PROCEEDINGS

OF THE

ASSOCIATION OF

Dominion Land Surveyors

AT ITS

FOURTH ANNUAL MEETING,

HELD AT

OTTAWA,

MARCH 8TH AND 9TH 1887

OTTAWA:
PRINTED BY A. S. WOODBURN, ELGIN STREET.
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ASSOCIATION OF DOMINION LAND SURVEYORS.

Organized, April 24th, 1882.

OFFICERS FOR 1887.

HON. PRESIDENT	Capt. E. Deville, Surveyor General.
PRESIDENT	Thomas Fawcett, D. T. S.
VICE-PRESIDENT	E. J. Rainboth, D. L. S.
SECRETARY-TREASURER	A. O. Weeeler, D. L. S.
EXECUTIVE COMMITTEE	A. F. Cotton, D. L. S. W. Chipman, D. L. S. Edgar Bray, D. L. S.
AUDITORS	J. A. Snow, D. L. S. J. S. Dennis, D. T. S.

HONORARY MEMBERS.

Capt. E. Deville, F.R.A.S., D.T.S., F.R.S.C., Surveyor General.

W. F. King, D.T.S., B.A., Chief Inspector of Surveys.

Alfred R. C. Selwyn, C. M. G., LL. D., F. R. S, Director Geological Survey.

Robert Bell, B. A. Sc., M. D., LL. D., Assistant Director Geological Survey.

Prof. Macoun, M. A., F. L. S., F. R. S. C., Dominion Botanist.

Prof. George M. Dawson, D. Sc., Assoc. R. S. M., F. G. S., F. R. S. C.

Prof. Harrington.

Andrew Russell.

E. E. Taché.

Bolton Magrath.

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CONSTITUTION AND BY-LAWS

— OF THE —

ASSOCIATION OF DOMINION LAND SURVEYORS.

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 and Honorary Members.

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

3. Honorary Members shall be such persons only who are distinguished for professional attainments. They shall be exempt from dues.

ARTICLE IV.

OFFICERS.

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

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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, to be elected at the annual general meeting by ballot.

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

4. The election of officers shall be the last business at the Annual Meeting of the Association.

ARTICLE V.

ELECTION OF MEMBERS.

1. Any Dominion Land Surveyor upon being proposed in writing by at least two members shall be eligible for election as a Member of this Association upon payment of the necessary fees.

HONORARY MEMBERS.

2. Honorary members must be recommended by at least two Members.

VOTING.

3. All voting for the election of Members shall be by ballot, and at a general meeting of the Association.

4. The majority of the ballots cast shall decide.

ARTICLE VI.

MEETINGS.

1. The Annual General Meeting shall commence on the third Tuesday in February, in Ottawa; and a General Meeting shall be held on the third Tuesday in April, in Winnipeg.

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. Five shall form a quorum at any meeting for the transaction of business.

ARTICLE VII.

AMENDMENTS.

1. Any member of the Association who may desire any change in the constitution of the Association, shall give notice of such contemplated change to the Secretary at least two months before the next Annual Meeting, and the Secretary 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. Notice of such proposed change and of the meeting at which it is to be considered, shall be given to the Secretary one month before such meeting, the members to be notified thereof by the Secretary.

ARTICLE VIII.

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 IX.

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 X.

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. Any member twelve months in arrears shall be struck off the roll, and no member in arrears shall be allowed to vote.

BY-LAWS.

ORDER OF BUSINESS.

1. Reading of Minutes of previous meeting.
2. Reading Correspondence and Accounts.
3. Propositions for Membership.
4. Balloting for 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 names 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 the casting vote, but 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.

Fourth Annual Meeting

OF THE

ASSOCIATION OF DOMINION LAND SURVEYORS,

Held at Ottawa, March 8 and 9, 1887.

:o:

MINUTES OF THE MEETING.

The Association assembled Tuesday, March 8th, at 3 p.m., at the offices of Messrs. Wolff and Cotton, Dominion Land Surveyors.

Thomas Fawcett, President, in the chair.

The Secretary being snow-bound up the Ottawa River, it was moved by Otto J. Klotz, seconded by William Ogilvie, and resolved, that J. S. Dennis do act as Secretary *pro tem.*

On motion the minutes of the preceding meeting, as printed in the annual report were accepted.

It was then moved by Otto J. Klotz, seconded by William Ogilvie, and unanimously resolved that Thomas Fawcett be President for the ensuing year.

The election of officers was as follows:

Vice-President,	E. J. Rainboth.
Sec.-Treasurer,	A. O. Wheeler.
Executive Committee,	A. F. Cotton, W. Chipman, Edgar Bray.
Auditors,	J. A. Snow, J. S. Dennis.

Otto J. Klotz reported having attended the dinner of the Ontario P.L.S. Association, at Toronto, on the evening of March 2nd, and of his having been requested to convey greetings to this Association.

THE PRESIDENT then delivered his Annual Address:—

Gentlemen of the Dominion Land Surveyors Association:

The year 1887 finds us again assembled at our Annual Meeting, and I am thankful that I am spared to greet you.

The events of the year touching on our profession, as far as my knowledge extends, have been of an ordinary nature and the operations have not been as extensive as in a number of the seasons past, when over one hundred organized parties were employed in surveying the Dominion Lands. Although the number that attended our last Annual Meeting was small, we regret to have to say that one who was here last year—interesting himself with the matters which were brought forward for discussion at that meeting, and whose name appears on the list of officers for 1886, —has left the stage of action and will assemble with us at our periodical meetings and social gatherings no more. We miss the familiar face of our genial friend. Many can bear testimony to the kind heartedness, the generous disposition, the universal good-will and fellowship of the departed Mr. J. J. Burrows, whose face this day we miss and to whose memory we wish to pay tribute.

One matter as touching the profession to which I will just refer is the meeting which was called by Mr. Chipman and others last winter for the purpose of organizing an Association of Provincial Land Surveyors for the Province of Ontario. There were some thirty-six Provincial Land Surveyors present at that meeting, and the result was an organization which I believe has been started to stay, and become an institution of great importance to the profession. I believe that Association has before it a brilliant future and will become a great educational institution, where professional men and men of large practical experience in all the branches in which the Provincial Land Surveyor has to interest himself, may acquire knowledge which could be obtained in no other way. The meeting held in Toronto last week, which extended over the greater part of three days, was in every sense a success.

There were two resolutions carried before the meeting last year which ended in two memorials being prepared by the committee, appointed for that purpose, to the Hon. Minister of the Interior. The first resolution set forth the injustice to Dominion Land Surveyors arising from allowing persons who were not Dominion Land Surveyors to make surveys along the line of the Canadian Pacific Railway, in the North-West and British Columbia, which according to the laws of the older provinces should be done by persons who possessed a legal qualification only. This memorial if not acted directly upon would, I think, bring the matter before the department in a manner which could not but be favorable to the profession, and strengthen us in our right to be protected from competition with a class possessing inferior qualifications, and whose blunders could not but have a tendency to degrade the profession—a result directly opposite to what we wish to obtain and are working for, and which is the primary object of this Association viz: "The promotion of the general interests and elevation of the standard of the Profession."

The other memorial referred to as drawn up by Messrs. Klotz, Dennis, Ogilvie and Drummond, set forth the public benefit to be derived from a Trigonometrical Survey to extend over the older provinces of the Dominion

These memorials were forwarded by me to the Minister of the Interior, and the letter acknowledging the receipt thereof, stated that the matter would come under consideration—but whether that consideration will result in anything further is a question which still belongs to the future. Copies of both memorials were forwarded to the Secretary with a suggestion approved by the several members of the Memorial Committees, that they be published and distributed among members of the Association for their information on the subject contained therein. As this was not done I would recommend that the memorials be read before this Assembly, so that if any member of the Association may wish to add thereto, or make any changes, an opportunity will be given, and that the memorials be perpetuated by publication in the report of the proceedings of this meeting, for our information, to which we may add from whatever sources we can, as this question of a Trigonometrical Survey of our Dominion must sooner or later come forward for practical consideration, and this result will only be brought about through agitation and education. We could not expect the Government to commit the Dominion of Canada to a considerable annual expenditure for Trigonometrical Surveys unless they could see the returns would justify the outlay, and that the country would be worth so much more in dollars and cents or their equivalent for having such a survey conducted. It therefore remains for us to make ourselves individually and collectively so well acquainted with such a work that we will be able to point out in what way it would be a public benefit to our country, and to give good practical reasons why a survey of that character should be undertaken.

