should procure for our own protection, and that of the public, legislation more stringent than the laws at present operative. So long as we continue to allow unqualified persons to "*work at surveying*," we may expect to find the Courts accepting as professional such evidence as they may give. The lawyer and the judge naturally, and not unreasonably, look upon the matter only in reference to the facts to be adduced in the case, no doubt concluding that inasmuch as we allow such persons to practice as surveyors, it devolves not upon them to question their qualifications, or protect our profession against them. The truth appears to be that our profession, like that of medicine, requires protection. The latter profession has had of late years to institute the most rigorous prosecution of those who were unlawfully practising as physicians, and thereby bringing their profession into disrepute. The Surveyors' Association must do likewise, if they would protect the interests of the public and preserve their own respectability.

I venture the declaration that our personal habits have an important influence, and are largely responsible for our degenerate condition as a body. Our standing, individually and collectively,

depends very greatly upon our every-day deportment. Our habits and customs have very much to do with the estimation in which we are held by the general public. The field practice of our profession tends to roughen our manners in many ways, and fasten upon us habits repugnant to polite society; hence if we would elevate our profession, we should exercise the greatest care in this regard. On extensive surveys we are to a great extent ostracised from the world and the advantages of more active society, which circumstance in itself has the effect generally of producing a carelessness of manner, which, taken in connection with our consequent lack of opportunities for the mutual interchange of ideas, all have a tendency to produce that carelessness and indifference which, perhaps more than anything else, affect our standing in the social and literary world.

Members of our profession are frequently being crowded out, and are driven to seek other employment, in order to procure a livelihood, while the work that should of right fall to them is being performed by those who are self-constituted surveyors, and presume to practice in direct violation of law. As I have already stated, the first practical work of the Association should be to discover and weed out of the profession such persons as are properly included in the term parasite. That being done promptly and efficiently, the status of our Profession must rapidly improve, till we take the place to which we are entitled among the learned professions.

WINNIPEG, Man. J. W. HARRIS.

A STANDARD OF PRECISION.

As time adds to the experience of the surveyor, he becomes more and more convinced of the necessity of applying some test to each of the operations which go to make a complete survey, to ensure a satisfactory degree of precision; while an exacting public, imbued with the infallibility of the maxim "a penny saved is a penny gained," ignorant of the illimitable possibilities of error that beset the surveyor, and careless to an extent that is to be wondered at of the magnitude of the evils that may result therefrom, insists with increasing rigour on cheapness, and the necessary accompanying speed; indeed the idea seems to gain in popularity that the surveyor, like the fairy Puck, can "put a girdle roundabout the earth in forty minutes."

In the struggle for his daily bread, confronted on one hand by a strong competition, and on the other with an empty purse, what checks are indispensable to ensure good work? becomes a question of interest, and it has occurred to me would form a profitable subject for consideration by this Association.

A brief glance at the work of a traverse survey will present many of the various points of interest which the subject presents. The point of commencement (the location of which, generally depending on evidence, will not concern us here) having been satisfactorily determined, and the direction of the initial course marked on the ground, we have as the first instrumental operation to find its azimuth, involving at the outset the determination of the degree of precision of angular measurement, which the interests that may depend on the work require, that is to say—we have first to determine what quantities can be omitted from the readings, and second, the methods to be adopted for eliminating instrumental and other errors, so that each course may within a stated variation agree with its azimuth as recorded in the field notes. This limit of variation we may call our standard of angular precision. The precautions to be taken to ensure good chaining now require our attention. On this, the weak point of all surveys, those who have been engaged on surveys where check chains were used could perhaps give some useful hints. The error which should not be exceeded with the precautions determined on may be called our standard of lineal precision. Having in the various operations comprising the survey carefully conformed to the requirements of our adopted standards, we have in the errors of the closing angle and

chainage, measures of the value of the work. If, for instance, we have decided to take the angular measurements to the nearest minute, with thirty seconds as the standard of angular precision, and have used those precautions considered essential for the elimination of errors, our closing error in seconds should not exceed the product of our standard of angular precision, thirty seconds, and the number of courses. Similarly the error shewn in the chainage of the last course should not exceed the product of the standard of lineal measurement adopted, and the sum of the measurements of all the courses. These quantities would have to be found by latitudes and departures in the field. The calculations can generally be made without delaying the other field work, and afford the additional advantage of locating and correcting an error, if any, before leaving the ground. The necessity of attention to this detail, particularly if the work is to have a guaranteed degree of precision, will be apparent. With judiciously framed standards, a departure from which would involve unnecessary minuteness and corresponding loss of time, or a gain in time at the expense of a probable inaccuracy, if not a downright mistake, the surveyor occupies unassailable ground.

If, in the event of a disputed survey, the surveyor can show satisfactory evidence as to the correctness of his work, his reputation will be enhanced, and the public will have an appreciable consideration for what might have been considered an unusual, if not an unnecessary, outlay for surveying. This evidence is afforded by our standards, when inserted with the result of the tests they supply, and a minute account of all the field operations in the note-book; for example—if the note-book of our supposed traverse, I mean the copy furnished with the plans as well as the field copy, records the bearings and distances corrected so as to balance, preceded by a statement of the standards of precision, and the data used for the determination of the initial azimuth, in the case, for instance, of an observation of the sun, this would be the latitude and longitude, stating how ascertained, time, registered declination, and instrumental readings, so that the calculation could at any time be checked, and all subsequent operations recorded with equal minuteness, followed on the last page with the closing errors and the deduced errors of each angle and linear unit, showing that the limits of the adopted standards have not been exceeded; confidence that could not be otherwise given to the work will be obtained. In those surveys where lines are to be run on stated azimuths, and the work terminates without the opportunity of

making a satisfactory check, perhaps nothing short of two independent measurements will ensure entire confidence, but this on ordinary surveys is out of the question; still if the precautions adopted in the standards of precision are rigidly adhered to, their insertion will certainly increase the confidence with which they will be received. The importance of an individual standard being admitted, it is but a step to the adoption of a uniform standard by the profession.

A standard, having in view the objects I have endeavored to set forth and having the weight of a formal approval by this Association, would as they became known, if they would have any use whatever, be looked on as the hall-mark of reliable field notes. Plans when furnished without notes, but containing a certificate that the Association standard had been complied with in the survey, would also have an increased value.

In this paper I have not attempted to formulate any particular standard, but simply to suggest, by showing some of the advantages that would result, a consideration of the utility of the approval by this Association of some standards for use by its members, as a means of securing greater uniformity, increased confidence, and corresponding weight in subsequent discussions of surveys made by them.

J. A. KIRK.

STRATFORD, February 15th, 1889.

COAL MINING.

MR. PRESIDENT AND GENTLEMEN,

Through the kindness of your Secretary, I have been asked to prepare a paper on Coal Mining for this meeting, and after some hesitation, decided to give a brief history of the mining of coal in our Western Territories. Owing, however, to the short time available, I was unable to collect sufficient data, and therefore had to abandon the idea for the present.

A discussion on theoretic mining and the practical management of a mine are subjects upon which I feel inclined to touch but lightly, for various reasons; therefore the only other way in which I may occupy your time in discussing coal is on those branches with which all Canadians have occasion to be familiar; one for instance, coal as a means of brightening our firesides, looking into, of course, the financial aspect, and closing with a problem for the astronomical section, viz.:—

What change would be necessary in our solar system, so as to relieve us of the monotony of putting our hands into our pockets to settle coal accounts so frequently during our late autumn and early spring seasons.

Seriously, however, I will endeavor to give a short account of the mining of soft coals, based upon observations made in several mines during my connection with the Lethbridge Colliery.

There seems to be a prevailing idea among a great many, that the extraction of coal is a very lucrative business, one which requires little capital for the development of the mine, and yielding immense profits. One of the sources occasioning this error is doubtless the fact, that seams of lignite and coal are very often visible in the outcrops, along the valleys of our rivers; and to those contemplating the working of many of these seams, I presume the two principal factors entering into their profit and loss statements would be the contract price paid to miners, and a trifle for transport to market, leaving a very wide margin up to the selling price to the consumer. For the proper development of a mine, the first consideration of the Operator is a thorough examination of the coal area to be worked out, and a Diamond Drill, though somewhat expensive, is probably best adapted for this work, owing to its withdrawing a "Core" from the different measures passed

through. The general dip of the seam may then be obtained, and shafts and surface works so located as to give the best combined results for the future development of the mine—for instance in underground-drainage, also underground-haulage with respect to grades.

Seams of coal may be found dipping from 0° to 90° and the nearer a horizontal position the easier worked for several reasons; one I might give is the adaptability of such a seam for the introduction of mining machinery, of which I will speak later on. Rarely, however, is a seam found to remain level for any distance, being more or less undulating. Dipping seams, especially when they approach a vertical position, are often very uncertain, as in this position the seam may be most "faulty."

I have seen in the mountainous regions of Southern Montana abandoned coal mines, where in one case probably five hundred thousand dollars were expended in developing a vertical seam, to find that the coal ultimately disappeared. The percentage extracted of the total amount in the seam varies from 50% in some mines to 80% in others, and depends altogether upon the character of the roof. In many instances, in a mine with a soft roof, unfinished chambers have to be abandoned on account of the roof coming down, leaving buried large tracts of coal which would be too expensive to reclaim.

Props for the support of the roof are quite an item in the cost of production, and as the mine becomes developed the percentage of timbering increases, owing to the "entries," or arteries, through which the coal is hauled, daily becoming longer. In addition these entries require constant attention in the renewal of timbers. Then again in the chambers, the props are rarely reclaimed, unless in mines where the roofs are composed of good strong shales or stand-stones.

The manner of mining the coal is governed to a certain extent by its physical conditions. If the roof is very good, the system of long-wall work may be adopted with advantage. In this system a long continuous face of the coal is exposed, and by propping the roof along this face, sufficient room is secured for the workmen, behind whom the roof keeps giving way as the work advances.

The necessary roads through the working are usually supported by masonry.

The other method of mining the coal is by "pillar and room" or chamber workings, which to be applied in different seams require changes and modifications, depending upon the nature of the roof.

Under this system we have what is known as "double entries," which consist of two passages, each about 8 feet wide, and driven parallel with a pillar of coal between them, varying in thickness from 15 to 20 feet. From these, chambers or rooms are laid off, leading to the right and left from respective entries. These rooms are driven 9 feet wide, a distance of about 15 feet, when they are widened out to various widths consistent with the quality of the roof. Usually, however, with a fair roof, rooms 21 feet in width may be driven the full depth required, before the superincumbent mass is likely to come down.

The locating of the rooms along the side of an entry depends upon the maximum width of the room after it "turns the pillar," *i. e.*, where the width is increased, after driving the first 15 feet. Provision is made so as to leave a pillar of coal about 12 feet in width between each room, running its entire length, from which the coal is extracted backwards to within fifteen feet of the entry, after the room has been driven the required length. By this means solid pillars of coal of about 15 feet in length by various widths may be found along one side of the entry, and separated by the 9 feet entrances to rooms either worked out or under process of extraction, while the opposite side, with the exception of cross-drifts for air or roadways, is one continuous pillar of coal, separating the two entries. These pillars are left for the purpose of supporting the roof, and though 15 feet is mentioned herein as the usual distance, pillars extend back from entries, yet this does not follow in all mines, as the dimensions of pillars left for the support of roofs depend entirely upon the depth of stratification overlying the coal. "double entries" are necessary for ventilation. If the workings are on an extensive scale, the ventilating current is by mechanical means forced through one entry up to near the "face" or end of that entry, supplying on its way the several rooms; then passing through a cross-drift, the other entry is converted into a return airway.

As the entries are driven forward, these cross-drifts are closed up, and new ones cut near the "faces," so as to ventilate the more advanced portions of the workings.

Should it be found necessary at any time to abandon any particular set of entries, the pillars then standing may be extracted backwards from the "face."

Some coals are much harder to cut than others, and owing to certain seams having a distinct clevage, with faces regular and parallel, the coal is much easier cut by working on or against

the faces, making it therefore necessary to drive the entries on or against the "butts."

This is especially the case with the lignites and bitumens of north-western Canada.

The maximum depth of the rooms or distance between sets of entries is variable in different mines, and the management in defining this distance is governed by the quality of the roof, and also the greatest distance it is desirable to make miners shove their mine waggons out of the entry, from which point the waggons are afterwards hauled to the shaft or other outlet, by means of either horses, mules or machinery.

Rapid strides have of late years been made in the improvement of machinery used in connection with collieries, such as Hoisting Engines, Coal Cutting Machines, Drills, Mine Waggons, Tipples, underground haulage by means of endless chains, &c., &c.

Respecting Coal Cutting Machines, several forms have been invented, of which the "Legg" is probably the best in use to-day. These machines are operated by compressed air, which is conveyed into the mine through large wrought-iron pipes about 5 inches in diameter, and stored in reservoirs situated in different parts of the workings. From these reservoirs, permanent pipes carry the air forward, from which smaller and temporary ones, supplying the machines, lead to the various portions of the mine.

The object of storing the air in reservoirs is manifold; the supply from them being more uniform than if direct from the compressor, as the deep pulsations of the piston would be felt by the machines. It is supposed that the exhaust from coal cutting machines adds to the ventilation; however, in mines of any magnitude, the assistance rendered by this means is hardly appreciable.

Coal cutting machines are undoubtedly of great value to Coal Operators as the work they perform, viz., the undercutting of the coal, is that which would otherwise require skilled labor, so that wherever in use the management is not altogether at the mercy of labor organizations.

Apart from this, the machines—especially in mines where Long-wall work may be carried on—materially reduce the cost of production; but if the roof of the mine is poor, necessitating the driving of narrow rooms, then it is questionable if mining by picks is not as cheap, owing to the time lost in moving the machine from room to room.

In conclusion, it is hardly necessary to state that coal mining is becoming quite an important factor in the development of trade in

the North-West. Mines already being in operation at different points along the Bow River from Calgary westward, also at Edmonton, Medicine Hat, Lethbridge, and on the Middle Fork of Old Man's River. Of course, some of these have not yet been developed to any extent, still the Colliery at Lethbridge may compare favorably with any in the Dominion of Canada, possessing as it does the latest improvements in all kinds of machinery requisite for the proper working of a mine.

It will therefore shortly be necessary for our Legislators to enact laws, governing the mining of coals in the territories, so as to insure safety against inexperienced and reckless miners.

C. A. MAGRATH.

LETHBRIDGE, N. W. T., 9th February, 1889.

A NEW FORM OF FIELD BOOK.

It was my intention to exhibit an improved steel band chain, made according to a design that occurred to me; but as there are no mechanics in that line of business where I live, and not having had time to make it myself, it still remains unmade. I now venture to submit to the Association an improved form of field book for Dominion Land Surveys, which is merely a modification of that now in use, for which I claim the following advantages: 1st. That the chance of error in ruling in a road is so much lessened, that it is practically reduced to nothing; 2nd. That as about half of the roads are printed in the blank, and that the half most difficult to rule in by hand, and also a good many of the signs to indicate "Post in Mound," the returns will have a neater appearance, and will be more readily made.

METHOD OF CONSTRUCTING THE BOOK FOR EAST BOUNDARIES.—Put in a road at the bottom of page 1, then one at the top of page 2, and so on for as many pages as there are miles of meridians in the township, the roads being at the bottoms of the odd pages, and at the tops of the even; and on the right at, say, $\frac{1}{10}$ of an inch distant from the ruled column, put a small N on the exterior line of the road at the bottom, and on the interior line at the top of the page; then, if the course of the line is north, N is on the side the meridian road is to be ruled, and on the line upon which the sign indicating "Post in Mound" stands; if south, S indicates the positions of the same.

FOR NORTH BOUNDARIES.—Put a road at top and bottom of the page, and (analogously to N and S on East Boundaries) put W on the exterior road line on the right of the ruled column, E on the exterior road line on the left, then when the course of the line is west, W indicates the side of the column upon which the road is to be ruled, and also the line on which the mound sign stands. When the course is east, E indicates the same.

The above holds good with one exception. In a township with a correction line on the south boundary, the mound sign will stand on the interior line of the road on the correction line.

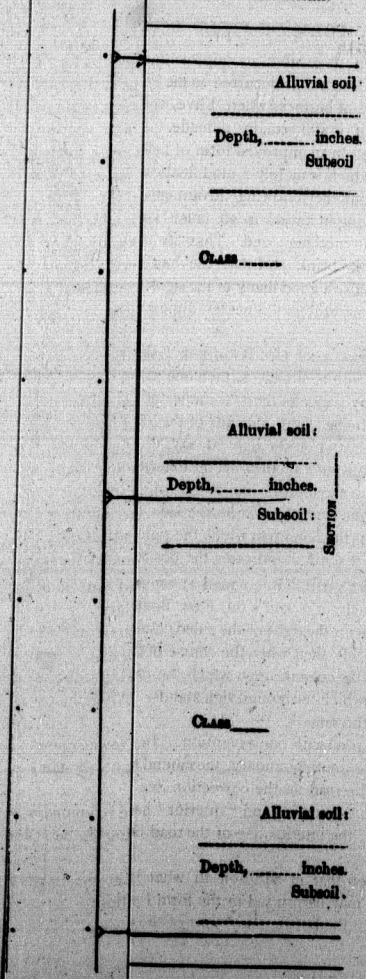
N.B.—The words "exterior" and "interior" have reference only to lines in the book, the interior line of the road being that next the centre post.

It will be seen then that in addition to what is in the existing form, the following may be printed in the form I submit.

(1) All the roads at the bottoms and tops of the pages.

West of _____ Meridian

Section _____ Course: _____



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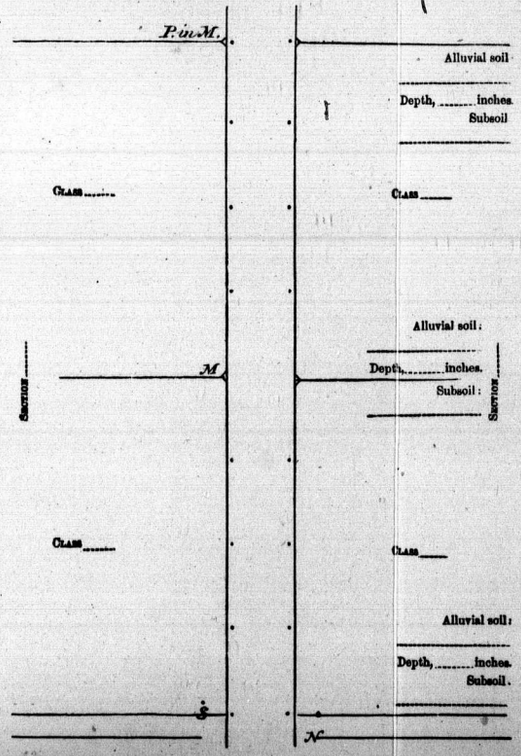

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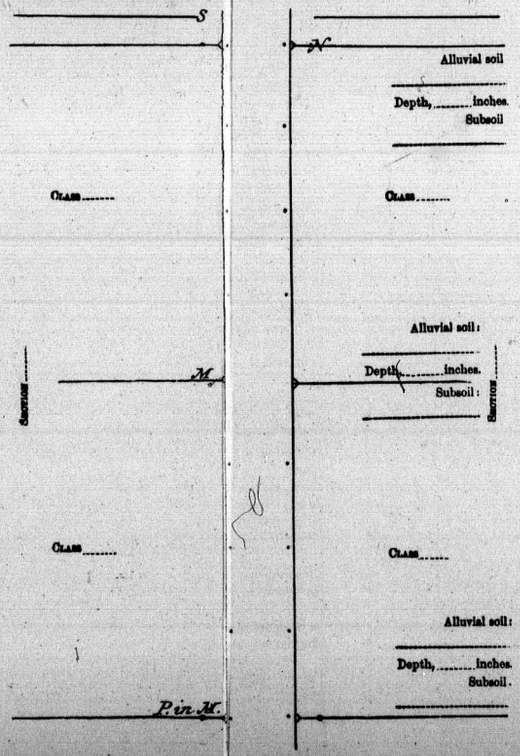
Township....., Range.....West of.....Meridian
East Boundary of Section.....Course:.....



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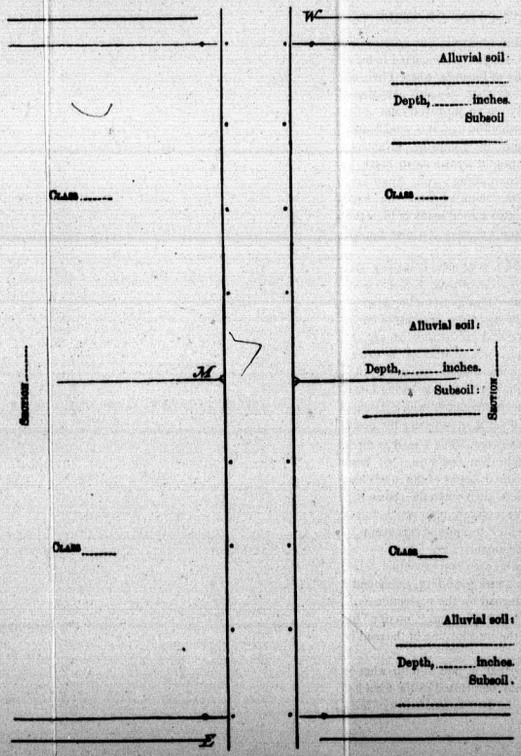
North Boundary of Section.....Course:.....



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(2) The mound marks at the tops and bottoms of the pages for east boundaries, where there are no roads.

(3) The mound marks for the centre mounds.

(4) "*East*" (boundary) at the top of the east boundary pages.

(5) "*North*" (boundary) at the top of the north boundary pages.

Some five or six years ago a very neat form of field book was adopted, but only for a short time, owing to the following objection: the courses were printed in the blank form, and all lines had to be run in the field on the courses given in the book, otherwise the notes had to be invented, or the roads, etc., crossed out and others put in. The only trouble of this kind that could occur in the form I suggest would be, if say the east boundary of Sec. 2 were run north one mile, and the east boundary of Sec. 11 run south to meet it, page 1 will be found to answer for either line, but page 2 for neither, unless the notes be inverted. It follows then that meridians should be run consecutively for two miles, and I may say they are so run almost universally; but the surveyor is at liberty to run either north or south, as may be most convenient.

A. J. BRABAZON.

A PLEA FOR PIONEERS.

I wish to say a few words in defence of pioneer explorers and surveyors. We may excuse or pass over the ignorant remarks of those who are not supposed to know anything of the surveyor's work, or of the difficulties he has to overcome; but when criticisms come from those of our own calling, they deserve a word of notice. It is, perhaps, too common a failing to point out, and perhaps ridicule, the imperfections of the first attempts to map a new country. Does it ever occur to those who indulge in such presumptions of their own superiority, to ask themselves the question, could they do any better or indeed half so well if placed under similar circumstances?

It is no doubt true that the preliminary maps of a hitherto unknown district do sometimes contain singular and unaccountable errors, even when these have been the work of the most careful and conscientious men. When we remember that important points in regard to the construction of such maps depend on single observations, with no means of checking them, it is easy to conceive how such errors may arise, and how easy it becomes to rectify them afterwards when they have been discovered, and the means of correcting them have been pointed out. Where there is no check, errors may arise, similarly, in plotting work which is itself good. These are imperfections which should be leniently dealt with. Let us take the case of the first attempt to construct a topographical plan of a district which had before been a complete blank on the maps. The explorer, let us suppose, has met with sheets of water which may be parts of one large lake, or they may be all separate lakes; but he has received what he believes to be reliable sketches or descriptions of their positions with regard to one another. These representations may agree with his own opinion from the lie of the ground, and he so represents them on his sheet, doing the best he can with the limited time and means at his disposal. Subsequent surveys show him to be wrong, perhaps only in small matters of detail, and, forthwith, some wiseacre, who thinks all maps must be judged by the standard of those—say of the Ordinance Survey of Great Britain,—pronounces him as incapable, or a fraud. The same kind of errors may be made in the first efforts to indicate the branches of rivers in a new country; but surely the best possible, under the circumstances, is better than nothing. Even in the surveys of townships with good instruments, mistakes of the kind here indicated may occur, and they were certainly frequent enough—the surveys of our predecessors.

But in those days, good instruments were not so easily obtained, and the pay of surveyors was no better than their work. Referring to misconceptions about the connections of rivers, many of us will remember the case of the upper waters of the Maitland River in Ontario, which for a long time were believed to belong to the Saugeen, as their names to this day testify. Similar errors as to rivers have occurred in all new countries. What better could have been done until more light was obtained? It is easy to point these things out after they have been discovered, and it is seldom that those who are the most uncharitable could have done as well themselves. The work of early explorers is often a labor of love, and it is not to be supposed that those gentlemen, while they were working hard, and doing the best they could to map the country correctly, would put down errors on purpose. How much easier they have made the work for their successors. The latter are glad to take the fullest advantage of their labors, and by means of their maps, even with their imperfections, the way has been made clear for them, and they can see at a glance just what more is wanted. Even the mere indication of a route for travelling by, or getting in provisions, is often of great assistance. For these advantages the surveyors should be grateful, who are thereby enabled to get along in more comfort and lay out more accurate work.

Allowances must also be made for the compiler of other men's work. He makes the best use he can of imperfect or preliminary materials, relying most on what he considers the best; but after all, mistakes are pretty sure to creep in. The first man to compile a sheet, showing the connections of townships with all their lakes, streams, roads, &c., which were before only to be found in a disjointed form, on many sheets or many scales, does a good work, which for the first time enables us to see our way, as it were, through the country. Such a map is of constant use for reference, even in the process of compiling an improved one, and it would ill-become those who benefit by the use of such maps to sneer at them or ridicule their unavoidable short-comings. The very person who does so is probably the one who has found it most useful, and has perhaps based his own work upon it. It is always so much easier for the average man to find fault than to do the work better himself. Besides, he imagines he has an opportunity of calling attention to his own accuracy by crying down the supposed errors of others.

The best of our maps are imperfect, and the superiority of the more modern over the older ones is only a matter of degree. We trust the best maps of to-day will be superseded by better ones by-

and-by, and if we take into consideration our present facilities and the improved methods at our command, we deserve no more credit for our comparatively accurate or fine work than do the pioneers for their equally honest attempts to do the best they could in their generation. Map making is always a process of development or evolution, and even yet we may not fully realize the future possibilities of the art of representing topography on paper.

DR. ROBERT BELL.

HON. D. W. SMITH, FIRST SURVEYOR GENERAL OF UPPER CANADA.

MR. PRESIDENT AND GENTLEMEN,

During the year A.D. 1888, the Toronto Public Library received from England a number of manuscript volumes, now known in the Library as the Smith collection. They relate to the times of the Hon. D. W. Smith, the first Surveyor General of Upper Canada, who was appointed by Royal Commission, dated 10th of May, 1800, but who had been acting Surveyor General since the year 1792. My attention was first directed to the existence of these records by Mr. J. S. Dennis, D.T.S., who suggested that an interesting paper for our Annual Report of Proceedings might be got from them. I have attempted to do this, and now submit my work to your indulgence. The Smith collection then consists of private letters to Mr. Smith, council office letters, lots and locations; letters which he received as head of the Surveyor General's office, with, in some instances, his replies, besides other documents illustrating the early history of Ontario. The contents of one volume are as follows:—

(1) Surveyor General's commission.

(2) Instructions of Surveyor General Smith to his deputies.

(3) State of the Surveyor General's office, July 1st, 1802.

(4) Several papers recommendatory of him, by the Parliament, the Duke of Portland, President Ruby, the Privy Council, the Chief Justice, Land Boards, Under-Secretaries of State, and Inspector General of Accounts.

(5) Correspondence with Brant, the Indian chief, and papers relating to the Five Nations.

(6) A proclamation, February 2nd, 1793.

(7) Several papers relating to the Militia and the Lieutenancy of the Co. York.

(8) Several papers relative to the culture of hemp in Upper Canada.

(9) Rules for preserving seeds.

After much debating as to what form my paper should take, I decided that the best thing I could do was to give a short introductory connected sketch of Mr. Smith, as derived from the Smith collection, and follow this by copies of some of the most interesting papers from the original.

The Hon. David William Smith was, it appears, the son of Lieut.-Colonel John Smith, of the 5th Regiment, and the earliest reference

to him, in the Smith collection, is contained in a recommendation of him by the Detroit Land Board, in A.D. 1791. This document is addressed to Lord Dorchester, Governor General, &c., &c., and is essentially an appeal for an increase of pay to Mr. Smith, as clerk of the said Land Board. In 1792 Lieut.-Governor Simcoe arrived in Canada, and it appears that he desired immediately to inform himself as to the Surveying Profession, as witness the following letter of the Surveyor General of Quebec:—

"I have the honor to enclose a list of Deputy Surveyors, with "the date of their commissions, under your Excellency's command, "to the best of Mr. Collin's and my recollection, the book of record "having been mislaid. The gentlemen who have been employed by "the Government have been paid up to the 10th of last April, "from which time they are considered to be on the Establishment "of Upper Canada, &c., &c.

"SAMUEL HOLLAND.

"QUEBEC, 7TH June, 1792.

"HIS EXCELLENCY LIEUT.-GOVERNOR SIMCOE."

On October 27th, 1792, was issued this circular:—

"GENTLEMEN,

"His Excellency the Lieut.-Governor has thought proper that "David William Smith, acting Surveyor General, should in that "capacity have a seat at the several Land Boards." It would appear then that some time in the latter part of 1791, or the early part of 1792, Wm. Smith was appointed "acting" Surveyor General, although he did not receive his commission until the year 1800.

In a despatch to the Home Government, dated February 28th 1794, Governor Simcoe refers to Mr. Smith. He says:—"His "Majesty's service has been essentially promoted by Mr. Smith, "late secretary. * * * * I have appointed Mr. Smith, a very "able gentleman, whom I have the good fortune to meet with, to "act as Surveyor General."

Here are, also, two extracts from Chief Justice Elmsley to Mr. Smith:—"It can hardly give you more satisfaction than it has me, "to hear that though I have heard every other officer in the Land "department complained of, I have not heard the smallest complaint "of you, and I believe your Deputies give great satisfaction."

After this introduction, our acquaintance with Mr. Smith is kept up through the record of his official correspondence. This is somewhat of a fragmentary character; but from it we make out that Mr.

Smith must have been very much a man of affairs. In 1797 he was nominated by the Indians of the Five Nations as one of the Trustees of the funds, to be derived from the sale of certain of their lands on the Grand River, an office which must have engrossed a good deal of his time, and caused him much solicitude. He was also an officer of Militia, being Lieutenant of the Co. York, as the following circular will show :—

"NIAGÁRA, 8th August, 1796.

"SIR,

"His Majesty having been graciously pleased to call me to the "administration of this Government, during the absence of His Ex. "cellency Lieutenant-Governor Simcoe, who is returned to Europe, "with leave for the recovery of his health, I have the honor to "communicate my appointment to you, and to request from you "every information which you may judge to be conducive to the "welfare of this Province. The Militia of your County being "peculiarly under your direction, I am to desire that you will use "without delay the best means in your power for carrying the "existing Militia laws into execution, and of obtaining lists of "all the persons therein who are capable of bearing arms, and that "you will form them into companies and battalions according to the "act. The Militia Act having vested you with a power of appointing "officers, you will be pleased to fill up all vacancies, and give me a "return of the names of the officers in each battalion. I shall "be glad to be informed what Protestant churches have been "erected in your District, and how they are served, and be pleased "to turn your attention from time to time to the Interior Govern- "ment of your County. And when you find magistrates wanting to "the suppression of vice and immorality, and the due execution "of the laws, you will recommend to me such persons as you may "judge qualified to be added to the Commission of the Peace. It "may be also proper that you recommend it to the Justices of the "Quarter Sessions, to report to me the state of the Prisons, &c., &c.

"You will find me at all times ready to attend to every measure "which you may recommend for the benefit of the District under "your charge, as it ever will be my ambition and pride to contri- "bute all in my power towards the organization, good government, "and prosperity of this infant colony."

(Signed), "PETER RUSSELL,
"*President Administering the Government.*

"Hon. D. W. Smith,
"Lieutenant of the Co. of York."

Mr. Smith accordingly furnished a statement of the condition of the First Regiment of York Militia, giving the names, residences, &c.

Under date of April 1st, 1799, Mr. Smith receives another circular letter from President Russell, asking for "a list of the gentlemen "residing in the County over which you preside, who are in your "opinion fit to be honored with His Majesty's Commission of the "Peace. * * * * * * My reason for addressing the Lieu- "tenants of Counties on this occasion is, because it is impossible to "know the merits or demerits of the inhabitants of the Province "who live at a distance from the seat of government, in conse- "quence of which ignorance many persons are made Justices of the "Peace, who are by no means proper for that high and important "trust, and others who are not only qualified for that office, but "might do honor to any other, are left out of the Commission. To "do justice, therefore, to the Province, and obtain reputable "Magistracy, I call upon the Lieutenants of Counties to assist "me in this selection. And as men of honor, and zealous in "promoting the welfare of the county they live in, I have a right "to expect they will be guided altogether by the above principles "in the recommendations they shall make to me: * * * *

(Signed), "PETER RUSSELL,
"*President, etc.*

"The Hon. D. W. Smith."

The following letter will be understood without the help of comment:

YORK, 17th July, 1798.

"SIR,

"I am extremely sorry for the occasion which has obliged you "to solicit my permission to go to Newark, and I sincerely hope "that my compliance with your request may be the means of restor- "ing Mrs. Smith to her former health. * * * * * * * * * "I own it will be with reluctance that I consent to your absence "from home until 1st of October, because the Chief Justice's judi- "cial duties will probably keep him away until that time, and I "cannot depend on Mr. McGill's assistance as a councillor, as his "employment of Agent for Purchasers is constantly calling him from "home. * * * * * I really see no probability of my being "able to collect a Council for any purpose, and the whole business "of the Province must be at a standstill until your return. * * * * * * * * *

(Signed), "PETER RUSSELL.

Hon. D. W. Smith,"

From all which it would appear that the duties of the Surveyor General in those days were of a very varied and multitudinous character, and with a little exaggeration, Mr. Smith may be said to have been "The Father of his Country." As already stated, Mr. Smith had been discharging the duties of Surveyor General from the year 1792 until 1800, without been confirmed in his office, or, as appears from one of the following extracts, receiving any higher salary than that of a Provincial Surveyor, a state of things not at all creditable to the Home Government, as the subjoined extracts will show that the matter had been brought under their notice.

The Duke of Portland to Mr. President Russell.

"I will take an early opportunity of communicating with Major "General Simcoe on the subject of Mr. Smith's memorial. The "merits and services of that gentleman are certainly entitled to "immediate attention, and I will inform you of the result by the "next packet.

(Signed), "PORTLAND.

WHITEHALL, 11th September, 1797."

Yet it was more than two years and a half afterwards before Mr. Smith received his commission, notwithstanding that he brought the most powerful influence in the Province to bear, in his behalf, as appears from what follows:

His Honor Mr. President Russell, administering the Government of Upper Canada to His Grace the Duke of Portland.

"YORK, 12th February, 1799.

"MY LORD DUKE,

"Mr. Smith is a most useful and deserving officer, and indefa- "tigable in his attention to the Department of Surveyor General, "over which he has for some years presided with no other salary "than that of a Provincial Surveyor."

"LEGISLATIVE COUNCIL, 28th June, 1799.

"*Resolved unanimously*,

"That the thanks of this house be given to the Hon. D. W. Smith, "acting Surveyor-General of this Province, who is now about to "return to Europe, as a mark of the very high sense which this "House entertains of the ability, assiduity and unblemished inte- "grity with which he has for seven years past discharged the duties "of that important office, and that the speaker do communicate the "same to him without delay."

It does not appear, however, that they voted him any money.

(Signed), J. ELMSLEY,
Speaker.

N.B.—The thanks of the Lower House are in similar words, and the resolution was passed on the same day.

A minute of Council, dated York, 11th July, 1799, recommends that Mr. Smith's memorial for leave of absence to go to England should be granted, and makes flattering references to him.

Mr. Smith it would appear then proceeded to England in 1799, and of course one important object of his mission would be the securing of his appointment as Surveyor General. He would take with him his testimonials, of which he appears to have possessed the following, in addition to those alreary given; before giving these, however we will first give extracts from his instructions to his Deputies for their guidance during his absence:

Instructions to William Chemett, Esq., Senior Surveyor and Draughtsman, and to Mr. Thomas Ridout, Principal Clerk in the Surveyor General's Department, Upper Canada.

"SURVEYOR GENERAL'S OFFICE, 17th July, 1799.

"GENTLEMEN,

"It being necessary, on account of my private affairs, and for the "perfect restoration of my health, that I should for a time absent my- "self from the labors of my office, and return to Europe, it affords "me great satisfaction and ease of mind that I have two gentlemen "in the department, whose merit, ability and integrity are such as "to entitle them to my fullest confidence, in the delegation of a "trust of such onerous importance as that of presiding over the "surveying department of this Province. To ye gentlemen jointly "do I delegate the office of Chief Surveyors of lands, acting as "Surveyor General, to be executed for me in the same manner that "I now execute it, with full power over the other branches of the "department, so as to enable you to carry all the orders of the "Executive Government into execution with promptness, as well "as you may have it in your power to regulate the official economy "of the office with ease and certainty. In the execution of this "business, you cannot be too scrupulously exact in complying with "whatever directions may be sent to the office for your guidance, "and at the same time that your endeavors employed more "immediately for Government, you will not forget to pay attention "to the calls of individuals, the satisfying of whom I have "always considered as essentially promoting His Majesty's interests "and the credit of the office. You will avoid all verbal communi- "cations as much as possible, and when you are obliged to act on "no better authority, you will make a minute of the transaction in "one of the books to justify your recollection, and to prevent mis- "construction afterwards. * * * * * * * * * * * *

"The stationery is to be used with frugality, and the covers of all "letters laid into some niche to serve for scrawls and calculations."

Then follow instructions about certain plans that are being made, and documents in the office that need attention; then he proceeds: "I have no doubt but you will be actuated by the "same principles which have uniformly influenced me in the dis- "charge of my duty. The office is to be regularly attended to "from ten o'clock to three, and when you are not there the doors "and windows are to be kept shut, and the fire left safe.

"The urbanity I have always observed in your manners and dis- "positions renders it unnecessary for me to say anything in detail "on the propriety and the necessity of civility and attention to all "persons who have business with the office, whether personally, by "letter, or attorney, as well to those whose appearance indicates "nothing but poverty as to those whose station, situation or char- "acter demand respect.

"I shall conclude these instructions with my hope that you will "lay your shoulder to the wheel, and strenuously exert yourselves "for the honor of the King's Government, the good of the public, "my credit and safety, and your own reputations, and I cheerfully "look forward from the product of my own labors, now in the "Secretary's hands, to be able to remunerate you for the additional "trouble, and I hope interest, you will have in the discharge of my "concerns, and so I bid you farewell.

(Signed), "D. W. SMITH,

"*Chief Surveyor of Lands.*

"Assist. Surveyor General, Upper Canada.

"To Wm. Chemett, Esq., Senior Surveyor, and

"Thos. Ridout, Esq., Principal Clerk, Surveyor General's Dep't."

18th July, 1799.

PRESIDENT RUSSELL TO THE DUKE OF PORTLAND.

"I am sensible that the loss of Mr. Smith's abilities will very "soon be felt, etc., etc..... .....As he will be charged "with my present despatches to your Lordship. I beg leave to "refer your Grace to him for whatever information you may be "desirous of receiving respecting Upper Canada, and I humbly "take the liberty at the same time of recommending him to your "Grace as a most zealous, active and intelligent officer, very highly "deserving from his signal services to this Province of your Grace's "protection and favor.