It is true, as pointed out in the memorial submitted to the Minister last spring, that all civilized nations on the face of the earth have incurred, and are incurring large expenditures on Geodetic Surveys and in scientific research, yet in every country these had a beginning, and in the United States, which may be said to take the first place in order of merit for the accuracy and extent of scientific surveys, the majority of the legislators resisted successfully for years the pressure brought to bear by parties who set forth the claims and urged the necessity of a Geodetic Survey.

The first attempt to organize a coast survey in the United States was by President Jefferson, who in 1807 in his message to Congress recommended the establishment of a National Coast Survey, and to Professor Patterson of Philadelphia it is supposed the honor is due for having first suggested the idea of a Geodetic Survey of the coast. At that time Congress passed an act authorizing such survey, and placing in the estimates $50,000 to meet the expenditures in connection therewith. The Government addressed circulars to the principal scientific men of the country requesting their opinions in regard to the best methods of conducting the proposed work, and the plan proposed by Mr.

Hassler who had been engaged in the Trigonometrical Survey of Switzerland was adopted, and he was appointed to superintend the work, but on account of war with Great Britain and other hinderances the field operations were not entered upon until 1817, ten years after the inception, when Mr. Hassler commenced his work in the vicinity of New York, but before he published his first report the work was discontinued and was not taken up until ten years later when in 1828 Mr. Hassler was again enabled to resume the work, which he continued to superintend until the time of his death, which took place fifteen years later. As the country began to realize the benefit derived from it the work continued to grow in extent and importance.

The parties were multiplied until there were operating Triangulation parties, Astronomical parties, Hydrographical parties, Topographical parties, computers and draughtsmen, a large staff of officers and men working under the direction of a superintendent until the breaking out of the civil war, when, the Southern States having removed from their harbors all buoys, lights and other aids to navigation, the Superintendent of the Coast Survey supplied from his own corps, men who had a local knowledge of the harbors, and who could pilot the largest vessels of war safely into them, and from their knowledge could restore the marks which had been removed.

Skilled Topographers were supplied to the army, and the services rendered by them were inestimable, and highly appreciated by the Government. At the close of the war it did not require any recommendation to have the work continued but ever since the work has been going on along the coast of the Atlantic, the coast of the Pacific, over many of the states in the interior, away to the north in Behring Strait and along the coast of Alaska.

During the latter part of the season just closed Messrs. Klotz and Ogilvie were engaged in establishing the Longitudes of several points in British Columbia and the North-West Territories by astronomical observation in connection with the electric telegraph. If this work should be extended over the several towns of the Dominion, and the Latitude and Longitude of some prominent points fixed, which could be used in tieing in the local surveys, a step would be taken in the right direction; but if we are to have proper maps and charts of our great lakes and rivers or of our sea coast or any part of the Provinces of our Dominion, this can only be accomplished by means of an accurate survey such as has been made by Great Britain, the United States and every civilised country on the face of our globe.

Every national undertaking is either patriotic or otherwise. Any work which has for its object the elevation of the country may be considered truly patriotic. That such a work as that recommended by this Association, through its members or through its committees, has been proved not only to be respectable, nationally speaking, but necessary; as human life should be protected. If it is a crime to take the lives of our fellow-men and destroy their property, is it not equally a crime not to supply those who navigate our waters with all the information necessary to enable them to do so in safety, without risking their own lives and the lives entrusted to their care, and the loss of property consigned to them for transportation? I wish to impress on this Association the fact, that through whatever influence or *whoever's* labors, the obstacles and hidden dangers to navigation shall be brought to light, the good that will be accomplished is beyond our limited ability to estimate. The loss resulting from lack of accurate knowledge of our waters in some single year would be as great as the cost of carrying on an accurate survey for a period of ten years. There is not a class in the Dominion who would not derive benefit from placing into the hands of our navigators accurate charts of our waters. There would be a reduction in freight rates, a reduction in insurance rates and an increased feeling of safety which would lead many to travel who at present would not run the risk of a trip because of the danger, and a result of that would be, lower passenger rates and a greater degree of intelligence amongst our fellow-men—intelligence of a kind which can only be acquired by visiting the different places in our Dominion. Thus we see the benefit to be derived in an indirect way, to say nothing of the direct saving in property and life.

How much would the commercial world take and dispense with all knowledge of the electric telegraph and telephone? I venture to say that millions of dollars would not purchase that knowledge, if such a thing were possible; and that knowledge was derived through the scientific investigations of single individuals whose labors are worth such a vast sum of money to the commercial world. And who will venture to say that millions have not been lost to our country in consequence of the loss of valuable lives through defective knowledge of our waters, and accidents which might have been avoided by spending a few thousand dollars in making a Hydrographic and Geodetic Survey?

In this agitation for a Geodetic Survey those who are the agitators will probably be looked upon as office seekers and boodle hunters, but it won't make much difference if those, who cannot grasp the magnitude of the question, should even think so, while there are thousands in every land who can testify to the practical importance and utility of the work and the fact that every country of any importance whatever, has for commercial and scientific, municipal and legislative purposes, taken steps to have accurate maps of its domain, based upon Geodetic Surveys made trigonometrically.

Should the work be undertaken and members of this Association placed in charge of different branches of the work, and prove themselves to be capable officers—would it be anything to their discredit that they had worked and used their influence for its inauguration? I cannot see it. Persons who had spent years in studying up the subject would be more likely to conduct the operations in connection with it successfully, than would a mere figure-head without a practical knowledge of the operations and principles involved.

Once again, if the work should be done under the direction of the officers in connection with the Department of the Interior and a staff of capable members of the profession take charge of the details, would it not be better than bringing men from other countries and paying them a large salary for work that could be done quite as well, if not better, by officers at home, who would spend whatever they gained by it in Canada? I believe that Canada can lay claim to possessing men who can carry on survey operations of all descriptions with as great a degree of accuracy, despatch and economy, as can be found in any land under the sun.

The ability acquired through the extensive experiences in the prosecution of surveys by a great number of our surveyors gives them the capacity to overcome obstacles with scarcely an effort that to the newly initiated would appear insurmountable.

I feel very much in sympathy with the cry "Canada first" and "Canada for the Canadians." Should not this scheme for obtaining accurate knowledge of our country, its lands and waters, its timber and minerals, its climate and agricultural capabilities, its geological formations, which date back as far as those of any other country, and forward up to the present, its cities, towns and villages—the construction of a map of the entire Dominion of which we would have no need to be ashamed, be considered a "National Policy" worthy of the name. I like the term "National Policy" but I don't think any policy, which does not include within its scope every thing that is for the benefit of the nation at large as far as the financial condition of the country would justify, is worthy of the name.

That gigantic work, the building of the Canadian Pacific Railway, was pre-eminently a National Policy, and a work which confers upon Canada the praise of nations.

Parts of our Dominion where heathenism prevailed a few years ago, are brought—by the Canadian Pacific Railway—to the very doors of civilization and culture, or rather civilization with its thousands of advantages and comforts, is carried by steam to those remote parts of Canada, and the whole distance from the Atlantic to the Pacific which a few years ago seemed so far, is bound by an iron band which brings Victoria on the Pacific Ocean to within a week's journey of the cities on the Atlantic coast.

Year by year something is added to our store of the geological and geographical knowledge of our country. A small staff under the direction of Prof. Selwyn, who has in charge that department of the work, has been exploring different parts of the country, examining the minerals and the geological formation, and are showing as far as they can the topographical features of the country explored by them.

But if the true geographical position of points were established and accurate maps of the country made, previous to their work or in conjunction with it, how much more valuable the work would be, and where valuable deposits of minerals are found the land could be described accurately, and not described and patented as at present without knowing where the land is situated except that it bears a certain relation to some other land which was described in the same uncertain way some years before as being near some point of a lake or stream that may be in latitude 49° or 50° and somewhere between Ottawa and the Rocky Mountains.

Any person with any degree of intelligence could see how much more satisfactory it would be to have his land located in its proper place on the map, having its correct latitude and longitude so that he could point out the meridians and parallels bounding the land, which would maintain that same relation so long as the earth continues to roll upon its axis, and the same land would occupy the same position on our charts, and the cause for that endless litigation which involves the ruin of hundreds of honest citizens without in any way remedying the defects or adding one particle to the information of any party concerned, would be removed, and harmony prevail, where under present conditions, discord and dispute reign supreme.