("Signed), "PETER RUSSELL."

QUEBEC, 26th October, 1799.

"SIR,

"General Hunter desires me to acquaint you that he has recommended you both to the Duke of Portland and Mr. King, Under-Secretary of State, in the strongest manner.

(Signed), "W. HURREY,
"*Aide-de-Camp.*"

GENERAL SIMCOE TO MR. KING.

3rd December, 1799.

DEAR MR. KING,

I have already mentioned to you the services of Mr. Smith, and have now at his desire furnished him with a representation on that subject to his Grace, the Duke of Portland. There is not a more valuable man in the service—in fact, he ought not to wither in Canada—you cannot patronize a more valuable man, his recommendations are from all that is valuable in that country; serve him, and you may eventually serve this country * * *

(Signed), GOVERNOR SIMCOE.

Governor Simcoe, at this date, was flourishing in England instead of withering in Canada.

At length Mr. Smith's commission was issued; although a somewhat lengthy document, I think it will bear reproduction here.

THE COMMISSION.

GEORGE R.,

George the Third, by the Grace of God, of Great Britain, France and Ireland, King, Defender of the Faith, and so forth.

To all to whom these presents shall come, greeting:

Know ye that we, reposing special trust and confidence in the ability, care and integrity of our trusty and well-beloved David William Smith, Esquire, have nominated, constituted and appointed, and by these presents do nominate, constitute and appoint him, the said David William Smith, to be our Surveyor-General for the measuring, surveying and setting out of lands in our Province of Upper Canada, in America, with power to the said David William Smith to do, execute, or perform, by himself, or his sufficient Deputy or Deputies, all things whatever belonging to the said office. And we do hereby charge and require the said David William Smith, his Deputy, or Deputies, in the exercise and execution of the said office, to observe and follow all such orders, rules and instructions as we, or the Commissioners of our Treasury, or

our High Treasurer, or our Commissioners for Trade and Plantations, for the time being, shall in that behalf, from time to time see fit to order, direct and appoint.

And all our Governors, Lieutenant-Governors, Commanders in Chief, and others, our Officers and Ministers whatsoever, within our said Province of Upper Canada, are to take notice herein, and to be aiding and assisting unto the said D. W. Smith, his Deputy or Deputies, in the due execution of the said office, in all things as becometh, and for the encouragement of the said D. W. Smith, well, truly and intelligently to execute and perform the office and trust hereby reposed in him.

And in reward for his care and labor therein we do give, grant and allow unto him, the said D. W. Smith, the sum of three hundred pounds per annum, to commence from the first day of January, 1800, and to be payable for and during his continuance in the due execution of the said office, or until directions to the contrary shall be given by us or by the Commissioners of our Treasury for the time being, an entry hereof being first made in the office of the Auditor and Surveyor-General of our Reserves in America.

Given at our Court of Saint James, this 10th day of May, 1800, in the 40th year of our reign.

(Signed), W. PITT,
" S. DOUGLAS,
" CHARLES.

DAVID WILLIAM SMITH, Esq.,
Surveyor-General of Lands in the Province of Upper Canada in America.

Mr. Smith remained in Canada about two years after his return from England with his commission; and again under date of July 17th, 1802, we find him preparing for another trip to Europe, by giving instructions to his Deputies as on the former occasion. We have space for only one or two extracts.

* * * * * * * "You will be very particular in the receipt of "fees, and take care that no other or greater sum be taken from "the public than 1s. 6d. for every search, and 1s. for the entry of "papers not exceeding 100 words. * * * * * * If any person "shall come expressly to town in order to obtain a deed, you will "further his business, all that in you lies" * * * * * continuing "a courteous behaviour to the public, a steady application of your "labours and time to the duties of the Department * * * * * * "You will take care that the Field Surveyors, should any be

"employed during my absence, make a proper use of their time, "and that neither their parties nor themselves are borne upon the "pay lists longer than they are naturally employed."

Mr. Smith did not return to Canada, this it would appear was due to ill health. It would appear also that he had been endeavoring to procure a pension in England, or something of that sort; the following letter bears on the question:

WHITEHALL, 26th July, 1803.

"DEAR SIR,

"I shall always be happy to give my testimony of the utility of "your public services, and ready as far as in my power to promote "your reasonable representations to public remuneration.

(Signed), "J. KING."

Under date of Downing Street, 29th April, 1804, the Under-Secretary of State writes to the Treasury on behalf of Mr. Smith, and prays that "some provision may be allowed to him in this country upon his relinquishing his office in Canada;" this was an account of Mr. Smith's ill-health, and the Under-Secretary asks that in case he cannot resume his office in Canada, that an allowance of £200 per annum be given him. He never did come back to this country, but became estate agent to the Duke of Norfolk for about 40 years.

The Smith family owned a large area of land in Upper Canada, over 20,000 acres altogether. Of this the Surveyor General had 6,400 acres, besides 200 acres of park lots. His five children are down for 1,200 acres each. Col. Smith, his father, "drew" 5,000 acres, his wife had 2,400 acres, and their daughter Miss Anne, the balance of the 20,000.

Among the Smith collection is a volume 16" × 12½" × 1", containing plans and descriptions of these lands, and entitled the "Smith Estates in Canada." There is a preface consisting of a dedicatory letter, dated at York, 28th April, 1802, signed by W. Chemett, Senior Surveyor and Draughtsman, which informs us that the said volume was compiled by Mr. Chemett, and presented to Mr. Smith. There are no courses or distances written on any of the plans, nor is any scale mentioned. The water colors do not appear to have faded at all, except the blue, perhaps. The lake, as it is called in an "explanation of the colors," is evidently as bright as it was when laid on. It looks like our carmine. These lands are scattered through nineteen townships, and the towns of York and Niagara.

A very interesting document is the one giving the state of his office on 1st July, 1802. Of surveying instruments we note "A "theodolite with vertical arch and telescope, legs, etc., etc.; an "old theodolite, a leveling instrument with legs and case.

"A Pentographer with case.

"A Gunter's chain.

"A large copying glass.

"A drawing frame.

"An old barometer.

"One case of instruments, new."

A great many plans and atlases are enumerated, among which the following are noted:

Plan of Kingston Harbor, with the heights of ground expressed in figures.

Plans of Meridian lines erected at Johnstown and at Malden respectively.

Plan of the Town and Fortifications of New Orleans, and Batteries on the River Mississippi.

Plan of Lake Huron, Rapids of St. Marys and Matchedash, supposed to be from Colonel Munns, Royal Engineers.

Plan of the Strait and Fall of St. Mary's, by De Pencier, under directions of Lieut. Brice, R.E.

Plan of the North side of Lake Ontario from Cataraqui to Niagara.

There are mentioned also three documents in reference to the Division Line between the Provinces.

Mention is made of Field-notes and of Meteorological Observations; also of Diaries, Volumes of Letters, Warrant Books, Schedules of Locations, Descriptions, Doomsday Schedules, Oaths of Allegiance, Scrawl Plans, Blotters, etc., etc., etc., but our space will not permit any more citations.

We shall conclude with a few letters from his correspondence. Most of the letters preserved in the collection are letters which he received, there being very few of those written by him. The most interesting are those from Captain Brant, the great Indian Chief.

"GRAND RIVER, April 3rd, 1796.

"DEAR SIR,

"As I understand the council are to meet at York the 5th inst., "I take the liberty to acquaint you of the present situation of "Indian affairs here, and more particularly in the westward. Our "former acquaintance inducing me to take that freedom, and more

"especially as it lies in your line of business. I am sorry to find, "by repeated informations during the winter from Detroit, that "Mr. Aikens and some other merchants have been seducing several "Indians to make over the lands to them. Last summer they "began to set this agoing, and it was they who prevented our "meeting taking place previous to the Indians going to Wayne's "Treaty. They have now engaged in a company to get from the "Chippewans, all the Wyandotte and Mingo people from Kaihope "upwards. If the English Government do not take some means "to put a stop to these proceedings of their subjects, I am appre- "hensive it may occasion some confusion among the Indian Nations. "It is certainly very hard for poor Indians that what land Wayne "left them, these fellows with their rum will endeavor to strip "them of; and Mr. Aikens has expressed himself in such a "manner as shows he would make no scruple to endeavor to "excite a war among the different nations, to answer his selfish "purposes. You well know that Sally Ainse's land was her right "before the purchase was made by Government, and that the "Land Board cut it in pieces afterwards; since, it has been pro- "mised, in presence of the Five Nations, to be restored to her, and "is not restored; yet, notwithstanding, I really must confess that I "begin to think it too hard to see our friends the English so very "strict about Indian lands, as for instance the great trouble we "have had about this land here, and yet cannot learn whether it "will end to our satisfaction or not. It grieves me to observe that "it seems natural to whites to look on lands in the possession of "Indians with an aching heart, and never to rest till they have "planned them out of them.

"Dear Sir, I am with respect,

"Your most obedient and humble servant,

(Signed), "JOSEPH BRANT.

"Captain D. W. Smith."

"HEAD OF THE LAKE, Dec. 15, 1797.

"DEAR SIR,

"It having been deemed necessary that Trustees should be "appointed on the part of the Five Nations, I take the liberty of "naming you as one, which I do with the greatest cheerfulness, "on account of your private as well as public character, and "which I hope you will do us the honor and satisfaction of "accepting.

(Signed), "JOSEPH BRANT.

"Captain D. W. Smith."

The Surveyor-General wrote a long letter in reply; we give two extracts.

"YORK, 22nd Dec., 1797.

"DEAR SIR,

"I have duly received your letter of the 15th inst., intimating a "wish to appoint me one of the Trustees on the part of the Five "Nations; not having had the pleasure of any conversation with "you on the subject of the Trust, to be committed to persons to "be appointed for that purpose, or that you intended me for one, "I am almost as much at a loss as you confess yourself to be. I "should suppose, however, that those who delegate the trust can "only say what that delegation should be, or to what extent it is "intended * * * * * * * On the score of the Trust, all I can "say is that as far as any mental labor or personal attention of "mind, which may be consistent with my public duty to the King's "Government, you may command on the part of the Five Nations, "if in the execution of said Trust I may not be liable to be called "from the seat of Government where my ordinary duty obliges my "constant attendance, and saving to myself the power of resigna- "tion in case of not coinciding in opinion with the other Trustees "(whom I do not yet know), on points which may be agitated "concerning your interests.

"I beg to assure you, dear Sir,

"That I am very truly your humble servant,

(Signed), "D. W. SMITH.

"Captain Joseph Brant,

"Grand River."

Brant thanks Mr. Smith for his acceptance of the Trust in the following terms:

"HEAD OF THE LAKE, Dec. 28th, 1797.

"DEAR SIR,

"I am very happy in the receipt of your favor of the 22nd inst., "which was handed me last evening by the Chief, who had it in "charge, and I can but express on behalf of the Five Nations the "very great satisfaction I enjoy in your obliging acceptance of the "Trust I have wished you to take on their behalf. Permit me, Sir, "to say that the great confidence I have in your abilities, integrity "and honor, renders us peculiarly happy in this acceptance, and I "am well satisfied to have it attended with the conditions you "have been pleased to mention * * * * * *

(Signed), "JOSEPH BRANT.

"Hon. D. W. Smith."

There appears to have been much misunderstanding between the Government and the Five Nations, in regard to the lands of the latter, and in the following letter to the Surveyor-General from President Russell, Brant comes in for a certain amount of censure, and even Mr. Smith does not wholly escape a mild rebuke, the single instance in which any fault is found with him. The great personal friendship which evidently existed between himself and Brant may have betrayed him into a weakness, if he were to blame at all, for the testimony at hand does not enable us to decide, but even at the worst it is clear that "even his failings leaned to virtue's side."

"YORK, 10th March, 1798.

"SIR,

"I have read the extract you send me from Mr. Stegman's letter "of the 7th inst., and your letter to Captain Brant in consequence, "on which I will only observe that you appear to me to have been "rather too mild for the occasion. With respect to the lands "appropriated to the Six Nations on the Grand River, we must "never lose sight of the letter as well as the spirit of Sir Frederick "Haldimand's Instrument by which they hold it. That Instrument "gives them possession of the lands 6 miles on each side of that "River from its mouth to its source. The courses of those bound-"aries were long since determined with Captain Brant and the "other chiefs in council with the Land Board of Nassau. They "were afterwards agreed upon and settled between General Simcoe "and that chief, and they have been again surveyed during my "administration, at his particular request, by two surveyors chosen "by himself, for which assistance I received Captain Brant's unqua-"lified thanks. I am, therefore, not a little surprised that Captain "Brant should, without previously communicating with you or "asking my permission, employ a private surveyor, who has been "neither examined, licensed nor sworn, to trespass on the King's "lands, by entering them without authority, and setting up survey "marks to confound those of the boundaries before established. "Had Captain Brant conceived that there were any mistakes in "former surveys, he should have addressed the Executive Govern-"ment to have them rectified. Wherefore if the information you "have received should turn out true, I must desire that you will "write to Captain Brant to desist, until he shall have explained to "me what complaint or objection the Six Nations may have "against the boundaries agreed upon. If Mr. Cockerel or any "other surveyor presumes to act as a surveyor in this Province,

"without a License for so doing, I shall direct the Attorney-"General to proceed immediately against him by information.

"I have the honor, etc., etc.,

(Signed), "PETER RUSSELL.

"Hon. D. W. Smith,

"Etc., etc., etc."

The following is from the beginning of a letter from Captain Brant to Mr. Smith, on the occasion of the latter's return from England.

"GRAND RIVER, 19th September, 1800.

"DEAR SIR,

"From the friendship you have ever been pleased to show us, "we cannot omit expressing the particular satisfaction we feel at "your safe return from the other side of the water, on which we "sincerely congratulate you. Further, your arrival is particularly "satisfactory as concerning our affairs, of which as a Trustee we "will take the liberty of consulting you." * * * *

Brant and the Surveyor-General appear to have been on terms of intimate friendship, and the latter was evidently very warmly interested in the welfare of the former, and in that of the Five Nations generally.

The following is from Captain Brant to Mr. Smith, in reference to the education of Brant's sons:—

"GRAND RIVER, 20th September, 1800.

"DEAR SIR,

"I have very seriously considered the petition to His Grace the "Duke of Portland for the education of my sons, which your "friendship for me prompted you to advise me to make, and I must "acknowledge the particular satisfaction I feel at this further "instance of your inclination to serve me with your friendly "advice, as I am confident it must have been suggested to your "mind from the most friendly motives, of which I have had suffi-"cient proofs since our acquaintance. But I am sorry I cannot "altogether comply with your opinion on this point, for consider-"ing the many oppositions I have met with since the establishment "of the Government of this Province, in obtaining what I only "considered as our rights, and which indeed seems yet in some "measure undetermined, I cannot flatter myself with any prospect "of succeeding in asking such a particular favor. I therefore "decline, purely from the apprehensions of having my feelings hurt

"by a refusal. Notwithstanding, I think such a thing being granted "would be extremely for the good of my family, and give me heart-"felt satisfaction could it be obtained for me by my friends, "without me running the risk of meeting with further rebuffs."

In a letter to Brant, dated 1st November, 1800, Mr. Smith regrets the decision of the Chief in the following language:—

* * * * "I cannot sufficiently lament that you have not followed "the advice I gave you in regard to your sons, as I had no view in it "but the uniform regard I have ever had for you and your nation."

It is with great reluctance that we take leave of Hayendanagea, but the limits of our space will not permit our further quoting him. His letters show him to have been a cultured, high-bred gentleman, and a collection of them would make as interesting a volume as anything of the kind that has ever been published.

This is the appropriate place to give extracts from some descriptions signed by Brant, in the Smith collection; no doubt they were drafted by some deputy surveyor, they are specimens of indefiniteness.

"Commencing at a white oak tree, marked and standing at the "southwest angle of the Reserve, made by the Indians on the East "side of the Grand River below Dickenson Creek. * * * *

"Hence S. 0° 31 E. to a basswood tree on the shore of Lake "Erie, near the mouth of a small creek, 514 50 chs.+

"Commencing at a post about one mile distant from the mouth "of a small creek called Chisholm's Creek, measured on a north "course therefrom, which said Creek falls into the Grand River on "the Eastern side thereof, about a quarter of a mile below a certain "pinery.

"Commencing at a point of land which constitutes the fork of "the Grand River, a small distance to the northward of Dundas "street." * * * * * * * * *

As already stated, some of the volumes of the Smith collection are collections of Council Office Letters, etc.; many of these are directed to the Surveyor General's Office, on matters relating to the taking up of land by different people, some being from U. E. Loyalists.

The usual procedure for obtaining Government land in those days would appear to have been to make application to the Council, sign a certain "Declaration," and take the oath of allegiance.

The following is from an application by a U. E. Loyalist. * *

"Your Memorialist carried provisions from his father's house to "the Rangers during the war, at the risk of his life, and in conse-

"quence of his attachment to the British Constitution and Govern-
"ment, he was imprisoned for two years in close confinement, and
"left all he had to the amount of £300," then after reciting the fact that land had been promised him, he goes on to ask that he may receive it, and that he may be treated like other settlers, and be put "on a reputable footing, having nine children being now in "a situation to cultivate, having good team and Memorialist's sons "able to work and carry arms. Your Memorialist fled to this Pro-"vince as soon as he escaped from jail six years ago. Your "Memorialist had five brothers who fought and suffered for the "King."

One or two extracts more, and we have done.

"COUNCIL CHAMBER, YORK, 10th July, 1796.

"Resolved upon the motion of His Excellency the Lieut.-Gover-"nor that the Order of Council of 23rd July, 1793, as far as relates "to the granting of one thousand acres of land to Lieutenant "Mayne Duncanson, be rescinded, he having become a citizen of "the United States, and that the same be kept open for other "applicants.

"J. SMALL,
"*Clerk.*

(An extract from Minutes.)

PAY OF SURVEYORS.

"I am directed by the Hon. the Chairman (to desire) that you "will please inform this Board by what authority the Deputy Sur-"veyors were continued at ten shillings per day when not in the "field, etc.

"J. SMALL,
"*Clerk.*

"Council Office, 19th August, 1800."

CONTEMPT OF COURT ! !

"DEAR SIR,

"I am directed by His Honor in Council not to locate (from any "recommendation), Justice Lovie, for his improper conduct before "the Board.

"J. SMALL."

With this we bring this sketch of the first Surveyor General of Upper Canada to an end. It is necessarily imperfect from the fragmentary nature of the sources of information. It is perhaps of less interest to us as Surveyors than as Canadians, for surveying

was then in its infancy, and in Canada especially the compass and chain was the universal outfit. In the document already referred to as giving the state of his office, a theodolite is indeed mentioned, but probably this instrument was used only for laying down meridian lines at a few places, to enable the Surveyor to obtain the "variation." From the evidence before us we can easily learn that Mr. Smith was an honorable, upright gentleman, and a painstaking official, conscientiously devoted to duty, and universally esteemed and respected, and one whose services it must have been a misfortune for the country to have lost.

JOHN McAREE.

TORONTO, 18th February, 1889.

AZIMUTH BY MEANS OF TWO STARS.

In the proceedings of the Michigan Engineering Society for 1888, one of our valuable exchanges, there is given a method of determining a meridian, by observing two circumpolar stars, when both are in the same vertical plane, or on the same vertical, as usually expressed. The calculation of an example is given upon which an immense amount of figures is expended, 500 I should say, and there would be more, if "another approximation to give nearly the correct azimuth" was given. I find this calculation a little difficult to follow, and as I have for many years corrected my watch by means of a plumb line and two stars, and I think my method is more simple and direct, I shall try to give it. Most surveyors, I presume, get each year a copy of the Canadian Almanac, in which is given the mean time of the upper transit of Polaris for every day, this year it is in twenty-four hour time, though not in astronomic time, and why that astronomic event is not given in astronomic time is a question that I do not expect to hear satisfactorily answered in the near future. I am sorry to say this Almanac is not as reliable as t should be, there was an error of 1° in the declination of the Sun for nearly the entire of last December (1888), and that the perpetrator of it is not in durance vile argues a sad defect in the Criminal Code. If this sounds harsh to any one, I would ask him to consider what the consequences of such an error might be, possibly the loss of a season's work in the North West. But to return to the subject of this paper. A moment's consideration will show that if we find the hour angle of Polaris, when on the same vertical with another star (which is nearly a constant angle) and get from the Almanac the mean time of the transit of Polaris, we have the mean time of the coincidence of the stars on the same vertical.

As an example let us find what the hour angle and azimuth of Polaris is when on the same vertical with β Ursæ Minoris for a place in latitude 45° 36′ 0″ taking as data, the mean right ascension and mean polar distances of the stars for the present year.

To fix the ideas, we will suppose β Ursæ Minoris *Subpolo*, close to the meridian going East; Polaris about 1½ hours after upper transit going West.

Let there be a rough projection on the plane of the meridian showing the stars in such positions, upon which A, at the pole is the difference of the right ascensions of the stars, B, at the zenith, azimuth of Polaris, C the position of Polaris, C′ of β Ursæ Minoris, b the polar distance of Polaris, b′ of β Ursæ Minoris, h the hour angle of Polaris, c the polar distance of the place.

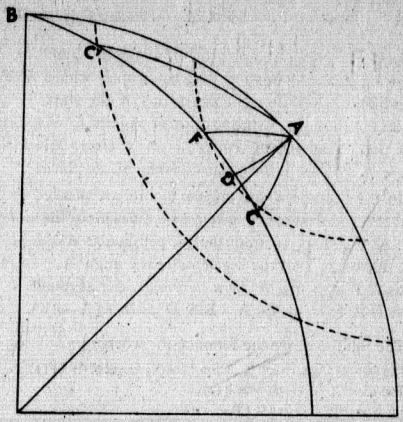
In the triangle whose angular points are marked by the two stars and the pole, there are given two sides and the contained angle, viz. A b and b′, to find the perpendicular AD (= p) from A on the third side, and the segments of the angle A. Draw an arc from A as A F bisecting A, let n be the greater segment of A, A—n the less, D A F = n—½ A B A D = (h + (A—n)).

The following are the formulæ for working :

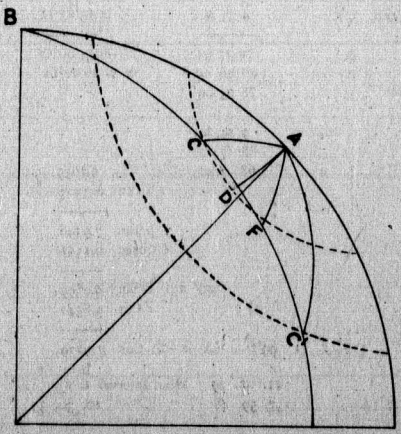
Tan (n—½ A) = Cot ½ A Sin (b′—b) Cosec (b′ + b) (1).
Tan p = Cos (A—n) Tan b (2).
Sin B = Sin p Cosec C (3).
Cos (A—n + h) = $\frac{\tan p}{\tan c}$ = Sin B Cos c (4) (p being a very small arc).

For 1889.

	h. m. s.			
Polaris R A—24h	25 18 6	P D b 1° 17′ 0″		
Kocab	14 51 2	b′ 15 23 18		
A	10 27 04	b′—b 14 06 18	Sin	938685
A in arc	156° 46′ 00″	b′+b 16 40 18	Cosec	054229
½ A	78 23 00		Cot	931297
n—½ A	9 54 20		Tan	924211
n	88 17 20			
A—n	68 28 40	Cos 9.5645		
		b Tan 8.3503		
		p Tan 7.9148		
		c Cosec 0.1551		
	40′ 23″	B Sin 8.0699		
		c Cos 9.8540		
	89°. 31′. 09″.	(A—n+h) Cos 7.9239		
		h m s		
h	21. 02. 29	Mean Interval 1. 23. 51		
2 (A—n)—h	157. 59. 48	" " 10. 30. 35		



Polaris below
β Ursæ Minoris above } the Pole



Polaris above
β Ursæ Minoris below } the Pole

S.L. Brabazon

Example—On the 1st of February, 1889, when had Polaris and β Ursæ Minoris the same azimuth, and what was it?

	Ast. Time h m s
(1) From Canadian Almanac, Transit of Polaris.....	4 28 46
h.....	1 23 57
Azimuth of stars = 360° 40′ 23″ or 359° 19′ 37″ at	5 52 43
(2) Transit of Polaris....	4 28 46
(23°56′ 04″—10 30 15) = ...	13 25 49
Azimuth of stars 40′ 23″ at.....	17 54 35

It must not be forgotten that the right ascensions and declinations of the stars vary, consequently B and h vary. For rigorous accuracy the calculation should be made with these quantities taken from the Ephemeris for the time of observation. Perhaps a little trouble might be saved by differentiating formula (1) thus—

$$\frac{d(n-\frac{1}{2}A)}{d\,\frac{1}{2}A} = -\frac{\mathrm{Cos}^2(n-\frac{1}{2}A)\mathrm{Sin}(b'-b)}{\mathrm{Sin}^2\frac{1}{2}A\,\mathrm{Sin}(b'+b)} = 0{\cdot}86 \text{ nearly.}$$

—d ½ A × ·86 gives a correction for $(n-\frac{1}{2}A)$, which if used with exact values of A and b in formulæ 2, 3 and 4 gives fair results. By this means for last year B was found 39′ 47″, h 1°24′ 31.″

The entire calculation gives B 39′ 48″ and h 1° 24′ 33″.

S. L. BRABAZON.

PHOTOTOPOGRAPHY IN ITALY.

Transmitted by Capt, E. DEVILLE, Surveyor General, to whom it was communicated by the Italian Geographical Institute, through the Royal Italian Consulate for Canada.

(Translated from the Italian by Rev. F. Filiatre, O. M. I.)

INTRODUCTION.

Although experiments for the application of Photography to Surveying were commenced in Italy towards the middle of the present century, and although in 1875 our Institute tried Photography as an auxiliary to the plane table, it is only in 1878 that the Institute commenced more precise studies. Experimental Surveys were made by means of Photography or, more accurately speaking, Phototopography: they had for object the determination of the Topography of a given district by means of special Photographic perspectives of the district taken from different points of view.

To the present Director of the Military Geographical Institute, Major General Hannibal Ferrero, is due the initiative of those studies, as well as their important result. At the Institute Phototopography has been brought into practical use. In consequence of the direction and impulsion given to these studies by General Ferrero, the process has been used with advantage, not only for the survey of special districts, but is now employed jointly with ordinary methods for plotting the sheets of the new map of Italy comprising the highest and most difficult Alpine regions.

1. FIRST ESSAY OF PHOTOTOPOGRAPHY IN ITALY—DIFFICULTIES ENCOUNTERED.

Let us see the difficulties Phototopography had to go through in Italy. As early as 1885, Professor Porro turned his attention to the application of Phototopography to Geodeosy, ("Spherical Photography," as he called it) and he was the first to propose a Phototopographic apparatus intended exclusively for Topography, but he died just as he was fully engaged in developing the practical part of Rapid Surveying by Phototopography.

2. PORRO'S APPARATUS.

This apparatus consisted of a Camera Obscura with spherical

focal plane, the center of the sphere corresponding to the optical center of the object glass. The latter was a hollow sphere filled with water, and provided with a proper diaphragm, precisely in the same manner as the object glass subsequently known as Sutton's.

We have a paper by Porro entitled "Application of Photography to Geodesy"; it is published in the Periodical "Il Politecnico" Volumes 10 and 11.

3. PHOTOTOPOGRAPHY AT THE MILITARY GEOGRAPHICAL INSTITUTE.

After the death of this prolific genius, no one appears to have taken up the new application of Photography until our Military Geographical Institute, being confronted by the difficult problem of the survey of the Alps for the new map of Italy, commenced to study the application of Photography to topographical surveys.

4. APPLICATION OF PHOTOGRAPHY TO PLANE TABLE SURVEYS.

First experiments in the Abruzzi-Gran Sasso.

The first trial was made in 1875 by Staff Lieutenant Michele Mausi, then engaged on the survey of the Gran Sasso in the Abruzzi. He used Photography as an auxiliary for drawing the survey on the plane table. The following year he was sent to the summit of Mt. Cenis where he made new experiments with a plane table and an ordinary photographic apparatus.

5. RELIEF OF THE GLACIER DU BART (MT. CENIS) SCALE $\frac{1}{10,000}$.

He brought back various panoramic views, taken by the wet process, by means of which he plotted the topography of Glacier du Bart, on the scale of $\frac{1}{10,000}$.

Numerous objections were urged against the new method: they were based on previous failures of this new application of Photography, due either to the employment of the wet process on high mountains or to the imperfect instruments of the time which did not furnish satisfactory images in the Camera Obscura.

6. BEGINNING OF SERIOUS STUDIES.

In accordance with the decision of a Commission, the phototopographic work of the Institute was suspended, not to be resumed until 1878. But General Ferrero, then Colonel and Chief of the Geodetic Branch of the Geographical Institute, could not fail to notice the wonderful improvements in photographic optics as well as in the processes for field photography, neither could he ignore the phototopographic work executed in other countries. In 1878

he again brought before the Directorate of the Institute the necessity of undertaking new studies of Phototopography. In pursuance to this proposal, Institute Engineer Paganini Pio was, during the summer of 1878, sent to the Apuane Alps with the following instructions :—

7. QUESTIONS PROPOSED AND CRITERIUM OF THE NEW STUDIES.

1. To find whether Photography was practicable on high mountains and whether on the difficult ground of the Alps such panoramic views could be obtained as would help the topographer in representing the true character of the ground.

2. To obtain extensive panoramic views which, properly reduced and reproduced by photogravure, could serve to improve the sheets of the new map of Italy containing the corresponding part of the ground.

3. To find whether such panoramic views could not themselves be employed for plotting the topography.

8. FIRST PHOTOTOPOGRAPHIC APPARATUS.

To answer these three questions, a new apparatus was constructed, consisting of an ordinary camera combined with a special instrument (Theodolite, Camera Obscura). In addition to extensive panoramic views free from distortion, the instrument furnished the data required for plotting, from the views, the corresponding survey.

9. FIRST EXPERIMENTS OF PHOTOTOPOGRAPHY—SURVEY OF THE MARBLE QUARRIES OF COLONNATA (CARRARA) IN THE APUANE ALPS. SCALE, $\frac{1}{25,000}$

During this first expedition 17 panoramic views, [110 perspectives] were obtained ; they answered the purpose set forth in the above mentioned instructions. With some of them was plotted at Florence, on the scale of $\frac{1}{25,000}$ the topography of the Marble Quarries of Colonnata, Carrara, with contour lines at the equidistance of 5 metres.

10. MARITIME ALPS—SURVEY OF THE SERRA DELL' ARGENTERA—SCALE, $\frac{1}{25,000}$

The introduction of important modifications in the apparatus previously used, and the employment for the new gelatino bromide process, enabled Engineer Paganini, the following year, 1879, to represent the Serra del l'Argentera, the highest and most difficult part of the Maritime Alps, on a scale of $\frac{1}{25,000}$ with contour lines

at the equidistance of 10 meters. The work was done by means of panoramic views taken during an expedition of two months and a half, from fifteen high stations and consisting of 113 perspectives. The plotting was executed at Florence the following winter and covered 73 square kilometers with 490 points located.

11. SURVEY IN THE GRAIE ALPS—SCALE $\frac{1}{50,000}$.

In 1880, the same Engineer commenced the survey, on the scale of $\frac{1}{50,000}$ of the part of the Graie Alps between the valleys of Orco, Valsoana, Cogue and Valsavaranche; comprising the highest group of the Alps within Italian Territory and with such high summits as the Gran Paradiso, the Grivola, the Gran San Pietro, etc. Engineer Paganini was engaged on the survey of this district, comprising about 1000 square kilometers, until 1885.

12. NEW PHOTOTOPOGRAPHIC APPARATUS AND DRAWING INSTRUMENTS FOR PLOTTING FROM PANORAMIC VIEWS.

In 1884, he used a new and improved Phototopographic apparatus constructed for the Geographical Institute at the Galileo works, on the designs of the above Engineer. He also devised three drawing instruments which simplify and render more expeditious the plotting of a topographical survey from panoramic views.

13. CONCLUSION DERIVED FEOM THE WORK EXECUTED AND RESULT-OBTAINED.

The last mentioned survey, although incomplete, fully demons strates that the phototopographic method can be employed with dvantage for the survey on the scale of $\frac{1}{25,000}$ or $\frac{1}{50,000}$ of the most important groups of the Alps. The technical problem was consequently solved if considered by itself.

14. NEW DIRECTION GIVEN TO PHOTOTOPOGRAPHIC WORK IN CONNECTION WITH THE REQUIREMENTS OF THE INSTITUTE.

The problem had also to be considered in connection with the requirements of the Geographical Institute and the compilation of the new map of Italy on the scale of $\frac{1}{100,000}$. The phototopographic surveys had to be employed jointly with the ordinary methods for the compilation of the sheets of the said map, phototopography being used as an auxiliary to the plane table in places where the employment of the latter is difficult. The financial side of the

question had also its importance; it was necessary not to do by phototopography surveys already executed or which were being executed by the ordinary methods, because this would have been been a duplication of the work.

After suspending temporarily the work executed by the Engineer in the Graie Alps by the phototopographic method, work which had ceased to have an immediate object since the same district was being surveyed at the same time by several other parties, General Ferrero gave a new and, for the Institute, more important direction to the phototopographic work.

15. RETICHE ALPS—SURVEY OF SHEETS SIX AND SEVEN OF THE NEW MAP OF ITALY.

During the summer of the present year he gave a draughtsman to the Institute Engineer in charge of the above mentioned work and instructed the small party just formed to survey sheets six and seven of the new map.

The district to be surveyed covers about 450 square kilometers and comprises the valleys of San Giacomo and Lei, north of Chiavenna, (Province of Soudrio) as far as the Swiss Boundary, with the Splugen pass and the important groups of Tambohorna and Suretta on the north, Pizzo Emet and Pizzo Stello on the east, Pizzo Quadro and Pizzo Terre on the west.

The survey on this important region was subdivided as follows: the survey of the bottom of the San Giacomo Valley below the contour of 2000 meters and the easy and flat ground containing the houses, pastures, and alpine cottages, was given to topographer Rimbotti, who completed it with the plane table during the present season.

The remaining part of the ground from the contour of 2000 meters to the crest of the mountains, is being executed by the phototopographic method by Engineer Paganini, and will be completed next year.

It is already possible to foresee that the connection of the surveys executed by the two methods will be satisfactory and will present no difficulty.

IRRIGATION.

MR PRESIDENT AND GENTLEMEN,

Instead of the paper announced, I beg to submit a few notes on the subject of Irrigation as supplementary to the introduction contained in my paper last year.

The first thing I noticed in looking over the report of my last year's paper, was a mistake in the formula for finding the capacity of a ditch, where the sign of addition had been substituted for that of multiplication. By reading the former part, however, most of the readers would understand that the plus sign was an error and that the sign of multiplication should have been used.

In my present paper, which will be a mere outline, I will first advance a few notes on the construction of ditches and canals for conveying water. Then the methods of preparing and distributing the water over the surface

The lack of general information on the subject of irrigation may be illustrated by a conversation I had with a gentleman a short time ago, who was highly educated in some branches, but entirely without information on the subject of irrigation as practised in countries where the rain-fall is insufficient. We were discussing the capabilities of British Columbia as a field for agriculture, when I mentioned the fact that in the interior part of the country crops could only be raised by means of irrigation, and that, in his opinion, precluded all crops, except those which could be raised on a garden patch, and could be watered by hand, this being the only method of watering land which had come under his notice.

In a few words, I gave him the substance of the present paper, which put the matter in a different light.

The first consideration preliminary to irrigation is to have the water stored or delivered at a point higher than any part of the land to be watered, and how to accomplish this will depend on the physical features of the country, and the circumstances governing in every case. Where the lands are in a valley contiguous to hills or mountains from whence issue streams or springs which form the water supply, the problem presents itself in the most simple form, and nothing requires to be done except construct ditches to convey the water to the principal points where required. The size of each

ditch will depend upon the area to be watered. Where the land requires full irrigation, there being no natural supply of rain to be depended upon, for each farm containing one hundred acres under crop there will be required as much water as will flow through a pipe twelve inches in diameter at a velocity of three miles an hour.

This we understand to be the quantity to be delivered at the farm, so that, at the origin of supply there will have to be added an additional quantity sufficient to make up for loss caused by evaporation and filtration, which when the water is brought a long distance in open ditches amounts to a large proportion. What the exact loss will be through these sources cannot be accurately ascertained, but the only means to do away with such loss would be to have water-tight canals closely covered and so avoid filtration, and prevent evaporation; but as this usually means a large expenditure of capital, an expenditure often out of proportion to the good to be derived, it would be well to take into account the above mentioned sources of loss, so that a proper allowance can be made for them. The loss through filtration or percolation depends to a great extent on the soils, and for this reason in contemplating the construction of a ditch the selection must be made with a view to having the most compact subsoil, clay being the best, while sand and gravel form the worst. If where the subsoil is porous, a puddle of clay could be formed along the bottom of the ditch it would do a great deal to prevent the loss of water. Sometimes the bottom of a ditch can be much improved by driving a flock of sheep along it when it is wet or dragging logs through it or puddling and smoothing in different ways. In some ditches the loss on account of filtration where the water is brought a long distance amounts to as much as 50 per cent. Loss through evaporation is reduced to a minimum by making the canal as deep as practicable for the width. The narrower and deeper the ditch the less exposure of surface and consequently the less evaporation, It is scarcely needful for me to say that previous to the construction of an irrigation ditch it is necessary to take the difference of level between the source of water supply and locality where it is required to be delivered. I have however seen in my travels in British Columbia long ditches in some localities, where capital had been wasted in attempting to run the water from lower to higher ground by reversing the operations of the law of gravitation and which of course didn't work. The more intelligent farmers take the difference of level or rather ascertain where the water will run, and also obtain a constant grade by means of an implement which any one can construct for himself out of

three pieces of wood put together so as to form a triangle which stands on two feet spreading any distance, but for convenience usually 16½ feet, this being a convenient unit of measure. This may be made into a level by attaching an ordinary level to the base of the triangle and adjusting in the ordinary way by turning the implement end for end.