I, for one, believe, gentlemen, that Canada will not long remain in the background in inaugurating and carrying on successfully a so much needed national improvement. The past history of our country during the last few years would point to this. Already the Federal Government has incurred considerable expenditure in the construction of lighthouses, thus adding to the safety of navigation in that respect, and in some places along our coasts soundings have been made and the waters examined in search for hidden rocks; but you all know, and all the members of our Government know, that information, obtained without any means of locating on a map or chart in their exact positions rocks and dangerous reefs discovered in that way, and that the time spent and the expense of such a survey, is little better than wasted. True, a buoy could be anchored which, for a time, would point out the danger, but it is liable to break away at any time, and nothing remains but to again repeat the soundings as at first, in search of the dangerous rock or reef, with just the same uncertainty in connection with finding them.

But what would be the difference had a proper survey been made and charts constructed? The azimuth and distance of every dangerous place would be given to certain points along the shore so that from these points the lost buoys or hidden rocks could at once be re-located without any uncertainty or further search, and the work once properly done, and permanent points established, would remain to bless the nation for all time to come. This question of a Geodetic Survey has been brought prominently forward by your ex-President and other members of this Association on several occasions, and I enlarge upon it at this time so that you will still keep it prominently in mind and not allow it to rest until it becomes an accomplished fact, when you will have the satisfaction of knowing that you have advocated a national improvement which will lift your country in the estimate of nations while it will aid our navigation, railroad interests, municipal and electoral divisions, statistic and agricultural bureaus, commercial, educational, mining and lumbering interests, and be a benefit to every resident of our Dominion.

In conclusion, I would thank you gentlemen for the honor you have conferred upon me by placing me in the President's chair during the year which is past, and wish that you may all be prosperous, physically and morally, in both temporal and spiritual things.

At the close of the President's address, it was moved by

Otto J. Klotz, seconded by J. S. Dennis, and resolved, that a committee, consisting of the President, W. F. King, William Ogilvie, the mover and the seconder, be appointed with reference to a Geodetic Survey, and be instructed to continue the agitation with regard to this matter by drawing up an additional memorial setting forth some scheme for its inception.

It was then moved by Otto J. Klotz, seconded by Professor Macoun, and resolved, that a vote of thanks be tendered to the President for his able address, and that the address as read be adopted.

In compliance with the request of the President, Professor Macoun addressed the meeting on the question of the necessity of a Geodetic Survey, and also in regard to general matters of interest.

It was explained by J. S. Dennis that at the request of the Surveyor-General he had prepared and submitted an additional Memorial regarding Right of Way Surveys in Manitoba and the North-West Territories.

W. F. King explained that in consequence of the absence of Dr. Bell he was unable to make any report on the question of Government Map Making.

In accordance with notice of motion given at the last meeting it was

1. Moved by J. S. Dennis, seconded by Otto J. Klotz, and resolved, that the constitution be amended so as to provide that the election of officers shall be the last business of the Annual Meeting.

2. Moved by William Ogilvie, seconded by Otto J. Klotz, and resolved, that the following be inserted in the Constitution: "No member of the Association shall fill the office of President for more than two consecutive years."

3. Moved by William Ogilvie, seconded by Otto J. Klotz, and resolved, that the following be inserted in the Constitution: "Any member of the Association who may desire any change in the Constitution of the Association, shall give notice of such contemplated change to the Secretary at least two months before

the next annual meeting, and the Secretary 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."

It was moved by J. S. Dennis, seconded by W. F. King, and resolved, that the Secretary be instructed to make arrangements for a suitable room in which the Annual Meetings shall be held.

The meeting adjourned at 5:30 p. m. to re-assemble at 7:15 p. m. at St. Andrew's Hall, for the Evening Session.

The meeting resumed sitting at 7:15 p. m.

William Ogilvie then read a valuable paper on "Micrometer Measurements."

It was moved by T. D. Green, seconded by G. A. Mountain, and resolved, that William Ogilvie be tendered a vote of thanks for his interesting paper on "Micrometer Measurements."—*(See below.)*

Next followed a very interesting paper on "A Traverse Survey," by Otto J. Klotz —*(See below.)*

At the close of his paper Mr. Klotz explained the difference between his and Mr. Ogilvie's deductions in micrometer measurements, stating that he had not gone into the matter as deeply as Mr. Ogilvie. Mr. Klotz concluded with some able remarks on the various forms of the micrometer in use and the methods of reading the angle, giving it as his opinion that the modified form of the Lugeol Micrometer was the best, and surest for accurate results.

J. S. Dennis made objections to Mr. Klotz's statement as to errors in solar azimuths, saying that he thought the amount of error claimed by Mr. Klotz was in excess.

Then followed an annimated discussion.

It was moved by E. J. Rainboth, seconded by T. D. Green, and resolved, that a vote of thanks be tendered to Otto J. Klotz for his interesting paper on "A Traverse Survey."

Dr. Bell stated that the Committee on Government Map Making would have its report ready for publication in the Annual Report of the Association.

Otto J. Klotz stated that Professor Macoun had expressed his willingness to prepare a paper for the Annual Report on Botany and Natural History.

Professor Macoun said, that collections of plants and minerals made by surveyors, had in several cases been found to be valuable. The Professor mentioned especially one kind of honey-suckle found by Otto J. Klotz on the Saskatchewan, and some grasses obtained by Thomas Fawcett on his exploration survey up the English River as belonging to a genus not before known to exist so far north, and which went far to prove that the climate was not so rigorous as report said. He proposed that his paper should contain instructions how to preserve and pack botanical, mineralogical and natural history specimens so as to best ensure their safe carriage.

Dr. Bell gave some valuable hints as to the selection and packing of mineral specimens that might at any time be found by surveyors, and said that no opportunities should be lost of transmitting the same to the Geological Museum, where a thorough examination would be made and those that were valuable duly appreciated.

J. S. Dennis then read the memorial sent to the Minister of the Interior by the committee appointed to enquire into the advisability of a Coast and Geodetic Survey for Canada. (*See below.*)

The President read a memorial and letter accompanying the same, to the Minister of the Interior, praying that action be taken by the Government with regard to Right-of-way Surveys in the North-West Territories, and that it be made a matter of law that such surveys should be performed by duly authorized surveyors as being men who were responsible to the Government for the correctness of their work. (*See below.*)

The meeting then adjourned until 10:30 a.m. the following morning.

WEDNESDAY, March 9th.

The Meeting resumed session at 10:30 a.m., at St. Andrew's Hall

It was moved by Otto J. Klotz, seconded by William Ogilvie, and resolved, that for the sake of uniformity in the Standard of Dominion Land Surveyors, the Board of Examiners of Dominion Land Surveyors be requested to obtain from the Secretary of the Board of Examiners for the Province from which a candidate, who is a P. L. S., presents himself before the Board of Examiners for Dominion Land Surveyors, a copy of the questions, and the solutions thereto, given by such candidate at his final examination for P.L.S.

It was moved by J. S. Dennis, seconded by T. D. Greene, and resolved, that the President be instructed to follow up the question of the acceptance and registration of Right-of-way Survey Plans by the Department of the Interior, by writing to the Minister of the Interior, asking what action had been taken in the matter.

There being nothing before the Chair, and the Annual Meeting about to close, Mr. Klotz alluded extemporarily to reminiscences of the good days of '83 when so many bonds of friendship were more closely riveted, and said that he had lately come across a bit of paper of that time. Mr. Klotz continuing, said "Who does not recollect the encampment at Moosejaw, where hundreds were under canvass at one time? Who does not recollect with a certain sense of pleasure, the distribution of the means of locomotion—the horses—which was done in the fairest and most impartial manner possible, consistent with the individual wealth and standing and ingenuity of the respective D. L. S.? Ah! What noble animals some of our horses were! One of mine, I remember distinctly, because he was a thoroughbred—of the breed "Mange;" he reminded one of a certain kind of African dogs—those without any hair.

I need only refer to you such words as bronco, balky, sloughs, Government assistants, cook, rain and snow, heat and cold, wood and water, and I know a panoramic procession is immediately set in motion and passes before your eyes. Tomes could be written were our experiences all gathered It has often occurred to me that a volume under the title of "Life of a Surveyor," would, if well written, find not only favor amongst the profession, but with the public as well.

In my rambling remarks I am wandering from that bit of paper of which I spoke. Well, you will remember that while waiting and camping at Moosejaw getting the outfits in shape, "At Homes" were inaugurated by the then President. These were social and convivial gatherings in the evening, and for which invitations were extended to the various chiefs. Each host tried to outdo his immediate predecessor, until a veritable Delmonico appeared in our lenten friend from Quebec.

A mandate had been issued that at these gatherings no one's name should be used in vain, as many of them were expressive as well as euphonious.