A more practical method, and one which I have seen adopted, was to attach a string at the vertex of the triangle at the other end of which a plummet was fastened; then this is prepared for use by marking the intersection of the plumbline with the base of the triangle then turning the implement end for end and marking again, then the middle point between the two marks will be the place where the plumbline will intersect when the two feet are on the same level. By taking the proportion of the height to the width, a scale of grades can be marked on the cross piece. To use the implement, a wooden plug is driven into the ground level with the surface to start from, at the beginning of the canal. One of the legs of the level is placed on the plug and the other forward in the direction in which the water is to flow and from side to side until a point is found level with the starting point or having the required descent. A plug is then driven into the ground at the second point and the operation repeated. We see that with this simple implement a person without any calculation may lay out a ditch with great accuracy at any required grade. To prevent washing away the banks and carrying out the bottom of the ditch it is important not to have a heavy grade. A fall of one foot in one thousand will give a velocity of about a mile and a half an hour, which is as great as would be practicable. The fall should be regular from beginning to end else the current will be more rapid when the fall is increased and will wash away the banks in the steeper parts and will deposit the detritus when the current slackens, which will soon spoil the canal or render repairs necessary. After the construction of the ditch the next important step is to have the surface properly prepared by furrowing or making water channels. The point to be remembered is that water always runs down hill. The surface to be watered should therefore have a slight slope as regular as possible in one direction. When the surface is plowed this is done in such a manner as to have it as level as possible, and sometimes it may be necessary to use a scraper in taking off the tops of knolls and filling up the depressions. Where fields slope in several directions, the supply canals have to be constructed

so as to convey the water to all the highest points. Sometimes the supply ditches run parallel to the main canal and at other times at right angles to it. The supply ditches are connected with the main ditches with gates at intervals of from five to ten chains so that the water may be let out at any point required. In British Columbia where I saw the process of irrigation the entire surface was covered with small water channels two or three inches deep made by dragging an implement like a wooden harrow with large teeth about eighteen inches apart up and down the slope forming striations over the entire surface. It intervals of four or five chains the supply canals would cross these, and when flowing full of water the water would distribute itself over the surface by overflowing the sides of the ditches into these little grooves and following these down until the next cross ditch is reached which supplies the land below it again. When the supply of water is limited only small portions of the surface can be watered at once, and it has to be turned in different directions so as to be allowed to flow over the surface just where required. Outlets are opened with a hoe in one place and closed in another, and constant attention by some one who understands the art of irrigation is needed to convey water to parts which may not be sufficiently saturated, and close the channels where the flow is excessive. The frequency with which the soil must be watered will depend upon the nature of the soil for retaining water. Evaporation from sandy soil is much more rapid than that from clayey soil, and a fine vegetable mold will retain the moisture longer than the clay, so that while sandy soil would require to be watered at least once a week, once in two weeks would be sufficient for a fine clayey loam. When once the water is delivered at the farm to be irrigated, the labor of irrigating a hundred acres or two to one who understands the method of arranging his supply ditches is not so great as one would naturally suppose.

In the above I have outlined the general method adopted in irrigating farms. It may be of interest to mention some methods which are adopted in different parts of the world for irrigating scientifically garden patches and other small patches of great value.

One method which has been in use for a number of years is that of sprinkling by means of hose with a perforated or flattened nozzle. The water is contained in an elevated reservoir from which pipes are laid underneath the surface of the ground and hydrants constructed at distances of say two hundred feet apart to which hose can be attached and the surface watered by one man at the rate of four or five acres a day.

A modification of this plan has been adopted in England for watering meadows where the pipes are perforated and laid on the surface at distances of some thirty feet apart, the water flows out of the perforations in different directions covering the surface of the ground, and requires no attendance except to turn the water on and off and to change the direction as required.

Another system sometimes adopted is that by means of perforated tiles, which are laid underneath the surface to a depth at which the plough share will not interfere with them and at distances of not more than eight or ten feet apart. The water escapes from the tiles and rises by capillary attraction or absorption to the surface of the soil. Of course this method cannot be adopted where the water supply is in any way limited as a great deal of the water will sink into the ground and be lost.

There is one consideration in favor of underground irrigation, the land does not leak but keeps moist and loose, and on that account requires a much less quantity of water.

One point to be remembered, and which might be overlooked by the inexperienced, where there is a copious supply of water is the possibility of overdoing the thing. Too much irrigation is worse than too little, and frequent light irrigation on the surface has a tendency to harden the soil and the water does not reach the roots where most required.

From this view we might infer that a thorough watering one in ten days would be by far preferable to frequent light surface sprinklings.

Some crops require more water than others, and those who would practise the art successfully, must familiarise themselves with the characteristics of each in this respect.

This question of irrigation is one which must soon become of vital importance and interest in Canada

I was pleased to see from the programme that we are to have in our report a paper on settlement and irrigation as applied to the Northwest, by a gentleman who on account of his extensive knowledge of the country and facilities for becoming acquainted with these problems will enable him to speak with authority.

Having brought the subject forward once more, believing it to be important as a question for consideration in Canada, I submit these few notes without further comment.

THOS. FAWCETT.

SUGGESTIONS FOR SURVEYORS' REPORTS.

For many years to come, as population in Canada spreads beyond its present limits, surveys of the newer and little known parts of the country will continue to be made. Whatever will add to the public value of the reports upon such surveys will necessarily be of interest to the members of the Association, and the object of my present communication is to suggest, from the standpoint of an outsider, some particulars in which these reports can be rendered even more useful than they now are.

I quite agree with those who in the discussion on Prof. Macoun's paper at the last annual meeting contended that a surveyor had, in such surveys, a particular limit of duties defined for him, and that the search for, and collection of Natural History specimens, involved special work, requiring a love for science to make it successful. It is not everyone who has scientific tastes, and the necessary knowledge which the preparation of, more especially, Zoological specimens implies.

Many surveyors will also, probably, consider that they already have sufficient work in the field of a mechanical nature. Every member of the profession must, however, desire to have his reports not only valuable to the Department of the Interior, or of Crown Lands, but useful to the general public, when they appear in the official documents of the Government. If this usefulness can be increased without materially adding to the labor involved, then an important advance has been made.

When surveying a new township, there are the best of opportunities for observing, without effort, its natural features. In the course of his ordinary duties the surveyor not merely meets with level country, but has to ascend the hills which lie in his way, cross the valleys which intervene between the heights of land, and track the courses of streams. He is thus led, by observation, and without going out of his way, to acquire a fair knowledge of the character of the soil, the kind of trees met with, the nature of the prevailing rock where exposed, the breadth of prairie available for cultivation, the extent of the marsh-land, the appearance of the grasses, and, generally, the suitability of the township for settlement.

The report made to the Government generally covers some, perhaps in not a few cases all, of these points, and are, thus far, very valuable to intending settlers.

Might I, however, suggest that they should be somewhat more detailed in order that the information may be useful also to the lumberer, the miner and those interested in science.

I have had occasion when studying the distribution of forest trees, to frequently consult the Crown Land reports, and have found it sometimes difficult to make them available because of the lack of definiteness in naming the trees. The beech and basswood are samples of trees not easily mistaken, as, in this country, there is only one species in each case. It is different, however, with the pine, spruce, ash, oak, maple, and other trees, where two or more species occur. To the lumberman and to those interested in forestry, it is essential to know what definite species is intended in each case. The white pine, *Pinus strobus*, is more valuable than the red pine, *P. resinosa*, and the Banksian or Scrub pine, *P. Banksiana*, is inferior to both. Oaks, both the White Oak, *Quercus alba*, and the red, *Q. rubra*, are commonly met with in the older provinces, and the former is the more important. The White Ash, *Fraxinus Americana*, is more useful in the arts than the Green Ash, *F. viridis*, or the Black Ash, *F. sambucifolia*, whilst among the Maples, *Acer, saccharinum*, is more valuable to the settler than the red Maple, *A. rubrum*. I would not propose that surveyors should become botanists, but that they should always indicate with sufficient accuracy both the occurrence and the abundance or not, of the important forest trees they meet with in each township.

In particularizing them it would be well to avoid the use of local names with which the general public would not be familiar and to, if possible, add the scientific after the commonly accepted name, Thus, when referring to a specimen of Pine, let it named, as the case my be, "White Pine, *Pinus strobus*" or "Banksian or Scrub pine, *P. banksiana*," a little practice would soon make these specific names sufficiently familiar to prevent any misconception as to the particular tree intended. That the character of the soil can to some extent be guaged by the trees upon it, is an additional reason for indicating the species with accuracy.

On the Western Prairies if the survey is made during a dry season of the year, it is possible to ascertain whether the land is marshy or overflowed during wet seasons by the occurrence of certain common species of grasses which frequent moist localities and which some observation soon enables anyone detect. It is in this way sometimes possible to avoid the mistakes which occasionally appeared in the original surveys in Manitoba in describing as dry, open country what, during wet seasons since, has been overflowed by water.

The surveyor unfortunately meets with, too frequently, immense stretches of country laid waste by fire and all its valuable timber totally destroyed. It is estimated that in Canada very much more timber has thus been burned than has, during the whole progress of lumbering in the past, been cut for the market and for home consumption. I have also always been of opinion that our Northwest prairies would now be largely covered with timber, and that the climate in consequence would be milder in winter, were it not for the vast prairie fires which annually sweep through whole townships at a time destroying, not merely all the grass, but all bluffs of young trees which appear in their path.

The origin of these fires is usually credited to hunters, Indians, pioneer settlers and parties of travellers who carelessly leave behind them camp fires still burning to which the dry grass and leaves surrounding furnish fuel on the slightest breeze. It is difficult, however, to fasten the blame on any particular shoulders, so distant, usually are the localities from the settled districts. The facts still remain that disastrous fires every season take place and vast damage is done, amounting annually to millions of dollars. Now, I think that surveyors and engineers can be of service in this matter not only in impressing upon the members of their parties the necessity of great care in putting out camp fires, but inducing others whom they meet in the bush and on the prairies to do the same. There is some patriotism involved in even an apparently insignificant matter like this.

Another suggestion and I have done. It would be idle to expect a knowledge of geology from everyone, but if the reports of surveyors upon the new or little know parts of the country would refer in general terms to the character and extent of the rocks where they crop out from beneath the soil, if would be useful both from an agricultural and from a scientific point of view. If the information went no further than alluding to the rock or sandstone, or lime, or granite, the mode in which it occurred and the extent to which it effected the agricultural capabilities of the township or section of country surveyed, the information would be valuable; how much more so, if it referred to the economic importance, if any, of the rock as furnishing building stone, phosphates, iron, copper, or other economic minerals.

The surveyor necessarily visits most parts of the township which he is mapping into sections or concessions and lots. The geologist often has to restrict himself to the larger rivers.

The general information which the surveyor gleams in following his avocations in the newer parts of the country, can thus be of considerable use to the geologist, and eventually to the miner; just as a rough preliminary survey along the route of a proposed railway gives hints to the railway engineer.

A. T. DRUMMOND.

SETTLEMENT AND IRRIGATION

OF THAT PORTION OF THE NORTHWEST TERRITORIES WEST OF THE EASTE N LIMIT OF THE MISSOURI COTEAU, AND SOUTH OF TP. THIRTY.

"Whoever makes two blades of grass grow where but one grew before is a benefactor to his race."

We hear of irrigation at a very early period of the world's history and in different quarters of the globe. The Egyptians adopted it extensively in the cultivation of grain, and Babylon and Nineveh had irrigation works on a scale, which even to-day, in this age of gigantic undertakings, would seem marvelous. Among the first inhabitants of the American Continent who were at all advanced in the arts and sciences, irrigation was employed to render fruitful land, that, unless supplied with moisture, must have remained barren for ever. Even the ignorant and uncivilized Indians of the South-western States and Territories of our neighbors to the South produce by this means what grains, fruits, &c., they are able to grow. It is said that were it not for irrigation, the garden and field products in the Territory of Montana would not equal two-thirds of the quantity raised now by the artificial distribution of water, and it may be said of Idaho, Utah, Colorado, New Mexico, Arizona, Indian Territory, Western Texas, and the southerly half of California, that in the absence of irrigation, not more that 10 per cent. of the present yield could possibly be obtained; and according to the reports of United States Engineers, a very large percentage of the territory west of the 100° longitude is useless without irrigation.

The settlers who have made their homes in the portion of our North-West, to which I now particularly refer, have, as a general thing, come from the eastern provinces of Canada and from Great Britain, countries in which the rain-fall and water supply are so abundant and so widely distributed that irrigation is unknown. Had our settlers come in any material number from irrigated districts, bringing with them for application here their knowledge and experience of the practices in vogue in Montana, Arizona, or any districts requiring an artificial water supply, it is probable that the number of our settlers would be greater than at present, and their advancement in production and wealth would be enormously increased.

The lands which they now occupy formed, at a very recent date, a part of what was erroneously described upon the maps of this continent as "the great American Desert," a term that certainly does not apply to any part of our territory west of the Missouri Coteau. While, however, this is the case, it is equally certain that the district in question is not favored with a sufficient rainfall, and that although the soil is of fair quality, it cannot be made productive, unless means are adopted superior to any now in use; it is, to my mind, of the utmost importance that some comprehensive system of settlement and irrigation should be originated, adopted, and made effective without delay. I am convinced that unless this is done, the progress of settlement will be slow, and the country necessarily so sparsely settled, that our people will not, for a very long time to come, enjoy the privileges of schools, churches and social intercourse, which are so essential to the well-being of all communities, and which might be made available to them if the right plan were designed. The present system of settlement is admirably suited to localities, where water can be obtained upon every quarter section, at an outlay commensurate with the means of the average settler. The danger however of pursuing this course, in the part of the Northwest which we are now considering, is that the earlier settlers will unquestionably occupy the lands bordering the streams, lakes, and rivers, representing, perhaps, not more than 15 % of the whole area that might be settled if water could be generally distributed.

Whatever is done in this matter should be done quickly. If irrigation is to be adopted, a reservation should be made immediately of right in the Crown, to enter upon lands entered for as homesteads or pre-emptions, or sold, for the purpose of constructing irrigating works across, over, or upon such lands. The settlement now taking place will probably, unless checked, control in a short time nearly all of the water that should be utilized to its fullest capacity, in rendering useful for tillage the 85 per cent of the whole area which is not suitable for occupation at present, in consequence of the very inadequate water supply.

These remarks apply with equal force to a large extent of country in the central parts of British Columbia. Several members of our Association, who have been engaged in surveys there, have in their reports directed attention to the condition of affairs referred to.

If my premises are correct, I repeat that no time should be lost in endeavoring to devise and carry out a scheme, that will enable this district to be utilized to the fullest possible extent; and it may be shown very clearly, I think, that if the means adopted were to

prove successful, the result to the Dominion at large would more then compensate for any possible outlay of the public funds in the works which might prove necessary.

It is apparent to anyone familiar with this district that apart from its mineral wealth, its resources are and must continue to be chiefly pastoral rather than agricultural, the raising of horned cattle and horses, sheep, hogs, poultry, and the manufacture of dairy products will probably be for all time the staple industries.

After very careful examination into the present condition of things, it has been estimated that 20 acres of land are required to support every cow or horse, or every five sheep. Now, as a settler cannot make a fair livelihood unless he has from 100 to 185 head of cattle, he requires from 2000 to 25,000 acres for his exclusive use, or, say, four sections. The plan adopted by the Department of the Interior, of leasing free from competition four sections to any *bona fide* settler, was probably based on the foregoing calculation.

The capacity of any country for stock may be gauged by the quality and extent of the pasturage available in winter. At all other seasons, the district which we are now discussing yields at least four times the quantity of grass that could be consumed by the number of cattle, which it would be safe or advisable to run during the winter months.

The area of this district is 66,960 square miles, and would, according to the above computation, allowing 4 sections for every settler, accommodate 16,740 families; and estimating that each is worth to the country $1000, owing to the custom and excise duties which he pays, the whole value would be $16,740,000. The value of the annual products of each settler may be estimated at $500, giving a total value of $8,370,000, and supposing that each settler has 100 head of cattle, 1,674,000 will graze in the district.

This condition of affairs, which unless special means are adopted we cannot, under the most favorable circumstances, hope to arrive at for some time to come, implies an exceedingly sparse population.

Suppose, however, that the productive power of the district could be quadrupled (and I hope to assure you that this may be regarded as a moderate estimate of the result to be achieved, by adopting a proper system), the number of resident families would be 66,960, the annual products $33,480,000, the value of these settlers to the country $66,960,000, and the number of cattle 6,696,000, the value of which, at $20 per head, would be $133,920,000. The value of the annual products would probably exceed largely $500 per head, as under the system which I have in view, their products would be

more valuable than at present. We would most certainly arrive at the highest state of perfection in all products, cattle and horses, hogs, poultry, dairy products, hides and leather, nature having richly endowed this district with the natural conditions requisite to this end.

It is generally conceded, that in order to minimize the risk of loss in cattle raising, it is necessary to provide for six weeks' winter feeding, spread over three months, and that by this means the country could be stocked to the limit of the summer capacity. Many stockmen assert that this provision is unduly large; that the only cattle requiring attention during any part of the winter are the fall calves and colts, and cows and mares expected to bring forth calves or colts in the early spring, together with the injured or weak stock. It is therefore safe to assume that six weeks' fodder for the whole herd would be adequate provision.

Should we not endeavor to bring about such a condition of affairs, that for ten and a half months of the year the country may support a number of cattle equal to its full summer capacity, as well as providing the fodder required for the six weeks of winter? Under present conditions we can accomplish not more than a quarter of that result—in other words, during one-eighth of the year only do we make use of its full capacity. Even should it require a very strenuous effort to remedy the existing state of affairs, does not the probable result amply justify it?

It occurs to me that the remedy can be found in adopting the hamlet system of settlement, coupled with irrigation. To this end, it is necessary, in the first place, that there should be a thorough inspection of the country, and then we should require an intelligent survey to ascertain levels. In this connection, I am of the opinion that a thorough trigonometrical survey, combined with a full showing of details of levels, designated by contour lines, would be of incalculable benefit; we should, at the same time, record full meteorological observations, gauge the flow of all streams and springs during every month of the year, and we should also make thorough tests for artesian wells.

Once this data obtained, an adequate scheme of irrigation could be readily elaborated. The hamlets would necessarily have to be located at those points from which water may be most easily distributed, the area irriguous at the several points, to determine the number of families to be settled at each; they would probably vary in number from 10 to 50, and in some cases might exceed the latter figure. The irrigated lands would be devoted to the growth of cereals, grasses, &c., and fodder required during the severe winter weather.

Each hamlet having a plentiful supply of water would develop into a dairying centre, where, at the minimum of cost, by the establishment of factories, and creameries, cheese and butter of the highest quality would be produced. The hamlets would also possess the social conditions necessary to the community, and all that are attainable in any well-settled agricultural region. Surrounding these settlements, the land required for pasturage by each would be set apart, defined, and reserved for that special purpose.

The more the writer has studied this subject, the greater the importance has seemed of the results aimed at, and the more easy their accomplishment. One season would be sufficient to obtain the data necessary to initiate the scheme, and it could thereafter be rapidly carried out as the progress of settlement might demand.

Upon the boundaries of the land allotted to each hamlet, firebreaks could be maintained, thus protecting the grass, and remedying the incalculable permanent injury to the productive power of the soil caused now by repeated burnings. This is a point to which public attention has not been directed as forcibly as it should be. Upon gravel ridges, and ridges of light soil, autumn fires destroy a large proportion of the grass roots, and the ground being left bare, every particle of snow that falls upon it is blown away; no moisture is retained, and by the time the spring and summer rains commence, usually after the 20th May, more of the grass is killed by hot suns and parching winds. Each year vegetation is becoming less, and if the process be but continued long enough, the lands referred to, which form a large proportion of the whole area of the district, will become practically valueless. In this particular alone, incalculable benefit would result from the adoption of the proposed system. If fires were prevented, and the sod torn by heavy harrows, the rain would moisten the grass roots, and the result would be a marvelous increase in vegetation. It has been observed that where rain upon cultivated land penetrated to a depth of ten inches, it does not penetrate one inch into these matted grass roots, but simply runs off the ridges into ponds and other natural basins. This agrees with the experience of every one who is accustomed to a prairie country dotted with sloughs, ponds, &c. The ridges being once cultivated, the area of these sloughs and ponds decreases, until finally they in many cases disappear altogether.

Nature seems to have fitted a large portion of the country for economical irrigation. There are strong inducements for the investment of private capital in extensive irrigation works, the profit resulting from the enhanced value of the lands. As a rule, irrigated lands are

four times as valuable as lands in the same neighborhood entirely dependent upon the natural rain-fall. In the former case the tiller of the soil has complete control; he may put on water at the right time and in proper quantity, which means simply that other conditions climatic, for instance, being propitious, a good yield is, with him, a certainty, whilst the tiller of land that is not irrigated is subject to the worst effects of the most serious evil from which the district suffers—drought.

In the Southern States, many "ditch companies" are now operating very profitably, supplying water to the settlers for irrigation purposes at specified rates. Innumerable advantageous openings for similar enterprises must in a short time present themselves here. In this connection it might be well that Parliament should be asked to enact the necessary legislation controlling the waters of rivers and streams for the public use and benefit, and restraining individuals from monopolizing more than they can themselves profitably use. It is obvious that the sooner this is attended to the better and easier it will be, and will prevent friction and annoyance that will certainly increase the more the longer we delay. There is nothing extremely radical in this proposal; the same principle has been the law of the land in respect to mining properties for many years. It long ago became apparent that to confer exclusive rights of ownership upon individuals, who thereby prevented others from gaining access to and using the water that was of no actual benefit to themselves, and was nevertheless an absolute necessity to the miner who did not occupy some part of the water front, was working serious injury to the mining interests. Public opinion ultimately compelled a change in the law that is found to work most satisactorily.

The necessity of legislation in regard to the freedom of access to waters, running through or being upon agricultural lands, is fully as urgent as it was in respect of mining lands; the profits from the former must ultimately far exceed the profit to be derived from mining lands; in the one case we keep adding to the value of our lands, and in the other their value is constantly diminishing through exhaustion of the minerals, the surface property being generally of small utility for any purpose.

It is worthy of the most serious consideration whether any large scheme of settlement and irrigation should not be conducted by the Government rather than through private enterprise. The enhanced value of the lands would amply recoup the Government for the outlay. What an enormous benefit would result to the country if set-

tlement and products could be increased, even to one half the extent which I suggest as probable, and certainly Government control is preferable looking to the general advantage. Private investors would be most anxious to secure large profits and quick returns, and would probably be somewhat dilatory in taking action, whilst endeavoring to demonstrate to investors and possible shareholders, the advantages which the speculation offered. The Government on the other hand, once convinced of the soundness of the scheme, the advantage to result indirectly from the improved settlement and producing power of the district, might feel justified in proceeding immediately, and in awaiting a slow return of the actual money invested. I dare say a calculation might readily be made, to show that a handsome percentage on the capital invested would very speedily result from increased customs and excise returns.

In the district mentioned there are two great sources of water supply, which lie high enough to permit of the whole volume of water being utilized for irrigation at a minimum cost of works. I refer to the Rocky Mountains and to the great Cypress Hills Plateau.

For hay lands the water can with advantage be laid on during autumn, winter and early spring, when cereals do not require its application. When it is necessary to apply it to the cultivated fields, the grass has so grown and so shaded the ground, then thoroughly saturated, that no more moisture is needed for the full fruition of the hay crop. The season when cereals require most water is when mountain streams are at the flood.

Many districts in the Southwestern States, after being comparitively well settled, have been almost deserted, owing to drought. Everyone who had the means to enable him to remove to another and more favored locality did so; those who were, through poverty, unable to seek a better place, managed in time to overcome the difficulties of their position by irrigation, and were no doubt eventually better satisfied with their lands and prospects than if they had gone elsewhere. Works accomplished under such conditions, done piecemeal, with lack of money, often with a not very intelligent understanding of the requirements of the situation, must necessarily prove more arduous, more tedious, and, indeed, in the end more expensive and less effective, than works undertaken with a full knowledge of present and future requirements, where each section as completed fits in harmoniously with every other section, and in due course forms a perfect system. If, therefore, works done by individual effort and under the difficulties which I have mentioned prove profitable and of public benefit, how much more profitable and beneficial are they

likely to be if conducted under intelligent and competent direction and on a comprehensive basis. Under such a system of irrigation, the destructive effects resulting from freshets in mountain streams, which now do very considerable damage, would be materially lessened and if the fullest precautions were taken would be avoided *in toto*. The saving effected in bridges, in the protection of "bottom" lands, detentions, and general inconveniences to the public would go a long way to meet the outlay on works. I may say further that benefit would, in no small degree, be conferred upon settlers in the country lying to the east of the irrigated track, whose lands would be affected by the distribution of the waters. It has gravely been suggested to the Government of the United States, by gentlemen of high professional standing, than whom no one on this continent is more competent to express an opinion in matters of this sort, that it would be a wise and economical project on the part of that Government, if five hundred of millions of dollars were devoted to damming the streams flowing east from the Rocky Mountains, thus preventing freshets maintaining the streams at as nearly as possible a uniform level, and also adding to the extent of navigable water, and producing some effect in the prevention of summer drought. Does it not seem that a scheme somewhat upon the lines of the above suggestion might very probably and profitably be attempted in our own country?

My object in presenting this paper has been simply to direct attention to the general subject, leaving to the future, and I trust the early future, its further and complete elaboration. If it appears to this Association to be one-tenth part the importance which I attach to it in the general interests of our common country, I may then look or hearty sympathy and for most valuable co-operation in the effort to utilize the valuable resources now dormant, with which Nature has endowed this western portion of Canada.

To the President, Vice-President and Members of the Association of Dominion Lands Surveyors, Ottawa, this paper is respectfully submitted by

WM. PEARCE.

CALGARY, ALBERTA, January 10th, 1889.

DOMINION GOVERNMENT SURVEYS IN MANITOBA, THE NORTHWEST TERRITORIES AND BRITISH COLUMBIA.

On the 22nd of June, 1869, His Excellency the Governor-General gave his assent to one of the most important Bills ever passed by the Parliament of Canada. This Bill was one providing for a Territorial Government for the Northwest Territory, arrangements for the purchase of which from the Hudson's Bay Company had been concluded.

The acquisition of this vast territory, known at that time as Rupert's Land, threw upon the Government the duty of promoting the early settlement of the country by the encouragement of immigration. To this end it was necessary that a comprehensive scheme or system of surveys, based upon the most accurate systems extant, should be initiated and developed.

To the Department of Public Works was delegated the important duty of initiating the system, and conducting the surveying operations.

On the 10th of July, 1869, instructions were issued by the Minister of Public Works to Lt.-Col. J. S. Dennis, P. L. S., directing him to proceed to the Red River settlement, for the purpose of selecting the most suitable localities for the survey of townships required for immediate settlement. He was also instructed to submit a scheme or system, to be followed in surveying the newly acquired territory, and to assist him in preparing this system, he was accredited to the Crown Lands Departments, in Canada and the United States, with the view of his obtaining all information and advice which were likely to be of use to him in preparing his system.

On his arrival in the Red River country, Col. Dennis proceeded to examine the districts requiring immediate survey, and giving due weight to the views of those with whom he had consulted on the subject, he formulated a scheme or system to be followed in surveying the country into townships and sections.

The system proposed was as follows:

(1) "The system to be rectangular, all townships and sections to "be east and west, or north and south.

(2) "The townships to number northerly from the 49th Parallel, "and the ranges of townships to number east and west from a given "meridian. This meridian to be drawn from the 49th Parallel, at a "point say 10 miles west of Pembina, and to be called the Winnipeg "Meridian.

(3) "The townships to consist of 64 squares of 800 acres each, "and to contain in addition 40 acres or 5% in area in each section "as an allowance for public highways.

(4) "The townships on the Red and Assiniboine Rivers, where "the same had ranges of farm lots laid out by the Hudson's Bay "Company, to be surveyed, the broken sections butting against the "rear limits of such ranges, so as to leave the same intact as indepen-"dent grants."

This proposed system was referred to the Minister of Public Works for confirmation, and on his recommendation was adopted and authorized by an Order-in-Council, dated the 22nd of September, 1869, and thus the survey into townships of newly acquired territory was begun.

The system adopted was founded on that in force in the adjoining Territories of the United States, but it differed from the American system, mainly in regard to the size of the townships, and in the percentage allowance for roads, there being no allowance for this purpose in the American system.

The surveys were begun late in the summer of 1869, two surveyors (Messrs. Webb and Hart) being engaged in carrying on the work, under Col. Dennis. The work performed consisted of the survey of the Winnipeg or Principal Meridian, and also of portions of the Bases according to the system adopted. There was also considerable work done in connection with the re-establishment of the lines bounding lots, surveyed by the Hudson's Bay Company along the Red and Assiniboine Rivers.

During the fall the work in the field was retarded, and finally stopped by the out-break which occurred in the Red River settlement.

In May, 1870, a portion of the territory was created a province under the name of Manitoba; but owing to the unsettled state of the country, nothing in the way of surveying was done during this year, because the question of surveys in the country received considerable attention, and in the early part of 1871 the management aud control of the surveys and lands was transferred to the Department of the Secretary of State, and in March, 1871, Col. Dennis was appointed Surveyor-General of Dominion Lands. A very important change was now effected in the system of surveys; the townships were reduced in size from 64 sections of 800 acres each, with road allowances as already mentioned, to townships of 36 sections, containing 640 acres each, and a fixed road allowance of 1.50 chains in width was provided on all sides of the sections.

This change in the system was provided for by an Order-in-Council, dated the 25th of April, 1871.

On the 1st of May, 1871, the Surveyor-General issued a Manual of Instructions, for the guidance of Deputy Surveyors,—as they were then styled,—engaged in the survey of Dominion Lands.

This Manual of Instructions, which was issued under the authority of the Secretary of State, and based upon the Order-in-Council above mentioned, set forth in detail the method to be followed in laying out and subdividing the townships in the field, as well as all other information to enable a surveyor to carry on his work satisfactorily.

This Manual may be said to form the basis or starting point for our survey system. I will therefore refer briefly to its main features.

(1) The public lands in Manitoba and the Northwest Territories were to be laid out in townships containing thirty-six sections of one mile square, together with road allowances between all townships and sections of one chain and fifty links in width.

(2) The townships were to measure on each side from centre to centre of road allowance bounding the same, 489 chains, this measurement on east and west boundaries being subject to excess or deficiency resulting from convergence of meridians.

(3) The townships to number northerly from the 49th parallel of latitude or International Boundary, and were to be numbered in ranges east and west from the Winnipeg or Principal Meridian, which had been established as mentioned in the first scheme submitted.

(4) The 49th Parallel or International Boundary to be the 1st Base Line, and the line between every fourth tier of townships to be a base line. The intermediate line, midway between the bases, being called a correction line, upon which the convergence of meridians is provided for by a jog between the meridians semi-north and south from the bases.

The first process in surveying any desired tract of country was to project blocks of four townships by running the base, meridian exteriors, and correction line bounding the same.

In surveying these lines the surveyors made all sections 80 chains in width, and provided a road allowance of 1.50 chains between all sections; on the meridian exteriors all sections were made 80 chains in length, excepting those adjoining the correction line, in which the excess or deficiency in the length between the bases was provided for. On these lines also a road allowance of 150 chains was left between all sections.

In establishing the correction line to complete the survey of his block, the surveyor ran the north or south side of the road allowance, the north side if the block being surveyed lay to the north

of the correction line, and the south side if the block lay to the south. In defining the correction line, the necessary jog was allowed at the intermediate township corner to provide for convergence of meridians, and the sections were so marked as to throw the excess resulting from the same cause into the tiers of quarter-sections adjoining the western boundary of the township.

The block of four townships was now ready for the subdivision surveyor, who proceeded to effect the subdivision: First quartering the block into townships by connecting the township corners, already established on the block outlines, by straight lines, he then subdivided the townships into sections and quarter-sections, by running each interior meridian parallel to the eastern boundary of the township, and making all sections 80 chains in length and width except those adjoining the western boundary, or adjoining the correction line, which were effected by the convergence, or excess or deficiency in length between bases, as has already been explained.

In all cases except the correction line, the lines surveyed were the south and west limits of the road allowance, and these lines only were marked.

The largest portion of the country to be surveyed being open prairie, and the conditions being so different to those to be met with in marking surveys in the old Provinces, an entirely new system of perpetuating the surveys had to be devised.

The difficulty was met by providing for placing posts only in wooded districts, and by marking the corners with posts and mounds in the open country. These mounds were constructed of earth pyramidal in shape, the bases being 5 feet and the mound 2½ feet high, the mound was surrounded by a trench, and there were also pits placed opposite and a short distance from the bases.

The posts placed at section corners were marked in a very simple and legible manner, and a further provision was made for perpetuating the township corners, by placing iron bars 1¼ inches square and 5 feet long, marked with a cold chisel, and finally driven into the ground at these points.

The mounds placed at township corners were also somewhat larger and better than those placed at section or quarter-section corners.

It is of course impossible to give within the limits of a paper of this kind, a full explanation of the system of survey, nor is this necessary, in view of the fact that the large majority of our members are thoroughly conversant with the system. I will therefore proceed to refer briefly to the amendments to this manual, which have since come into force, and to some other changes which have been made in the details of the management of the surveys.

One of the first important changes made was in the title of the surveyors engaged in surveying the Dominion Lands. These surveyors had first been styled Deputy Surveyors, but in the year 1872 when the Board of Examiners was constituted, the title was changed to Dominion Land Surveyors; and later on a further provision was made for the granting of higher certificates to surveyors styled Dominion Topographical Surveyors.

The first Manual of Survey and second System remained in force until the year 1880, at which date a change was made in the manner of running the block lines, the correction lines being run as base lines, and in subdividing townships the interior north and south lines were run as true meridians, and not as lines parallel to the east boundary, in manner provided by the Manual of Surveys.

The size of the blocks first laid out was increased from four to sixteen townships. However the district affected and the work done under these amendments was comparatively speaking very limited, and it was not until the 17th March, 1881, that any marked change was made in the system.

At this date a new edition of the Manual of Surveys was issued by Mr. Lindsay Russell, the then Surveyor-General, and some important changes in the system were made, in fact what is properly the Third System came into force. The main features of change were as follows: the method of laying out blocks of 16 instead of 4 townships, as the first operation of surveying, any given tract of country which had been in force during the previous year was given effect, the provision of the first manual regarding road allowances was altered, so as to provide roads of one chain instead of one and a half chains, and the road allowances on the first, third and fifth interior east and west section lines to be abolished.

Provision was made for the equal distribution among all the sections of the error resulting from convergence of the meridians, and a slight change was made in the mounds placed to mark the corners of townships, sections, and quarter-sections.

This second manual, or third system, remained in force until the 1st of June, 1883, when a third and further amended edition was issued, this being the manual and system now in force, the system being the fourth authorized.

This last-mentioned manual differs only in some minor details from that issued in 1881. The important points of difference being in regard to the marking of corners with iron posts and tins in prairie districts, instead of with a wooden post.

Provision was also made for the survey into river lots of the lands

adjoining the Saskatchewan and Bow and Belly Rivers, this provision has however since been done away with.

The foregoing is a brief mention of the manner in which the surveys in Manitoba and the Northwest Territories were initiated, and of the systems which have been in force since the inception of the surveys, together with a short synopsis of the provisions of the manuals of survey, which have from time to time been issued for the guidance of those engaged in carrying on surveys for the Government. I have also noted the changes which have taken place in the system, and the manner in which it has been perfected, until we now have a system which, for simplicity, accuracy, and general public utility, will compare favorably with any in the world.

It may be of interest now to note the amount of work which has been completed, under the different systems from the inception of the surveys in 1869 to date.

System.	Number of Townships subdivided.	Miles of Outlines Surveyed.	Remarks.
1st		100. 00	(Approximate.)
2nd	870	619. 00	
3rd	141	150. 00	
4th	2,101	11228. 00	
	3,102	12097. 00	

These figures give an average of 173 townships subdivided, and about 670 miles of outlines run each year, and when it is considered that these figures do not include the large amount of work performed in surveying the river belt parishes in Manitoba, the survey of river lots in 179 townships along the Saskatchewan, Bow and Belly Rivers, and the extensive exploratory surveys referred to further on in this paper, the showing is certainly a most creditable one, and one which has not been excelled, if equalled, by any other country.

I will now refer shortly to the surveys which have been performed other than those which come properly within the scope of the systems, as provided by the Manuals of Survey; these are:

1st. The Special Survey.

2nd. The determination of the latitudes of certain points by astronomical observation.

3rd. Exploratory surveys.

4th. The traverse of the C. P. Ry. line through British Columbia.

5th. The subdivision surveys in British Columbia.

6th. The determinations of the longitude of certain points by the interchange of telegraphic signals.

7th. Topograpical Surveys in the Rocky Mountains.

8th. The surveys of Trails in Manitoba and the Northwest Territories.

THE SPECIAL SURVEY.

The Special Survey was begun in 1874. Its object was to establish, by means of a trigonometrical survey, certain additional initial meridians, which it was foreseen would become necessary, owing to the fact that in carrying the surveys west from the Winnipeg or Principal Meridian, the errors would accumulate, and the jogs on correction lines resulting from convergence of the meridians would become very large, and also that the numbering of the ranges would be greater than was desirable.

It was decided that these initial meridians were to be established at equal distances apart, of four degres of longitude, and that the 1st of the mor the 2nd Initial Meridian was to be in longitude 102° W.

The establishment of the 2nd Initial Meridian was effected by the Special Survey in the above-mentioned manner. The triangulation was commenced at the Winnipeg or Principal Meridian, which had been previously accurately tied in to the post at Pembina, on the International Boundary; the longitude of this post had been determined by an interchange of telegraphic signals, the work being performed by the officers of the joint commission, engaged in establishing the International Boundary.

From the point of commencement the chain of triangulation was carried across the country by way of Portage Creek, Westbourne, Palestine, Beautiful Plains, Minnedosa, Shoal Lake, Fort Ellice, and Scissors Creek.

The first base was measured at "Grosse Isle," a point near the Principal Meridian about twenty miles north of Winnipeg. Other bases of verification were measured at the "Salt Plains," near Westbourne at "Long Lake," near the Little Saskatchewan, and at Scissors Creek.

Want of space prevents my entering into any lengthy description of the instruments used, the manner of conducting the work in the field, or the results of the same.

It seems a pity that there has never been any complete report published of the operations of this Survey, which may be said to be the first trigonometrical survey of a geodetic nature, effected in Canada.

The 2nd Initial Meridian was established in 1875, and there the trigonometrical survey ended, the establishment of the other Initial Meridians, by means of a triangulation, was given up, as it was expected that the completion of the telegraph line between Selkirk and Edmonton would enable the positions of the other Initial Meridians to be laid down by the method of the interchange of signals over this line.

Owing however to the faulty construction of the telegraph line this method failed, and the 3rd, 4th and 5th Initial Meridians were finally established by surveyors in charge of sections of the Special Survey, who ran base lines through from one Initial Meridian to the next, the distances being measured by check chains.

THE DETERMINATION OF THE LATITUDE OF CERTAIN POINTS BY ASTRONOMICAL OBSERVATION.

In connection with the establishment of the Initial Meridians by the Special Survey, it was decided to determine the latitudes of certain points in the Northwest Territories.

This work was effected by Mr. W. F. King, D. T. S., astronomical assistant on the Survey.

The points at which the observations were made with the resulting latitudes, etc., are here given.

NAME OF PLACE.	LATITUDE.	LONGITUDE.
At iron bar on cross line Parish St. James Intersection 102nd Mer., & Qu'Appelle Trail	49° 53′ 06″40	97° 10′ 41″.51W
	50 22 21.85	102 00 00 "
Battleford, on line S. of Battle River	52 42 38.69	108 16 59.02 "
106th Meridian and Gabriel's trail	52 34 32.69	106 00 00 "
Fort Edmonton, on line W. of Fort	53 31 59.16	113 30 28.6 " 113 32 58 "
Fort Pitt, on River bank S. W. of Fort	53 34 05.28	109 47 10 "
North of Quill Lake near line between Ranges 16 & 17 W. 2nd I.M.	52 04 55.88	104 18 14.02 "
On 12th Correction Line, 19 Ranges and 4 sections W. 2nd I. M.	53 04 02.38	104 52 28.33 "
On 10th Base, 58½ sections W. of 3rd I.M.	52 11 07.455	107 24 06.24 "
On 11th Base, 27 Ranges and 2½ sections, W. of 3rd I. M.	52 32 15.465	109 58 39.45 "
On 14 Base, 64 sections W. 4th I. M.	53 35 58.30	111 34 58.53 "
Touchwood Hill trail, on 102nd Mer., 8 sections N. 5th Correction Line	50 42 29.74	101 59 56.77 "
At Swan River Barracks	51 54 21.515	101 57 16.75 "
On Meridian between Ranges 8 & 9 W. 2nd I. M., ½ mile S. 8 Correction Line	51 38 40.70	103 07 57.58 "
Near Ft. Qu'Appelle in Valley	50 46 15.51	103 48 02.69 "
McLeod Creek N. of Fort McLeod	49 45 20.64	113 24 00.04 "
On 114th Meridian N. of Bow River near Calgary	51 01 55.71	114 00 00 "
On E. boundary, Range 17 W. 2nd I. M., 11.64 chs N. ¼ sec. post., N. 7 Correction Line	51 18 31.27	104 15 55.17 "
Qu'Appelle Valley on low hills N. of River	50 52 59 58	105 59 21.55 "
On plain two miles N. of Red Deer River near forks with Saskatchewan	50 57 57.62	110 02 43 "

The object in determining the latitudes of the points mentioned above was that the latitudes as determined by the survey might be checked and corrected if necessary, so as to agree with the observed latitudes; this was done, but the results proved far from satisfactory, and judging from the general closings of the Bases in latitude between the Initial Meridians, it would seem that the results would have been better had these corrections not been applied.