Just before our meeting on the evening of April 27 of that eventful year, when we were the guests of Mr. E. Bray, an idea struck me to combine in one, a complete breach of the mandate, and on this bit of paper is what I dashed off and read to you on that evening. * * * * * *

Mr. Klotz was heartily applauded, and on motion, with his consent, it was resolved to print his reminiscences in the Annual Proceedings. (*See below.*)

It was then moved by J. S. Dennis, seconded by Otto J. Klotz, and resolved, that the Secretary-Treasurer be instructed to remit to Mr. Taylor the sum of $5.00 for the use of St. Andrew's Hall during the meeting of the Association.

Moved by Otto J. Klotz, seconded by T. D. Green, and resolved, that the meeting adjourn until the third Tuesday in February, 1888.

Hon. Members Present:

Robert Bell, B. A. Sc., M. D., LL. D., Assistant Director Geological Survey; W. F. King, Chief Inspector of Surveys; Professor Maconn, F. L. S., Dominion Botanist.

Members Present:

Dennis, J. S.,	McLatchie, John.
Fawcett, Thomas,	Ogilvie, William,
Green, T. D.,	Rainboth, E. J.,
Klotz, Otto J.,	Wheeler, A. O.,
Mountain, G. A.,	Wolff, C. E.

MICROMETER MEASUREMENT OF DISTANCES.

By William Ogilvie, D. L. S.

In preparing a paper on this subject, for beginners in the profession, it would be natural and proper to begin by describing the many forms of the Micrometer, their uses, construction and adjustments, the advantages or disadvantages they may have, and more especially their adaptibility to the purposes of Land Surveying or more properly the astronomical and trigonometrical problems which the Land Surveyor usually meets with in the practice of his profession.

In the present instance I think nearly all this may be dispensed with, as I fancy nearly all if not all of the members of this Association know quite as much as I do about the various forms of Micrometer and the uses to which they have been applied, and very probably many of them know more.

I may, however, classify the Micrometer which might be used for our purposes as follows:

First a simple telescope with two wires in its focus at any convenient distance apart—this distance of course to remain constant, and the base to be used with it to change in length as its distance from the telescope may be greater or less. For this purpose one of the targets or vanes on it—which throughout this paper I will call discs—should be moveable; or both might be moveable. I need hardly say that the distance between those discs, after they have been so set that they are exactly bisected by the wires in the telescope, is to be accurately known, in order to deduce the distance of the base from the telescope. Could we accurately measure the distance between the wires, and the focal length of the telescope used, it would be a simple matter to deduce the distance from the focus of the telescope to the base, as we have two similar triangles: the focal distance of the telescope forming two sides and the distance between the wires the third side of one triangle and the distance from the base to the focus of the telescope forming two sides and the length of the base itself the third side of the other; and as the wire interval is to the focal length, so is the length of the base to the distance sought. But it is practically impossible to measure with sufficient accuracy the wire interval and focal length so we obtain the ratio they have to each other by setting the base up at a convenient measured distance from the focus of the telescope and making a careful determination of the length of base the wire interval gives at that distance.

The distance from the base to the focus of the telescope divided by the length of base so found gives the ratio of the wire interval to the focal length of the telescope and is a constant factor by which all lengths of base due to the wire intervals are to be multiplied to find the distance from the focus to the base. This ratio should be determined at several distances.

The base must be placed carefully at right angles to the line of sight. This is not always practicable where micrometer measurements of distances are most convenient—that is in rough country—and in practice it is better to hold the base rod vertical and measure the angle of elevation or depression to it from the telescope, and from the known length of base and the angle of elevation or depression, reduce the base to its length at right angles to the line of sight by multiplying it by the cosine of the angle of elevation or depression; which though not rigorously accurate is practically so.

This is the simplest form of Micrometer for distance measurement, but in practice is not so convenient for all distances as other forms to be noticed presently, as at distances which other forms of Micrometer with a practical length of base, would give fair results, this form would require such a length of base as to be practically out of the question—unless the base were placed horizontally; and this would require the base man to have an instrument with which to place it at right angles to the sight line end and even then its length would not permit its transport—thus a wire interval in the telescope which would give a base of say five feet at ten chains, at forty chains would require twenty feet of a base and so on proportionally. Another objection to this form is, at long distances the projective wire images cover so much of the base, that the point of intersection is hard to define, except indeed we take the edges of the wires; and in my opinion worse than this is the fact, that the images of the discs are very rarely—owing to irregular refraction—steady, and as both discs cannot be distinctly and critically under sight at the same instant it is difficult to mark exactly the wire interval on the base rod, and this difficulty increases vastly with the increase of distance from the telescope to the base.

In a double image Micrometer the images of both discs are seen simultaneously and this difficulty is got over.

Another serious objection is that the wire interval—especially if they are long wires—may be affected by atmospheric moisture and temperature, and also by very rough handling.

This form of instrument I think is not suited to the needs of a survey of any great extent, such as an exploratory survey. For short distances and short times of use it may give fairly satisfactory results, and its simplicity enables us, with the aid of a spider, to always have it at hand.

To the other form of this instrument in which one of the wires is fixed and the other movable by a screw, as in some astronomical Micrometers, the same objections apply, only that a convenient base can be used at long distances.

Another form of the wire Micrometer is the telescope with one wire as in the ordinary transit or theodolite, which wire can, by a suitable Micrometer screw moving the telescope, be made to bisect the discs and from the readings of the Micrometer head on each disc, the angle subtended by the base can be deduced—the value in arc of a revolution of the Micrometer screw of course being known. I had an ordinary transit fitted with a screw of this kind by putting a divided head on to the vertical tangent screw. I found it fairly satisfactory at short distances, but I had to be careful that the axis of the telescope did not leave its place in the Y's during a movement of the screw: and to anyone intending to use this form I would say emphatically, "See that your telescope cannot climb in the Y or move in any way except revolve on its axis, while the Micrometer tangent screw is being used."

We will now consider some of the double image Micrometers. The Rochon is a convenient and quick form of this, but in my opinion too much light is absorbed by its thick double refractory prisms, and there is a consequent dimness of the images which is exactly the opposite of what is required in a good Micrometer; besides this, there is a want of uniformity in the brightness of the images in all the instruments of this kind that I have seen which is inconvenient in practice especially so at long distances. In an instrument of this kind, with which I once made some experiments, one of the images of the discs—which were a bright vermilion—appeared a pale pink and the other a good red.

The results of some measurements—under the best atmospheric conditions—with a ten link base at about forty chains, were anything but satisfactory, although every care was used and every expedient tried which we thought would better the conditions; but after every expedient and five or six trials, we gave it up as unsatisfactory.

Others may have used the instrument with more satisfaction, if so, I would be glad to hear from them. As generally made its greatest angular measurement is about thirty minutes of arc, which is too small for practice.

The only other form of the double image Micrometer, I will notice, is that which I have used on surveys for two seasons; one season on an exploratory survey when there was no check on the the distances determined by it, the other on a survey when it was used as a check on the chaining of the courses of a traverse survey, comprising 1,849 courses.

From the records of this survey, I will tabulate for various atmospheric conditions some of the errors of the distances determined by it, as compared with the same distances chained.

This instrument or a modification of it as made by Mr. Foster of Toronto, I presume many of you have seen, and as my own in the original form is in the exhibition of instruments here, I will only say in description of it, it consists essentially of a telescope with the object glass cut diametrically in halves, each half is suitably fixed in a frame which slides in another frame. To the frame holding each semi-objective, motion is communicated by a screw, of the shaft of which one half is a right hand screw, the other half a left hand screw and each part turns in a corresponding nut fixed to its half of the object glass. On the original form of the instrument there is a circle attached, to which the motion of the screw is communicated and on the circumference of which the displacement of the semi-objectives, relative to a common focus, is read in minutes and seconds. The designer of the instrument evidently did not think it as accurate as it is, as he divided the limb of the circle to divisions of 20″ and put on only a pointer for us to estimate by the value of parts of a division. A vernier reading to 2″ would enable us to obtain more uniformity in our results, as it would eliminate all uncertainty that arises from errors of estimation in the value of parts of a division. Before using mine again I will have such a vernier put on.

In Mr. Foster's modification this circle is dispensed with and the displacement of the semi-objectives is measured by the revolution and parts of a revolution of the screw which moves them, on the head of which is placed a circle divided to hundredths. In Mr. Foster's instrument the value of a hundredth of a revolution is about 8″ of arc, and by using a magnifier, tenths of a division can be easily estimated.

Before using this form of the instrument we would first, by trial, have to determine the exact value in arc of every revolution of the screw and tabulate them, and from them determine the value of the parts of each revolution: or, more convenient still, set up the base we intend to use with the instrument, at various distances, beginning say at five chains and increasing by five chains until we arrive at a distance as long as any we may be likely to use in the work. At each distance determine carefully the turns and parts of a turn of the screw due to the base used, and tabulate them.

The use of this table is obvious. In the original form the angle being read, we are saved this preliminary trouble, and all we require is a table of the factors for the angles used. These factors can be easily computed, being the ratio of the tangent of each angle to radious.

A single reading of an angle I define as follows: First, right hand motion of screw, make coincidence of images; read limb. Second, continue motion until images pass each other then by a left hand motion of screw make coincidence of images; read limb. Third, by left hand motion of screw, make semi-objectives pass in the other direction and make coincidence of images; read limb. Fourth, continue motion until images pass, then by right hand motion of screw make coincidence; read limb. The mean of these I call a single reading. In my experience the best results were obtained by making the images of the discs about half overlap horizontally. In that position I think one can tell better when the bottom or top edges of the discs form a continuous straight line and better results be obtained than when one makes the images overlap altogether or makes the upper edge of one image in contact with the lower edge of the other and *vice versa*. In this last way too, there is danger at long distances, when the depth of the disc would not make an appreciable angle, of making two successive readings with the same edges of the discs in contact, which would have the effect of altering the length of the base used by one half of the depth of the disc used and this would make quite a large difference in the result sought.

To give an idea of the accuracy that can be attained by the instrument, I give the following result of measurement on a ten link base. The discs were pieces of wood painted a bright red as they had a snow back ground. They were each twelve inches long by four and a-half deep. I set up three bases; two were vertical, the other horizontal. No. 1, as I will designate it, was vertical, with the lower disc six feet above the surface of the snow. No. 2 was vertical, with the lower disc two feet above the surface and No. 3 was horizontal, and about five and a-half feet above the surface.

My object in placing them in this way was to determine approximatly, by observing on them in different days and in different atmospheric conditions as to temperature and moisture, the effect irregular refraction would have on the angles subtended by the different bases; my opinion being that under varying conditions the angle subtended by No. 1 would be less affected or more constant than that subtended by No. 2, or the low base, while the angle subtended by No. 3 or the horizontal base would be more constant than either of the other two.

Since setting them up the weather has been so stormy and I have been away from home so much that I have only got three readings. As I said before a part of the difference in the angles is probably due to the want of a vernier on the instrument.

The distance from the point of sight to the bases was by chaining 42.05 chains, which was the mean of two independent chainings, differing by six tenths of a link.

February 19th.—Thermometer 26°, sky cloudy, a little snow falling, a very strong wind blowing across line of sight which made it very difficult to hold the telescope steady enough to see well. No noticeable irregular refraction.

Five readings on each base:—

Base No. 1 Vertical.			Base No. 2 Vertical.			Base No. 3 Horizontal.			Distance by bases
Reading.	v	vv	Reading.	v	vv	Reading.	v	vv	
1=8′ 10″.2	—.7	.49	1=8′ 11″.7	+2.2	4.44	1=8′ 10″.5	+2.3	5.29	1st base 42.018 chs.
2=8′ 10″.2	—.7	.49	2=8′ 09″.2	—0.3	.09	2=8′ 06″.5	—1.7	2.89	2nd » 42.135 »
3=8′ 11″.7	+.8	.64	3=8′ 09″.2	—0.3	.09	3=8′ 07″.5	— .7	.49	3rd » 42.252 »
4=8′ 11″.2	+.3	.09	4=8′ 08″.7	—0.8	.64	4=8′ 08″.7	+ .5	.25	
5=8′ 11″.2	+.3	.09	5=8′ 08″.7	—0.8	.64	5=8′ 07″.7	— .5	.25	Mean 42.135 »
M. 8′ 10″.9	E=±.″67		M. 8′ 09″.5	E=±1.28″		M. 8′ 08″.2	E=±1″.51		
	E_0=±. 20			E_0=± .40			E_0=± .47		

M. is the mean.

E is the mean error of a single reading.

E_0 the probable error of the mean.

February 20th.—Clear mild day, thermometer 22°, light breeze across line of sight, no clouds, very little irregular refraction; altogether a nice day for good reading.

Base No. 1 Vertical.			Base No. 2 Vertical.			Base No. 3 Horizontal.			Distance by bases.	
Reading.	v	vv	Reading.	v	vv	Reading.	v	vv		
1=8′ 08″	+ .2	.04	1=8′ 08″.	−1.2	1.44	1=8′ 07″.8	−.5	.25	1st base	42.286 chs
2=8′ 06″.2	−1.6	2.56	2=8′ 08″.7	− .5	.25	2=8′ 07″.5	−.8	.64	2nd "	42.162 "
3=8′ 08″.5	+ .7	.49	3=8′ 09″.2	0.0	.00	3=8′ 08″.7	+.4	.16	3rd "	42.243 "
4=8′ 07″.	− .8	.64	4=8′ 10″.5	+1.3	1.69	4=8′ 08″.7	+.4	.16		
5=8′ 09″.5	+1.7	2.89	5=8′ 09″.5	+ .3	.09	5=8′ 08″.7	+.4	.16	Mean	42.23 "
M. 8′ 07″.8	E = ±	1″.29	M. 8′ 09″.2	E = ±	.″95	M. 8′ 08″.3	E = ±	.″58		
	E_o = ±	.40		E_o = ±	.30		E_o = ±	.18		

February 25th.—Clear and cold, thermometer 14°, a pretty strong wind blowing obliquely across line of sight. A good deal of irregular refraction in the lower atmosphere; images very unsteady. Not good readings.

Base No. 1 Vertical.			Base No. 2 Vertical.			Base No. 3 Horizontal.			Distance by bases.	
Reading.	v	vv	Reading.	v	vv	Reading.	v	vv		
1=8′ 08″.5	+1.3	1.69	1=8′ 01″.2	+1.6	2.56	1=8′ 07″.5	+.9	.81	1st base	42.330 chs.
2=8′ 06″.8	− .4	.16	2=8′ 00″.7	+1.1	1.21	2=8′ 06″.5	−.1	.01	2nd "	43.006 "
3=8′ 07″.5	+ .3	.09	3=7′ 59″.0	− .6	.36	3=8′ 06″.2	−.4	.16	3rd "	42.386 "
4=8′ 04″.5	−2.7	7.29	4=7′ 58″.3	−1.3	1.69	4=8′ 06″.0	−.6	.36		
5=8′ 08″.5	+1.3	1.69	5=7′ 59″.0	− .6	.36	5=8′ 07″.0	+.4	.16	Mean	42.574 "
M. 8′ 07″.2	E = ±	1.″65	M. 7′ 59″.6	E = ±	1.″24	M. 8′ 06″.6	E = ±	.″61		
	E_o = ±	.50		E_o = ±	.37		E_o = ±	.19		

I will continue these readings after I get a vernier on my instrument, and would be glad to know that some other member of the Association carried on similar experiments. It will be borne in mind that a 20-link base would give only half of the above errors, and the probable error of reading would probably be the same with it as a 10-link base.

A word or two now on the base and its fittings. The base may be of any convenient length, but the longer it can be made without being inconvenient the better the results, the errors being probably in the inverse of the ratio of the lengths of the bases. This would be strictly true were there no varying conditions, in the atmospheric moisture, temperature and density, all of which constitute the greatest barrier to reasonably uniform results with any form of Micrometer.

The discs should be of some material that will be well seen under the greatest number of possible conditions.

Now an opaque substance can be seen best by reflected light as when we are between the sun and it, but no matter how brilliant it is we can hardly see it distinctly when it is between the sun and us, or when its shaded side is towards us, and at long distances it becomes invisible altogether. To overcome this glaring defect, I used discs of a translucent material; painted glass—ground or opal glass would be as good, if not better.

For winter work coloured glass would have to be used, preferably I think light red. This substance can be seen much better by transmitted light than by reflected, but can be seen well in any position. A bad back ground of course will effect it as much as an opaque disc, and it is always well to have an artificial background such as a piece of black cloth, which the base man can attach to the base rod in the proper manner whenever desired to do so by a prearranged signal. A piece of clean white cotton or paper is not a bad substitute for glass. The manner of carrying the discs and attaching them to the base rod, each of us might devise for himself and each method be convenient enough.

Mr. Foster, of Toronto, has constructed for the Department of the Interior a style of frame and attachment which will be found as convenient as any. The frame holding the glass should be bevelled from the outside into the glass so that at the glass it may be but little thicker than the glass. In this shape it can always be held so that no part of the glass will be shaded by it. The base man should always hold the base so that the glass discs will be fully illuminated in sunshine, even if he has to turn the plane of the discs to quite a sharp angle to the line of sight. An inclination to the line of sight of 30° gives us visually one half of the surface of the disc and that, well illuminated, is better than the whole of it in the shade. When intended for use on a river or lake survey, the frame should be of light wood and of sufficient bulk to float the metal and glass attached to it, so that in case of accident one would not be deprived of his apparatus.