This was of course not in any way owing to errors in the latitude observations, but was due no doubt to the great difficulty in making chain measurements agree with observed positions.

EXPLORATORY AND MICROMETER SURVEYS.

Among the surveys, other than those which come properly within the system as provided by the Manual, and which were found at an early date to be necessary, may be mentioned those known as Exploratory and Micrometer Surveys.

The primary objects of Exploratory Surveys are to determine the position, size, and course of important streams and water areas, and to provide data relative to the topographical features of new and unexplored districts. Among the surveys of this kind which have been made, the following may be mentioned:

The explorations in Lakes Manitoba, Winnipegoosis, and Winnipeg, and adjacent waters, by Mr. H. B. Smith, in 1872.

The explorations in Lake Winnipeg and vicinity, by Mr. G. C. Rainboth, D.L.S., in 1872.

The exploratory traverse of the North Saskatchewan River from Edmonton to Prince Albert, by Mr. W. F. King, D. T. S., in 1878.

The explorations which have been carried on in the Saskatchewan, district in 1879 and 1880, by Mr. W. F. King, D. T. S.

The exploratory traverse of the Carrot River, by Mr. A. L. Russel, D. L. S., in 1879.

The exploratory traverse of the North Saskatchewan River between Rocky Mountain House and Edmonton, by Mr. J. C. Nelson, 1880.

The traverse of the trail from Fort McLeod to Fort Qu'Appelle, by Mr. M. Aldons, D. T. S., in 1880.

The explorations by Mr. W. F. King, D. T. S., in the Cypress Hills District, in 1881.

MICROMETER SURVEYS.

The Peace River was surveyed from Fort Chipewyan to Dunvegan, by Mr. Wm. Ogilvie, in 1884.

The Athabasca River was surveyed from Athabasca Landing to Fort Chipewyan, by Mr. Wm. Ogilvie, in 1884.

The Saskatchewan River was surveyed from the Forks to Grand Rapids, by Mr. O. J. Klotz, D.T.S., in 1884.

The Nelson River was surveyed from Lake Winnipeg to Hudson's Bay, by Mr. O. J. Klotz, in 1884.

The Winnipeg, English and Albany Rivers, and connecting waters, were surveyed by Mr. Thos. Fawcett, D.T.S., in 1885.

The shore line of Lake Winnipeg was surveyed by Mr. F. W. Wilkins, D.T.S., in 1886.

Part of the shore line of Lake Winnipegoosis was surveyed by Mr. I. J. Dufresne, D.T.S., in 1887.

The Yukon River from Taiya Pass to longitude 141 W. was surveyed by Mr. Wm. Ogilvie, D.L.S., in 1887.

Part of the Mackenzie River was surveyed by Mr. Wm. Ogilvie, D.L.S., during the past year.

These Micrometer Surveys in many cases, notably those performed by Mr. Ogilvie and Mr. Fawcett, may be said to be original explorations, and in effecting them many obstacles and difficulties had to be overcome.

In his explorations in the Yukon and Mackenzie River Districts during the past two years, Mr. Ogilvie has carried on the most extended and important exploration which has been conducted under the Department of the Interior; and although we can only speak from conjecture as to the many difficulties met with, and hardships to be borne, still we most of us know enough of what explorations in new and unknown districts entail, to realize what Mr. Ogilvie has gone through, and I think the Association should be among the first to congratulate him on his safe return, and the successful accomplishment of the expedition.

THE SURVEY OF THE LANDS WITHIN THE RAILWAY BELT, AND THE TRAVERSE OF THE CANDIAN PACIFIC RAILWAY LINE IN BRITISH COLUMBIA.

When the belt of land extending for twenty miles on each side of the Railway line through British Columbia was acquired by the Dominion Government, a scheme for the survey of lands within the belt had to be devised.

The tract requiring survey being much broken by mountainous ranges, many difficulties were foreseen in attempting to survey the agricultural portion of the belt.

The system which was finally adopted, and the manner of carry-

ing it into effect in the field, has been very exhaustively and interestingly dealt with by Mr. W. F. King, Chief Inspector of Surveys, in his annual report for the year 1886. I will therefore confine myself to a brief reference to the main features of the system and its difference from the system under the Manual of Surveys.

The important change, and the only one in fact requiring special notice, was that the fixed road allowances were done away with, a percentage acreage being provided in each section for this purpose.

As it would be impossible to follow the method laid down in the Manual for the projection of base lines and township outlines, some other primary foundation for the surveys had to be adopted.

The road-bed of the Canadian Pacific Railway through the mountains afforded an easy route for an exact traverse survey, to be used as a base for the subdivision surveys required at different points.

This traverse was effected during the years 1884, 1885 and 1886, by Messrs. Fawcett, Klotz and Ogilvie. The manner in which the work was done has been exhaustively dealt with in the reports of these gentlemen, and the method by which any required point of the subdivision surveys is established from the railway traverse is very clearly shown in the report of Mr. W. F. King above referred to.

THE DETERMINATION OF LONGITUDES BY MEANS OF THE ELECTRIC TELEGRAPH.

In 1885, it was determined to begin the work of establishing the longitude of certain points in British Columbia and the Territories, by an interchange of telegraphic signals.

During that year the longitudes of Victoria, Port Moody and Kamloops were established in that way, and the latitudes of these points were determined by astronomical observation.

The work during this season was performed by Mr. O. J. Klotz, D.T.S., and Mr. Thos. Drummond, D.T.S.

The initial point from which the longitudes were determined was Seattle in Washington Territory, U.S.A.

In 1886, 1887 and 1888, this work was continued, the longitudes of the following points being fixed: Revelstoke, Field, Calgary, Winnipeg, Wapella, Port Arthur, Kalmar, Edmonton, Fort Pitt.

In 1886, Mr. Wm. Ogilvie was associated with Mr. Klotz in this work, and during the past two years the work has been carried on by Mr. W. F. King and Mr. Klotz.

The methods used and the results attained in this work have been thoroughly treated of in the reports of the gentleman engaged on the same, and also in the very interesting papers on this subject

read at our last annual meeting by Mr. King and Mr. Klotz; it is therefore quite unnecessary for me to say anything in connection therewith, other than to refer to the work as the most scientific work which has been carried on by the Department.

TOPOGRAPHICAL SURVEY OF THE ROCKY MOUNTAINS.

One of the most interesting surveys, which has been carried on under the Department, is that which comes under the above heading, and has been going quietly on during the past three years.

I understand that a paper, descriptive of the manner in which this survey is being effected, is to be read at this meeting by one of the gentlemen engaged on the work, and I will therefore not attempt to write anything regarding it; in fact in doing so, I would be discussing something about which I know very little other than that a large portion of the mountains have been accurately mapped at a very small cost.

However I feel sure that when the facts regarding this survey are before us, we will be glad to bear testimony to the great credit due the Surveyor-General, for the very able manner in which he has originated this system in Canada and brought it to a successful issue.

THE SURVEY OF TRAILS IN MANITOBA AND THE NORTHWEST TERRITORIES.

Altough our survey system makes a most liberal allowance for public roads, it has been found that in many cases the needs of the settlers would be better served by adapting certain of the old travelled trails or roads, instead of waiting until the road allowances were made practicable.

Many of these old trails follow a very meandering course, and they had to be accurately surveyed so that the necessary right of way could be provided across the lands affected.

The trails are laid out with a right of way, 1 chain in width, and they are carefully tied in to the general surveys.

In making the survey, the surveyors have of course deviated in many cases from the old trail, and have effected many advantageous straightenings of the same.

Up to date the Department have surveyed about—miles of trails in Manitoba and the Territories, and it may be safely said that in no country in the world has there been a more liberal provision made for public highways than in Manitoba and the Territories.

CONCLUSION.

I had intended to refer shortly to the errors which have occurred in the general surveys, and the corrections of the same, but this paper has already exceeded the limits originally intended.

To treat fully of the surveys which have been performed, and to do justice to the subject, would make a good sized volume.

I hope that at some time in the near future we will find the subject receiving the attention which it merits, by the publication of a detailed report of the surveys performed up to date.

The remarks herein contained are offered to the Association, not because they are in any way new to many of the members, but with the hope that a short connected narrative of the surveys since the beginning may be of interest.

J. S. DENNIS.

OTTAWA, February, 1889.

DISTANCE MEASURING MICROMETERS.

The instruments of which I intend here to treat are those telescopes which are provided with proper appliances for measuring distances by comparison of the magnitudes of an object and its image in the telescope.

FIXED THREAD MICROMETERS.

The simplest instrument of this class is the telescope with two threads fixed in the diaphragm. The distance of a point is found by counting the number, included between the two threads, of divisions of a graduated rod, such as a levelling rod, held at the point whose distance from the instrument is required.

Let m be the linear distance between the threads.

Let b be that length of the rod whose image is included between the threads.

Let x be the distance of the rod from the object-glass.

Let u be the distance of the image from the object-glass.

Then since the lines joining the coresponding points of an object and its image must pass through the centre of the object-glass, we have, by similar triangles,

$$b = m\,\frac{x}{u}$$

And by the optical theory of the convex lens, if f be the principal focal length of the object-glass.

$$\frac{1}{x} + \frac{1}{u} = \frac{1}{f}$$

Eliminating u between these two equations we have

$$\frac{x-f}{f} = \frac{b}{m}$$

Now $x-f$ is the distance of the rod from the *outer* focus of the object-glass.

That is, the feading of the rod is proportional to the distance of the rod from the *outer* focus of the object-glass.

MOVABLE THREAD MICROMETERS.

The next micrometer is that which is applied chiefly to instruments intended for astronomical purposes, but may be used for finding terrestrial distances; that is, a movable thread is placed in the focus

of the object-glass, and is moved by a screw having a graduated drum head, and affords the means of measuring the linear dimensions of the image of a rod of known length.

Here, as before, we have

$$x-f=\frac{bf}{m}$$

Here m is the variable reading instead of b, so in this case also the distance must be measured from the outer principal focus of the object-glass, and the reading is inversely proportional to this distance.

ROCHON MICROMETERS.

We now come to two-image micrometers, of which the first to be considered is the Rochon Micrometer.

In this micrometer a doubly refracting prism is placed behind the object-glass, so that part of the rays are intercepted in their passage to the eye-piece, and turned through a constant angle and thus are formed two complete images of the rod. By sliding the prism from or toward the object-glass, these images are made to approach or recede from each other, and the observation is made by reading from a scale along the telescope tube the position of the prism in the tube.

Using x, b, f, m, and u, to represent the same quantities as before, and calling the distance from the object-glass to the image, l, and the constant angle, Θ, we have the distance between two images, or $m=(u-l)\tan\Theta$.

$$\text{so that } \frac{u}{x}=\frac{(u-l)\tan\Theta}{b}$$

$$\text{and } \frac{1}{x}+\frac{1}{u}=\frac{1}{f}$$

Whence, by eliminating u,

$$\frac{x-f}{f}=\frac{b-f\tan\Theta}{(f-l)\tan\Theta}$$

Or the distance of the object from the *outer* focus varies inversely as the distance of the prism from the *inner* principal focus $(f-l)$.

LUGEOL MICROMETERS.

Next we come to the Lugeol Micrometer, where the division of the images is effected by a separation of the two semicircular halves of the object-glass, by means of a micrometer screw.

Let m be the distance apart of the two half lenses, x the distance of the object, u the distance of the image from the object-glasses, b the length of the rod. Then since when the two images are brought

into end contact the straight lines joining the extremities of the rod with the centres of the lenses must meet in the point of contact of the images, we have

$$\frac{x+u}{u}=\frac{b}{m}$$

and $\frac{1}{x}+\frac{1}{u}=\frac{1}{f}$ or $\frac{x+u}{u}=\frac{x}{f}$

whence $x=\frac{bf}{m}$

or the distance from the object-glass is inversely proportional to the reading.

GENERAL REMARKS.

There are other forms of micrometers such as the divided eye-piece micrometer, &c., but the above are those commonly met with.

Any theodolite or level instrument may be used as the first kind of micrometer, and good results can be got at short distances.

The movable thread micrometer is not so convenient for use, and a serious fault in all thread micrometers is the uncertainty due to the coarseness of the thread.

Of the double image micrometers, the Lugeol is to be preferred to the Rochon, because with the latter, the images are usually of unequal brightness, and it is therefore difficult to make a proper contact.

I shall now consider the effect of small errors in the instruments and in the readings on the calculated distances.

For all the micrometers

$$x=\frac{bf}{m}$$

where x is the distance of the object, measured from the object-glass in the Lugeol Micrometers, and from the outer principal focus in the other three.

b is the length of the rod, which must in the case of the Rochon be diminished by the constant quantity $f \tan \Theta$, f is the principal or sidereal focal length, m is the separation of the two half object-glasses in the Lugeol, and the size of the image in the two thread micrometers and in the Rochon $(f-l) \tan \Theta$ or the linear separation of the images of an infinitely distant object, such as a star, with the prism in the actual position which it occupies during the distance measurement.

Assuming the focal length to remain constant, and calling the

small increments of x, b, and m, δx, δb, and δm, we have by differentiating

$$\delta x = \frac{f}{m}\delta b - \frac{bf}{m^2}\delta m$$

which may be written

$$\delta x = \frac{f}{m}\delta b - \frac{x}{m}\delta m$$

which in the first mentioned micrometer, where b and x are the variables and f and m constants, means that the error in distance is proportional to the error in reading the graduated rod; and the error in distance due to error in the bisection of the marks on the rod by the threads varies as the distance.

The above differential formula may also be written

$$\delta x = \frac{x}{b}\delta b = \frac{x^2}{bf}\delta m$$

so that in the other micrometers, where x and m are the variables, the error in distance due to a given error in measured length of the base varies directly as the distance, and that due to error in the reading (m) varies as the square of the distance. In the Rochon m or δm is the reading or error in reading mutiplied by $\tan\theta$, provided the graduation, as above supposed, is along the tube of the telescope.

These formulæ may be used to find the actual error caused by errors in the data, in the following manner:

A Lugeol micrometer, the parts of which I have measured, has a a focal length of about 13 inches. The shaft of the micrometer head has two screw threads, whose pitches were right and left hand respectively, the pitch of one being about $\frac{1}{21}$ of an inch, and of the other $\frac{1}{28}$ of an inch, so that one turn of the head moves the two half object-glasses apart $\frac{1}{21}+\frac{1}{28}$ of an inch, about $\frac{1}{12}$ of an inch. The drum-head is divided into one hundred parts, so that one division corresponds to $\frac{1}{1200}$ of an inch.

Now suppose the distance to be 40 chains, the length of the base 15 links, and an error of one division to be made in the reading, so that $\delta m = \frac{1}{1200}$ of an inch.

Then the formula $\frac{x^2}{bf}\delta m$ gives for the error δx, of x, in chains

$$\frac{40^2}{\frac{15}{100}\times\frac{13}{792}} \times \frac{1}{1700\times 792} = 0.48 \text{ or } 48 \text{ links}$$

For the Rochon Micrometer we have

$$\frac{x-f}{f} = \frac{b-f\ \tan\theta}{(f-l)\tan\theta}$$

Now f can be measured directly if an observation be taken on a base of known length at a known distance, so that b and x are known, then l can be measured, and thus tan θ can be got, the constant angle for this instrument.

Thus if x be 19.05 chains, $b = 15$ links, f 16 inches, and $f - l$ be found to be 11.7 inches, we get $\theta = 36°$ as the constant angle.

The differential formula may then be used

$$\delta x = -\frac{x^2}{bf}\,\delta m = -\frac{x^2}{bf}\tan\theta\,\delta r$$

when δr is the error of the scale reading on the telescope tube.

Suppose the error of reading to be $\frac{1}{10}$ of an inch.

Then with the above constants, for $x = 40$ chains we have

$$\delta x = 35 \text{ links approximately.}$$

The length l from the object-glass to the point of separation of the rays in the prism, is difficult to measure directly; but if we have two readings taken on the same rod at distances x and x^1, the corresponding readings being l and l^1, $l - l^1$ may be readily measured, and we have

$$l = f - \frac{f}{x - f}(b\cot\theta - f)$$

$$l^1 = f - \frac{f}{x^1 - f}(b\cot\theta - f)$$

whence we have

$$l - l^1 = f(b\cot\theta - f)\left\{\frac{1}{x^1 - f} - \frac{1}{x - f}\right\}$$

so that $l - l^1$ being known as well as x and x^1, we have an equation to determine θ.

In this manner we get the error in distance due to a given error in reading.

So if we assume a probable error of reading of one division of the micrometer head in the Lugeol, or a certain fraction of an inch in the Rochon, we get the probable error of a distance determination.

From this can be found the probable error of the distances of a traverse or the total probable error. This total probable error being equal to the square root of the sum of the squares of the probable error of each line.

It should be noticed, however, that there is a great likelihood of errors of reading being due to constant causes, such as imperfect optical definition, or lost motion of screws, so that the errors may be cumulative, and may not tend to counteract one another as is assumed in the theory of least squares.

The theory of the Lugeol micrometer, as above, gives the distance of the object as inversely proportional to the reading. This is not quite true in practice. See Mr. Klotz and Mr. Ogilvie's papers on the subject, read before this Association two years ago. It would be worth while to make experiments, to determine whether these differences are due to refraction, or to some other cause.

I have no data to shew whether the theory I have given for the Rochon Micrometer holds good in practice.

ANALLATIC LENS.

In the Stadia micrometer, the first of the above forms, a second lens is frequently placed behind the object-glass, the effect of which is to bring the point from which the distances are to be measured from the outer principal forms to the centre of the telescope tube, or to any other point which may be required.

As above we have for the distance of the object from the object-glass

$$x = f\left(1 + \frac{b}{m}\right)$$

Now suppose a second lens introduced into the tube of the telescope, at a distance a behind the object-glass, and having a focal length f_1, let v be the distance of the former image behind this lens, v_1 the distance of the new image, m and m_1 their sizes.

Then we have

$$\frac{1}{v_1} - \frac{1}{v} = \frac{1}{f_1}$$

$$\text{also } \frac{v_1}{v} = \frac{m_1}{m}$$

$$\frac{m}{m_1} - 1 = \frac{v}{f_1}$$

$$\text{and } \frac{1}{x} + \frac{1}{v+a} = \frac{1}{f} \text{ whence } v = \frac{fx}{x-f} - a$$

$$\text{also } x = f\left(1 + \frac{b}{m}\right) \text{ whence } m = \frac{bf}{x-f}$$

So we get

$$\frac{bf}{m_1(x-f)} - 1 = \frac{fx}{f_1(x-f)} - \frac{a}{f_1}$$

$$\text{whence } x + \frac{f(a-f_1)}{f+f_1-a} = \frac{bff_1}{m_1(f+f_1-a)}$$

Here $x + \frac{f(a-f_1)}{f+f_1-a}$ is the distance of the object from a point at a

constant distance behind the object-glass. This distance by varying a can be made anything we like, as for instance the point of suspension of the telescope, and then the distance from that point will be directly proportional to b, that part of the rod the image of which is included between threads at a constant distance m.