For extensive surveys of this kind the base rod should be made of well seasoned wood, and of such a form as to insure rigidity throughout the season. For this purpose I screwed two pieces of inch board together in the form of a **T** and although being alternately wet and dry it kept its straightness throughout the season.

I am convinced that better and more uniform results would be obtained by placing the base horizontally about six feet or more from the ground, than in any other position, but to so place a base would always entail a lot of extra trouble and some times would be very inconvenient if not impossible. The next best thing to do would be to have the base so made that when vertical the lower disc will not be less than six feet above ground. To enable the base man to set and hold the base vertically, I attached a plummet to it in the angle of the T, the bob of which was inclosed in a small box to protect it from the wind. A universal level bubble could be used but rough places would require more care.

Now as to the closeness of the results to the truth, I will say to those who have had little or no experience, *do not expect too much.* My experience justifies me in saying, that with care, making say three readings of the angle and using a fairly long base, not less than fifteen links in length, and in fair atmospheric conditions, distances of half a mile can be determined within five or six links of error; but take the same base on the same distance in a bad day and we may look for an error of fifty or sixty links or even more, and that too, though we use the utmost care.

It may be said that by observing in every possible state of the atmosphere and under all conditions possible of light and shade and contour of the ground that we could deduce very close corrections for each condition or combination. I think it would be nearly impossible to do this with any degree of certainty, the elements of disturbance entering the problem are so many and diverse; and apart from external disturbances our own nervous conditions enter the terms of the problem. Measuring Micrometer angles, where quantities that are barely perceptible come into prominent notice is just about as trying on our senses as any work we can attempt.

To illustrate:—An error of one second of arc in the angle subtended by a twenty link base at forty chains distance, gives an error of four links in the distance deduced Now one second of arc at forty chains subtends about ⅛ of an inch. I think most of us will concede that dealing with such small fractions of an inch at such a distance, is fine work, work that requires the most perfect condition of our faculties to give it justice: but we are not always in even normal condition, so that, external sources of error apart, there are sources of error within ourselves. When we come to consider and combine all the different conditions of atmosphere, density at different altitudes, the conditions due to different temperatures and degrees of moisture, the intensity of light and shade, I consider it impossibe to even make a table of corrections that will be anything but, in many cases, a very poor approximation. Notwithstanding all these objections there are many places where the Micrometer is invaluable; especially, in mountainous countries, where chaining would be difficult or impossible, the Micrometer comes in and promises closer results than the chain would give under the conditions; for it is in a rough, hilly country that we find the best conditions for Micrometer work—that is elevation above the lower disturbed stratum of air.

Traversing shores, where chaining would be tedious and inconvenient, by using a base of twelve or fifteen links and distances about twenty chains, the results would be almost, if not altogether, as close as chaining.

On extensive exploratory surveys it is just the instrument required. Its results can be approximatly checked by latitude observations from time to time, and it enables us to make a fairly reliable survey of a large extent of country in a season. About three hundred miles of ordinary river work can be averaged per month with it.

I will now consider some of the conditions which hinder us obtaining as close results as a theoretical consideration of the instrument would lead us to expect.

First, through its prominence, and from the fact that it is the only one we cannot conveniently modify, is refraction; not refraction as taught us and tabulated for our use, but refraction as we see it at work—up and down and across.

According to the theory of refraction, at first thought we would expect all vertical angles to be decreased by the difference of the refraction due to the altitudes of the points sighted on, but in practice we find this is not always so, more especially in warm, moist weather and when one of the points of sight is close to the ground and the line of sight is parallel, or nearly so, to the ground for some distance; then we find the angle increased and the law that "a ray of light in passing from a thinner to a denser medium is bent towards the denser" is still true because the heated atmosphere near the ground is less dense than the cooler above; consequently a ray of light emerging from this heated stratum of air is bent upwards to the cooler above, and the hotter and more moist the ground is, the greater the refraction.

The effect of this on a vertical base is, that the ray from the lower disc, if it is near the ground, is bent upwards as it rises to the eye this projects the image of the lower disc to a point lower than it really is, while the ray from the upper disc may travel through a stratum of uniform density and suffer little or no refraction. The consequence is the angle subtended by the base is apparently increased and the distance deduced from it shorter than the true distance. When the ground and the atmosphere are at the same temperature and the light rays travelling through an atmosphere of about the same density, there is probably no refraction and the Micrometer distances will show both plus and minus errors and be much nearer to the truth than on a hot day or after a hot time. Again when the ground is colder than the atmosphere refraction probably has the opposite effect to that in warm weather and the distances will very probably come out longer than the true distances. One thing has been often very apparent to me, on a hot day when the line of sight to the lower disc touched close to the ground at some point in the intervening distance the image of this disc would be refracted out of shape, often apparently being twice the depth of the upper one. *In such a case always make coincidence with the upper edges of the discs* as the lower edge of the lower disc has been refracted downwards and if you measure by it, you will find your distance away out. Often a mass of rock in the line of sight or a sharp knoll will have the same effect.

As I said earlier to produce the best results with a vertical base, have the base rod long enough to have the lower disc at least six feet above ground.

A horizontal base well above ground would be better- but even that is effected by irregular refraction in that we cannot read the angles so closely in a disturbed as in a quiet atmosphere, but whether or not there is a constant direction for the differences there may be, owing to the position of the sun and the direction of the wind with reference to the sight line, I do not yet know. On the three bases I have already alluded to, I got only three determinations and only one of those was at all disturbed by irregular refraction. For determination of that nature one would require variable weather as in the fall or spring when we might have it cool, clear and steady, or hot, dull and unsteady in a short interval of time. The other mischances of improper light and shade and bad back ground can, as I have already said be remedied by the baseman with proper appliances.

I will now give a list of distances as chained on my traverse survey and the same distances as determined by the Micrometer using an eight link base with discs of painted glass, five inches by eight. I will give no distances under twelve chains as at about that distance the forces of the telescope used was about normal; for shorter distances it was out of normal focus and the angles read on the circle would not be the true angles, it being graduated for the normal focal length, and I did not go to the trouble to reduce them to what they would be at normal focus. I will classify these distances under four widely different atmospheric conditions.

At first I thought of putting them under four atmospheric conditions and arranging them in grades of temperatures differing by ten degrees, beginning at thirty degrees Farenheit, and using all my available distances, but, I found this would entail a lot of work more than I had time for and I decided to arrange them under four atmospheric conditions and in grades of distance differing by five chains, beginning with 12–15 chains, then 15-20 chains, 20–25 chains and so on, and give as far as my records would permit ten distances in each grade and under each condition. This number will give an approximation to a correction, a little larger perhaps than it ought to be as the distances will be selected to show—except under accidental conditions—about the range of error, thus making the sum of errors greater relative to the sum of the distances they are deduced from, than they would be were all the distances taken, as one or two large errors in ten is a greater ratio than would be found were all the distances taken. All the Micrometer distances were with the exception of one or two, determined from a single reading. It must be borne in mind that an eight link base was used in all cases. Had I used a twenty link base at the longer distances, the probable error of the angular readings would have been about the same but the resulting errors would only be 40 per cent of what they are with the eight link base.

Also had I used larger discs I would probably have had less error in many cases, especially in the longer distances where they were some times difficult to see, particularly so in gloomy days.

d

CONDITIONS "HOT AND MOIST," TEMPERATURE 70° to 100° IN THE SHADE.

12—15 chs.			15—20 chs.			20—25 chs.			25—30 chs.		
Chain	Mic.	Error	Chain	Mic.	Error	Chain	Mic.	Error	Chain	Mic.	Error
14.19	13.91	−.28	17.67	17.52	−.15	24.47	24.06	−.39	28.68	28.47	−.21
12.31	12.37	+.06	17.80	17.82	+.02	20.19	19.97	−.22	26.01	25.01	−1.00
12.99	12.94	−.05	18.23	18.50	+.27	25.76	25.28	−.48	29.79	28.65	−1.14
13.18	13.18	.00	17.33	17.15	−.18	23.53	23.38	−.15	26.76	26.19	−.57
13.10	13.05	−.05	19.07	18.99	−.08	24.31	23.80	−.51	28.79	27.69	−1.10
13.78	13.76	−.02	15.67	15.66	−.01	22.15	22.03	−.12	25.84	25.23	−.51
13.01	13.03	+.02	16.73	16.42	−.11	20.55	20.30	−.25	27.17	26.61	−.56
13.28	13.26	−.02	17.33	17.27	−.06	20.93	20.56	−.37	29.65	29.00	−.65
12.35	12.38	+.03	18.87	18.78	−.09	23.29	23.00	−.29	26.97	26.70	−.27
13.75	13.79	−.04	19.78	19.65	−.13	21.45	21.33	−.12	25.55	25.37	−.18
131.95		−.35	178.48		−.52	226.63		−2.90	275.21		−6.19
per 40 chs.		.11	per 40 ch.		−.116	per 40 ch.		−.51	per 40 ch.		−.90
Reduced to 20 link base....			"		−.046	"		−.20	"		−.36

30—35 chs.			35—40 chs.			40—45 chs.			45—		
Chain	Mic.	Error	Chain	Mic.	Error	Chain	Mic.	Error	Chain	Mic.	Error
34.72	34.04	−.68	35.55	34.45	−1.10	44.84	44.40	−.44	60.32	*58.32	−2.00
32.48	31.68	−.80	36.12	*34.45	−1.67	40.48	39.92	−.56	45.82	45.41	−.42
34.91	34.53	−.38	39.12	38.37	−.75	41.86	*40.11	−1.75	47.91	*45.46	−2.45
32.30	31.79	−.51	35.56	34.27	−1.29	44.60	*41.77	−2.83	52.31	51.61	−.70
30.77	30.29	−.48	36.04	35.32	−.72	41.88	41.25	−.63	47.23	47.14	−.09
31.25	30.56	−.69	35.67	34.44	−1.23	42.42	41.99	−.43	52.31	51.61	−.90
35.32	34.97	−.35	35.55	34.45	−1.10	43.15	41.82	−1.33	47.30	46.62	−.60
32.65	32.01	−.64	35.26	34.14	−1.12	41.86	*40.11	−1.75	45.68	*44.21	−1.47
31.15	30.89	−.26	36.11	*34.45	−1.66	43.61	43.26	−.35	47.19	*45.83	−1.36
32.30	31.79	−.51	35.32	34.96	−.36	45.07	44.12	−.95	61.75	*60.45	−1.30
327.85		−5.30	360.30		−11.00	429.77		−11.02	507.81		−11.09
per 40 ch.		−.62	per 40 ch.		−1.22	per 40 ch.		−1.02	per 40 ch.		−.88
"		−.25	"		−.49	"		−.41	"		−.35

Those marked with an asterisk (*) were read in a very hot temperature; about 100° in shade.
The Condition "Hot and Moist" was when the sun was shining strongly after a heavy rain-fall.

per 40 chs. .11 Reduced to 20 link base...	per 40 ch. .116	per 40 ch. .51	per 40 ch. .90	per 40 ch. .62	per 40 ch. 1.22	per 40 ch. 1.02	per 40 ch. .88
	" .046	" .20	" .36	" .25	" .49	" .41	" .35

Those marked with an asterisk (*) were read in a very hot temperature; about 100° in shade.

The Condition "Hot and Moist" was when the sun was shining strongly after a heavy rain-fall.

Conditions "Hot and Dry" Temperature 65° to 100° in Shade.

12—15 chs. Chain	Mic.	Error	15—20 chs. Chain	Mic.	Error	20—25 chs. Chain	Mic.	Error	25—30 chs. Chain	Mic.	Error
13.63	13.64	−.01	15.52	15.52	.00	20.73	20.80	+.07	25.47	25.36	−.11
13.98	14.05	+.07	19.14	19.33	+.19	24.27	23.91	−.36	26.77	26.75	−.02
13.52	13.45	−.07	18.89	18.83	−.06	20.67	20.58	−.09	25.37	25.55	+.18
15.00	15.00	.00	17.19	17.22	+.03	20.36	20.27	−.09	25.85	26.05	+.20
12.99	12.99	.00	17.19	17.18	−.01	22.12	22.15	+.03	29.56	29.57	+.01
13.76	13.76	−.01	18.39	18.22	−.17	21.55	21.63	+.08	29.77	29.89	+.12
12.27	12.26	−.01	17.87	17.84	−.03	23.28	23.60	+.32	27.30	27.48	+.18
13.60	13.56	−.04	18.39	18.22	−.17	21.95	21.92	−.03	26.57	26.35	−.24
14.60	14.66	+.06	17.90	18.00	+.10	23.14	23.13	−.01	24.76	24.77	+.01
13.89	13.85	−.04	17.82	17.74	−.08	20.59	20.50	−.09	26.66	26.66	.00
136.70		−.06	178.30		−.20	218.74		−.17	268.08		−.38
per 40 ch.		−.01	per 40 ch.		−.045	per 40 ch.		−.031	per 40 ch.		−.056
Reduced to 20 link base...			"		−.018	"		−.012	"		−.022

30—35 chs. Chain	Mic.	Error	35—40 chs. Chain	Mic.	Error	40—45 chs. Chain	Mic.	Error	45— Chain	Mic.	Error
32.85	33.00	+.15	37.07	37.50	+.43	42.42	41.99	−.43	46.68	44.25	−1.43
32.61	32.29	−.32	36.42	36.35	−.07	41.39	40.69	−.70	49.60	48.53	−1.07
32.70	33.03	+.26	37.39	36.93	−.46	41.88	41.26	−.62	51.22	49.62	−1.60
31.15	30.90	−.25	36.60	36.25	−.35	42.73	42.97	+.24	61.75	60.45	−1.30
30.80	30.89	+.09	37.83	37.59	+.26	42.39	41.98	.41	54.79	53.85	−.94
31.53	31.58	+.05	37.94	37.46	−.48	40.88	40.80	−.08	46.86	45.88	−.98
33.43	33.57	+.14	36.55	36.46	−.09	40.78	40.34	−.44	51.53	50.89	−.64
30.13	30.37	+.24	35.59	35.64	+.05	44.78	44.48	−.30	45.99	45.68	−.31
31.83	31.82	−.01	35.57	34.49	−.08	44.90	44.76	−.14	56.50	55.94	−.56
34.91	34.45	−.46	36.87	37.04	+.17	43.30	43.66	+.36	66.93	66.15	−.78
322.01		−.09	367.30		−.44	425.48		−2.52	530.85		−9.61
per 40 ch.		−.01	per 40 ch.		−.048	per 40 ch.		−.24	per 40 ch.		−.72
"		−.004	"		−.019	"		−.096	"		−.29

The Condition "Hot and dry" was during a continuance of dry, hot weather.

CONDITION "COOL AND MOIST," TEMPERATURE FROM 30° TO 65°.

12—15 chs. Chain	Mic.	Error	15—20 chs. Chain	Mic.	Error	20—25 chs. Chain	Mic.	Error	25—30 chs. Chain	Mic.	Error
14.19	14.32	+.13	18.94	18.96	+.02	20.62	20.77	+.15	27.66	27.76	+.10
13.43	13.53	+.10	16.91	16.99	+.08	20.00	20.04	+.04	27.12	27.11	—.01
14.71	14.76	+.05	17.35	17.45	+.10	21.47	21.42	—.05	25.24	25.28	+.04
13.30	13.44	+.16	19.05	19.31	+.26	20.02	20.01	—.01	25.34	25.34	.00
14.72	14.76	+.04	15.62	15.68	+.06	21.22	21.27	+.05	26.21	26.25	+.04
13.08	13.12	+.04	17.32	17.33	+.01	21.95	21.97	+.02	27.88	27.91	+.03
14.40	14.40	.00	18.99	19.07	+.08	23.02	23.10	+.08	27.87	28.01	+.14
14.68	14.77	+.09	18.33	18.40*	+.07	24.87	24.82	—.05	28.14	28.25	+.11
14.71	14.76	+.05	17.51	17.50	+.01	22.12	22.12	.00	28.84	29.15	+.31
13.44	13.53	+.09	19.97	20.02	+.05	23.49	23.49	.00	27.21	27.18	—.03
140.66		+.75	179.99		+.74	218.78		+.23	271.51		+.73
per 40 ch.		+.21	per 40 ch.		+.16	per 40 ch.		+.04	per 40 ch.		+.11
Reduced to 20 link base....			"		+.06	"		+.016	"		+.044

30—35 chs. Chain	Mic.	Error	35—40 chs. Chain	Mic.	Error	40—45 chs. Chain	Mic.	Error	45— Chain	Mic.	Error
31.02	31.05	+.03	36.71	36.72	+.01	40.65	40.65	.00	59.55	58.96	—.59
33.90	33.82	—.08	39.74	39.81*	+.07	44.12	44.02*	—.10	78.34	79.71*	+1.37
34.04	34.24	+.20	34.01	33.96	—.05	42.73	42.70	—.07	56.73	56.43*	—.30
31.18	31.02	—.16							60.65	60.35	—.30
34.56	34.67	+.11							86.69	86.85	+.16
30.89	30.93	+.04							62.04	60.77	—1.27
30.52	30.56	+.04									
226.11		+.18	110.46		+.03	127.50		—.17	404.00		—.93
per 40 ch.		+.04	per 40 ch.		+.01	per 40 ch.		—.05	per 40 ch.		—.09
"		+.016	"		+.004	"		—.02	"		—.036

* These were read while it was raining. The Micrometer distance 79.71 was across the valley of the Eagle River, and was nearly all the distance 12 to 15 feet above ground.