The second lens is called the anallatic lens. It is usually so placed as to bring the measuring point at or near the point of suspension of the telescope. It is usually adjustable, so that it can be moved along the tube. It may then be used to adjust the ratio of b to m, so that some exact number of division of the rod may be made to correspond to an exact number of chains distance, so as to simplify the readings of distance with the instrument, and this is the usua purpose of the adjustment.

W. F. KING.

REGARDING GEOGRAPHICAL NOMENCLATURE.

An active connection for many years with the enterprises in the Northwest, as well as in the investigation of the geographical description of plants in all the provinces, has long since led me to see the necessity of some statutory regulations, under which not only the duplication of names, so frequent especially in the Northwest, would be remedied and rendered impossible in the future, but the use of grossly absurd and inapplicable names would be prevented, and the whole subject of Geographical Nomenclature of Canada brought under systematized control. It was not, however, until 1887, that I ventured to bring the matter before the late Honorable Thomas White, then the Minister of the Interior, who with Mr. Burgess, the Deputy Minister, entered heartily into the consideration of the subject, and I am glad to find it has been taken up with equal heartiness by this Association, and I have reason to believe by the present Minister of the Interior.

That the subject needs immediate attention is clear to us. Topographical, Railway and Geological surveys are being yearly conducted on a large scale in the Northwest, and in the less known parts of the older Provinces. New geographical features are being constantly mapped out, and older and more imperfectly known features accurately traced. Population is gradually following on, and new post offices are being continually demanded, especially in the newer districts, whilst railways are being pushed into the less settled sections, and new stations—the forerunners of future villages and towns—are being established every few miles along their track. At present there is nothing to prevent duplication or the use of objectionable names; but it is the privilege of every explorer and map maker, however ignorant he may be of the country at large, or however coarse in his nature—to originate new names. Hence we have duplications in large numbers, and some names of so low a character that we may well feel ashamed of them, and every map that is issued is aiding in giving permanency to such names.

Cases are also constantly occurring where the local name familiar in the surrounding district is either changed or added to, by those who map out the same and who will not take the trouble to ascertain or will not recognize the names of prior right. And all these names are to be the property of our descendants as well as ourselves,

and will be perpetuated in the thousands of deeds and documents which will be executed, and in the numerous maps and books that will be published, in coming years, when change will become more difficult and impossible.

While there can be no question that duplicate names, in at least Manitoba, the Northwest and British Columbia, should be at once altered, it is more difficult to deal with mis-appropriate and ill-sounding names. It is not generally advisable to change a name which has become familiar, because it is unsuitable or is not euphonious; Wherever, however, it shocks the moral senses, or is simply barbarous, alteration ought to be made.

There should be no excuse afforded for such names appearing in publications circulated in a civilized community; and yet we find Stinking River, Drunken River, Cow Dung Lake (which gave its name to a pass, now fortunately better known by its alternative name of Yellow Head Pass), Death's Door Point, Kicking Horse Pass, and many other objectionable though perhaps less offensive names, appearing on maps issued by the State.

In the present paper, I merely propose supplementing, by a few brief suggestions, the proposals made last year in the published report of the Committee of the Association, as follows:—The whole matter might be entrusted to a Commission, comprising a representative of each of the Departments of the Interior, and the Post Office, and to these full powers should be given, and the subject grappled with in its entirety. It is not sufficient that the Department of the Interior should be dealt with, the co-operation of the Post Office should be obtained, in order to secure system in the naming of the many hundreds of new Post Offices which in coming years will be demanded.

The Department of Crown Lands in Ontario, Quebec and British Columbia should also be induced to interest themselves, since the more northern parts of each of these Provinces are to a large extent unexplored, and it is most desirable that in the progress of surveys there, the system of naming new physical features should be uniform with that of the Dominion. Supervision must go even further. There must be sufficient control exercised in matters of Nomenclature, over both the publishers of local maps, and the management of railways.

The rule should be enforced by a statute, that newly observed geographical features, recently surveyed townships in the Northwest, proposed post offices, and new railway stations on railways subject to the Dominion control, should receive only those names which have been approved by the Commission.

The name proposed by the discoverer of a new geographical

feature should be given a preference if it is suitable, but care should be taken before approval is given, that no suitable name of prior recorded right, or known to be familiar in the neighborhood, is thereby suppressed.

Where a name is suggested by some characteristic feature, as in the case of a mountain range, lake, or river, the feature should characterize the whole or the greater part of it, and not be a mere localism.

It cannot be too often repeated that the Indian names, where they are euphonious and not too long, should be retained; with the different Indian languages and dialects there is a wide field for names, and no danger of repetition, although the words rendered in English may mean the same in many instances.

Present objectionable names are probably mere translations of original Indian names, which the better second thought and better sense of the explorer would have well left alone.

Duplication even of post offices in different Provinces should be strictly avoided.

Where duplication has already taken place in geographical features in Manitoba and the Northwest territories, it should be remedied at once, before the increase in the population, and the fixing of the names amongst the people of the locality render change difficult and impossible. In the other provinces the attention of the local Government should be drawn to it, with a view to remedy measures there as far as feasible.

The friendly co-operation of all the provinces of the Dominion and of all railways subject to Provincial control should be sought in carrying out the general object of the Commission.

Names which are barbarous or morally objectionable should be changed without delay.

Before authenticating any name by giving it a place in the proposed Official Geographical Dictionary, great care should be taken to correctly ascertain its spelling, syllabication and accentuation, this being particularly necessary in words of Indian and French derivation, amongst which very many errors in this respect are believed to exist.

It would also add considerable further interest if the special reason, which occasioned the giving of each name, should be put on record, whenever it can be ascertained.

When alterations are determinated on, the expunged name should appear alongside the new name, within brackets, in the first official maps published thereafter, so as to accustom the public to the alteration.

A. T. DRUMMOND.

MONTREAL.

SURVEYS OF THE PROVINCE OF QUEBEC.

The earliest records we have of surveys in the Province of Quebec are those of the fiefs and seigneuries conceded by the King of France to subjects who had, in some way, distinguished themselves in active service on this continent.

The title in virtue of which these seigneuries were conceded being translated was as follows:—

"To all whom these present letters may be seen, be it known on the petition to us presented by Denis DeLaronde, Chevalier, of the Mititary Order of St. Louis, Captain of Marine, in the service of the King. It pleases us to accord the territory of two leagues in front along the River Chambly, by three leagues in depth, and a little island above the Island aux Tests. The said two leagues in front to be taken from the boundary of the seigneurie newly conceded to M. De Levy, ascending towards Lake Champlain, in which territory is the river called Lacolle; thewhole to be held as a fief and seigneurie, with the right of high and moderate justice, right of fishing and hunting, and effecting treaties with the Indians, as well without as within the said territory; wherefore we, having regard to all in virtue of the power to us jointly given by His Majesty, have given, accorded and conceded, give, accord and concede to the said De Laronde, the said extent of two leagues of territory in front by three leagues in depth, thus and in the manner as it is above described, which said extent of territory shall be bounded on the north side by the seigneurie newly conceded to De Levy, and on the same line, and on the south by a line drawn east and west of the world, in front by the River Chambly, and in the rear a distance of three leagues joining the unconceded territory, including the little island which is above Tests Island, to enjoy by himself his heirs and assigns a perpetuity and forever, as a fief and seigneurie high and moderate justice, the right of fishing and hunting, and treaty with the Indians, within the whole extent of the said concession, subject to the charge of fealty and homage at the castle of St. Louis, etc." *Seigneur*, taken in connection with *Seigneurie*, signifies a proprietor of a *fief*, or extent of territory, to whom certain rights and duties are due from those who hold under him, and a *fief* is a heritage held from the King or other *Seigneur*, subject to fealty and homage, and the performance of other rights. *Fiefs* are held by different titles which determine the duties

of the holder in each case, and differ greatly from lands held in free and common soccage, which are exempt from all seigniorial rights. These different marks of what is known as the direct *Seigneurie* have now disappeared, and the only privileges of the *Seigneur* are to be found recorded in an act respecting the general abolition of feudal rights and privileges. *Seigneuries* in the Province of Quebec were held *en roture*, by which is meant, land held subject to an annual rent or *cens* and *lods et ventes*.

The surveyors in those days were commissioned and styled "*Arpenteurs du Roi*," who acted under order of the Intendant, but were virtually in the employ of the *Seigneurs*. The first *fief* and *seigneurie* conceded dates back to February, 1626, and the last to the year 1755, the number whereof according to the best authority is 586. Those situated on the River St. Lawrence were established by *règlement* of 1676, northwest and south east astronomically, excepting a few on the north shore near Quebec which were made to run N. W. by N. or N. 33¼° W.

In the same way the side lines of the *seigneuries* of the Ottawa River were made to run N. by W., or N. 11¼° W., being about at right angles to the general course of the River. These surveys were performed in general by the "*boussole*" or surveyor's compass, which at that time appears to have been similar to the Mariners Compass, allowance being made for the declination of the needle. The measure used being "*pieds du Roi*," or French foot, which in comparison with our English measure, one foot French = 1.06576542 English feet.

These surveys, in general, are fairly correct, excepting in a few cases, where the proper amount of declination appears to have been either deficient or in excess of quantity. These *fiefs* and *seigneuries* were in due time subdivided, with a view of protecting the settlers from the incursions of the savages at that time, in long and narrow lots, laid out in front ranges and in double concessions, in order that the settlers might be situated as closely as possible, in case of surprise from the enemy. We find this same method of survey employed by Lord Selkirk in 1811, in the settlements on the Red River in Manitoba, and which appear to have answered the requirements of the time.

The year 1760 brought to a final close the era of French dominion in Canada, and peace was concluded between Britain and France in 1763, when Canada was formally ceded to England. In the same year a small portion of the recently acquired territory was organized by royal proclamation under English laws. The same year we find a copy of a Survey Warrant by Governor Murray to Captain

Samuel Holland, "Surveyor of the Province of Quebec," directing him to survey a tract of land at Murray Bay, for Ex-Lieutenant Malcolm Frazer, of the 78th Regiment; these are the oldest instructions on record.

In the following year, March 6th, 1764, the appointment of Captain Samuel Holland, Esquire, Surveyor-General, for making a survey of the northern district upon the Continent of North America took place.

Following the appointment we find a copy of a memorial of Surveyor-General Holland, addressed to the Right Honorable the Commissioner of Trade and Plantations, which may perhaps not prove uninteresting, and reads as follows:

"Proposals for carrying on the General Survey of the American Colonies.

The general survey shall be made on a scale of one mile to an inch, the places of note—channels, harbors, &c.—by a scale of four inches to the mile, being four times larger; the sounding of all harbors and channels shall be taken with a natural and historical description of the countries, the rivers and lakes, and whatever other remarks may be thought necessary. The Latitudes and Longitudes of all capes, headlands, &c., shall be determined by astronomical observation.

It will be necessary to have orders for all the Provincial Surveyors in the Department to give their assistance, and also copies of their surveys already made which are in their possession.

An armed cutter or other small armed vessel will also be wanting, with two whale boats and one large long boat, which will also serve to transport the party over bays and arms of the sea, and may be used in the River St. Lawrence, against smuggling, and to prevent the French from trading on the Continent.

The following is an estimate of the pay of Assistants and other expenses without which the service cannot be carried on:

	Per annum. £	s.	d.
For a Deputy Surveyor to be left to act in Quebec, that the Memorialist may not lose the emolument of his office, nor the Provincial Surveyor of the Colony by his absence.....	100	0	0
Two Assistant Surveyors at 7s. per day each.....	254	10	0
One draughtsman at 5s. per day.....	91	5	0
One Sergeant, one Corporal and 12 men to serve as Camp Colour and Chainmen, and to make signals along shore and on tops of mountains, viz:			
One Sergeant 18d. per day (additional).....	27	7	0
One Corporal 1s. " " do	18	5	0
12 men 6d. each do	109	10	0
Extraordinary expenses for horses, guides, etc., to be accounted for	100	00	0
Total.....	£700	00	0

For making the survey with a proper degree of exactness, the following instruments will be necessary, the price of which is annexed to each:

	£	s.	d.
An Astronomical Quadrant	21	0	0
A Micrometer	5	5	0
A Theodilet with vertical arch and Telliscope divided to every minute	30	0	0
Three pocket Theodiletts at £1 10s. each	4	10	0
One small Teliscope divided to every minute	20	0	0
One Azimuth Compass	4	14	6
One 12 inch Round Proctractor with index and nones to every minute	2	12	6
One Hadley's Quadrant 18 inches radius	4	14	6
One Telescope and Rules	5	5	0
Mr. Short's Reflecting Telescope 24 inch focal length with Rockworth stand	36	15	0
Skelton's Clock or timepiece for Astronomical observations	40	0	0
A pair of globes 17 inches	6	6	0
A copying glass	2	2	0
3 brass chains, 50 feet each	3	3	0
Stationery, wares, drawing paper, &c.	15	0	0
Total	£201	7	6

According to the foregoing estimate as the instruments will serve for the whole survey, the expense will not amount to £700 a year, and in 5 years at the furthest surveys of all the coasts, rivers and bays, and such parts of the lands as can be settled for many years to come, will be finished, at which time this additional expense may cease, if the Government shall not think it necessary to prosecute the plan of survey of the whole northern district.

The Memorialist has the honor to subscribe himself,

My Lords,
Your Lordships' most obedient and most humble Servant,
SAMUEL HOLLAND."

These proposals were, it appears, accepted and the trigonometrical survey of the St. Lawrence was proceeded with; but owing to hostilities with the Americans, it was somewhat retarded, and was only completed in 1780.

The position and limits of *seigneuries* were defined, as well as other reserves along the River from Bic upwards to the Gallop Rapids.

The greater part of the Ottawa River was surveyed in 1789 and 1790.

The earliest township plan on record is dated September 2nd, 1765 by John Collins, Deputy Surveyor, being a plan of Port Daniel, Bay of Chaleur; scale 400 feet to the inch, is laid out in ranges, at right angles to the Bay, and in lots of 50 acres each 742 by 2935½ feet; then follows the Township of Gaspé Bay North in 1785, Ashford in 1791, and Ascot in 1793. These townships were only partially surveyed, were outlined, and two or three ranges laid off. These latter were on a scale of 40 chains to one inch.

A copy, diagram E, may be seen in the Record Office, approved 30th May, 1794. by the Governor in Council, consisting of 11 ranges of 28 lots in each range, 75.5 by 28.75 chains, and of 200 acres each. This appears to have been about the standard at that time for townships, and some 50 were thus laid off in the Eastern Townships. At a still later date, however, this form was slightly changed, and an allowance of 5 per cent. for highways allowed, which form is still adhered to. On September 11th, 1783, Mr. Collins, Deputy Surveyor, was instructed to lay out lands at Cataraqui for the "United Empire Loyalists"; these were laid out in townships of 6 miles square, and subdivided into lots of 120 acres each, in order to suit the settlers, who appear to have been used to that form.

Surveyor-General Holland was succeeded by Joseph Bourchette, Esq., who was promoted Surveyor-General in 1804. This office was abolished in the year 1845, and was superceded by that actually known as Commissioner of Crown Lands, who controls all work formerly exercised by the now defunct office of Surveyor-General, The work of the Commissioner of Crown Lands, relating to Crown Lands Surveys, is more immediately under the control of the Deputy of the Commissioner, which important office is now held by E. E. Taché, Esq., a most accomplished, painstaking and thoroughly practical man, to whose kindness and urbanity, and that of F. X. Genest, Esq., I am largely indebted for a great deal of the data contained in this paper.

At the time that Mr. Bourchette acceded to office, the surveys were still performed with circumferentors, a primitive instrument provided with sights, and the bearings taken from the magnetic needle. It now became important that greater precision should be taken, consequently meridians were established at certain important local points, for the purpose of ascertaining the variations of the compass at each locality. With the increase of surveying operations, the use of improved instruments were introduced, and about the year 1830, the theodolite with telescope came into general use. Other surveys were subsequently effected with instruments of a higher

order of precision, establishing greater scientific knowledge of the requirements of the profession. The first official act of importance undertaken by Mr. Bourchette, after his appointment to office, was to establish the boundaries of the different seigneuries previously conceded and held as such, so as more definitely to determine their separation from the Crown Lands. Other surveys were undertaken at the instance of the Government for the various purposes of Colonization, but are too well understood to call for any special remark. Base lines were early recognized as of great importance, in establishing starting points in surveying operations, and facilitating the work of the surveyor. They originated first in connection with the laying out of townships, and were adopted for a similar object in the concessions made of timber limits, for lumbering operations, the utility of which in such connection will be easily understood by the practical professional.

The most important surveys undertaken in recent years by the Province of Quebec were those concerning the cadastration of the cities, towns, parishes, townships and incorporated villages of the Province of Quebec. The importance of this work can scarcely be overrated, it was undertaken for the purpose of facilitating the identification of lots, for the purpose of registration of real rights affecting real estate. The law under which it was undertaken provides that when a copy of the plans and book of reference for the whole of a registration division has been deposited in the office for such division, and notice has been given by proclamation in the manner provided by law, the number given to a lot upon the plan and in the book of reference becomes a true description of such lot and is a sufficient description of such lot in any document whatever. The mode followed in the cadastration alluded to is to give to each lot, according to its previously existing dimensions, the number originally borne by such lot in the townships only, and in similar work performed in parishes, cities, towns and villages, by substituting a new series of numbers for the old ones, and any description in any document whatever of such lot, by its cadastral number, is a sufficient designation and identification thereof.

The book of reference prepared likewise by the surveyor, in connection with the survey, contains a more minute description of the lot by giving a description of the confines thereof, together with the boundaries and the quantity of land contained within such defined limits, including in separate columns the number of the lot or piece of land indicated on the official plan, and the name of the proprietor.

There is another authoritative mode of survey, which I believe is confined in its operation, and is peculiar to the Province of Quebec I allude to the surveys undertaken and performed in all cases arising under an action, known to the laws of the Province of Quebec as actions *en bornage* or actions of boundary, or to verify or rectify ancient boundaries, and take place under the authority of the Court before which such action is instituted, and occur whenever two contiguous lands have never been bounded, or the boundaries have disappeared, or the fences or boundary works have been wrongly placed, and one of the neighbors refuses to agree upon a surveyor to determine the boundaries, or to verify or rectify the division line, as the case may be, or one of the parties interested, having consented to have such survey performed, afterwards refuses to sign the *procès verbal* of such survey, determining the line between the adjoining properties. The duty of the surveyor in all such cases is to be guided by the respective titles of the parties produced, if any, and such instructions as may be given by the judge, according to the contestation raised. In virtue of such authority, the surveyor proceeds to run a line strictly adhering to the orders given him by the Court, and makes a report of his work, to which is annexed a plan which he addresses and returns to the Court. This report, which is usually found to contain the division line between the contestants, as revealed by their respective titles or legal pretensions and rights, is subsequently, if found correct, homologated by the Court, and irrevocably establishes the division between such parties. It frequently happens that a surveyor in the execution of his work is called upon to act *quasi judicially*, by taking the evidence under oath of any person or persons in a position to establish the locality of an ancient post or boundary which may have disappeared. Whenever any such contingency arises in connection with the survey, special mention thereof is made in a *procès verbal*, drawn up by the surveyor, to which is attached the evidence so taken.

In conclusion, I may say that the various duties assigned to the surveyor and incumbent upon him, in the discharge thereof, involve great responsibility in the faithful and intelligent performance of the same, and ought to stimulate one and all to discharge their important functions in a manner to reflect the greatest possible credit on the Profession, and attract towards it the respect and confidence of the public.

G. E. McMARTIN.

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