* These were read while it was raining. The Micrometer distance 79.71 was across the valley of the Eagle River, and was nearly all the distance 12 to 15 feet above ground.

CONDITION "COOL AND DRY," TEMPERATURE 30° TO 60°.

12–15 chs. Chain	Mic.	Error	15–20 chs. Chain	Mic.	Error
14.32	14.43	+.11	16.68	16.79	+.11
12.54	12.60	+.06	17.51	17.60	+.09
13.20	13.25	+.05	19.14	19.17	+.03
12.87	12.96	+.09	16.17	16.20	+.03
14.60	14.65	+.05	16.01	15.97	−.04
13.89	13.94	+.05	15.98	16.06	+.08
14.22	14.29	+.07	18.45	18.53	+.08
			19.73	19.76	+.03
			17.76	17.81	+.05
			16.55	16.50	−.05
95.64		+.48	173.98		+.41
per 40 chs.		+.20	per 40 ch.		+.095
Reduced to 20 link base...			"		+.04

20–25 chs. Chain	Mic.	Error	25–30 chs. Chain	Mic.	Error
21.58	21.62	+.04	22.53	22.51	−.02
24.98	25.02	+.04	29.41	29.48	+.07
24.16	24.23	+.07	28.52	28.49	−.03
24.21	24.29	+.08	25.64	25.59	−.05
22.75	22.81	+.06	28.88	28.75	−.13
			25.51	25.67	+.16
			25.96	26.00	+.04
			28.32	28.10	−.22
			25.30	25.36	+.06
			23.27	23.22	−.05
117.68		+.29	263.34		−.17
per 40 ch.		+.10	per 40 ch.		−.02
"		+.04	"		−.01

30–35 chs. Chain	Mic.	Error	35–40 chs. Chain	Mic.	Error
33.90	33.84	−.06	38.44	38.76	+.32
33.75	33.75	.00	39.69	39.67	−.02
35.56	35.68	+.12	38.75	38.65	−.10
34.49	34.38	−.11			
33.50	33.64	+.14			
34.24	34.25	+.04			
205.44		+.17	116.88		+.20
per 40 ch.		+.032	per 40 ch.		+.07
"		+.013	"		+.028

40–45 chs. Chain	Mic.	Error	45— Chain	Mic.	Error
42.12	42.24	+.12	60.95	60.30	−.65
40.88	40.96	+.08	58.31	57.61	−.70
			46.79	46.39	−.40
			46.60	46.20	−.40
			53.54	53.36	−.18
			69.02	68.81	−.21
			121.41	*123.66	+2.25
			50.27	49.93	−.34
			66.35	66.35	.00
			52.00	51.35	−.65
83.00		+.20	625.24		−1.28
per 40 ch.		+.10	per 40 ch.		−.09
"		+.04	"		−.036

* This distance was across the valley of the Eagle River, and for over two-thirds of the way was from 20 to 35 feet above ground. It was taken at sun-down on a cool evening with the sun shining full on the discs: two readings, 2′ 13″.5 and 2′ 13″.75.

Taking the sum of the distances in each column and the algebraic sum of the Micrometer errors for each column and reducing the errors to what they would be were a 20 link base used, except under the condition hot and moist, nearly all the errors, reduced proportionally to 40 chs., come well within the 5 or 6 link limit I gave earlier. Taking the arithmetical sum of the errors, some of the errors so reduced would be increased a little. With one or two exceptions all the distances were deduced from one reading of the angle, two or three readings would probably have reduced the errors, and very likely a part of the error is due to the want of a vernier for reading the parts of divisions. Whatever part of the errors is due to errors of estimation of the parts of divisions, is probably pretty constant and always in the same direction. Summing the distances under each condition and the errors under the same condition, we get, under the first condition or "Hot and Moist," a total distance of 2438·00 chains and a total error of — 48·37 chains or an error of about one part in fifty short. This reduced to what it would have been had a 20 link base been used, we get a total error of — 19·35 chains or a correction under this condition of about one part in one hundred and twenty-five, to be added. Taking the same quantities under the condition "Hot and dry" we find a total distance of 2447·43 chains, with a total error of — 12·71 chains or an error of about one part in one hundred and ninety-two, short. This reduced to a 20 link base would give an error of — 5·08 chains or an error of about one part in four hundred and eighty chains, short. Under the condition "Cool and Moist" the total distance is 1679·01 chains with a total error of +1·56 or an error of about one part in one thousand and seventy-six, long. This reduced to a 20 link base gives 62 links of an error long or a correction of one part in about two thousand six hundred and ninety, to be subtracted. Under the condition "Cool and dry" the sum of the distances is 1765·4 chains and the algebraic sum of the errors 30 links which is practically nothing, being only one part in five thousand eight hundred and eighty five. The arithmetical sum would give a much larger error. Were all the columns filled up the errors would be much larger under the last two conditions but not beyond or even up to the limit I gave. Summing all the conditions we get a total distance of 8329·84 chains or 104 miles, with a total distance algebraic error of 59·24 chains of which 48·37 chains belong to the worst condition "Hot and Moist;" this total error reduced to a 20 link base would give an error of 23·69 chains in the total distance, or about one part in four hundred, of a correction to be added. I do not think the algebraic sum of the errors for the whole season and distance of 367 miles, would be nearly so large a ratio to the distance as this.

Taking the columns 40 to 45 chains under each condition, we find under "Hot and Moist" an aggregate distance of 429·77 chains and an aggregate error of 11·02 chains; this reduced to a 20 link base would be 4·41 chains or about 41 links error short to a half mile. Under "Hot and Dry" we have 425·45 chains distance and an algebraic total error of 2·52 chains; this reduced to a 20 link base gives an error of 1·008 chains, or about 9·5 links per half mile. The aggregate under "Cool and Moist" is 127·37 chains and an error of — 17 links; with a 20 link base this would give 7 links or about 2 links per half mile. The aggregate under "Cool and Dry" is 83 chains and an error of + 20 links; with a 20 link base this would be 8 links or about 4 links per half mile.

All these measurements were made along the line of the Canadian Pacific Railway when the heat radiated from the bare gravel, ties and rails, reminded one of———well, of the tropics, and caused a disturbance in the lower atmosphere that probably never would be experienced elsewhere: especially so after a heavy shower of rain or a wet day. The probability is I think strong that we would never find errors of the same magnitude on a survey of a grassy country or on a river or lake survey. Moreover, the errors on a river or lake survey would probably have a different sign from those of a survey on bare unsheltered ground, as the water is generally cooler than the atmosphere and the lower atmosphere cooler than a few feet above.

It will be noticed, in the long courses that three of the errors have the + sign; these were from the summit of one ridge to another across a valley, when the line of sight was from 15 to 35 feet above ground most of the way. Long distances measured on the same day on a level had the opposite sign.

A portion of the errors are no doubt due to errors of graduation of the instrument but I am not in a position to say how much, and as this paper has drawn out beyond the length I intended, I will now leave it to the members of the Association to draw their own inferences and make what use of it they may see fit, feeling that I am well rewarded for it, if I have added one idea to the general stock of knowledge and experience.

A TRAVERSE SURVEY.

By Otto J. Klötz., D.L.S.

By Traverse Survey the surveyor generally understands a rapid expeditious survey of a stream, using a compass and Rochon micrometer, or for better work a repeating instrument. The Traverse Survey of which I speak, more properly termed "Deflection Survey," is of a somewhat different nature, being a survey of precision instead of a mere meander.—I allude to the survey of the Canadian Pacific Railway, from the summit of the Rocky Mountains, across the Selkirk Range and to the Columbia River. This survey was made for continuing the system of land survey in the North-West, as it is impracticable to carry the system by projecting base lines and meridians over the mountains,—thus the Canadian Pacific Railway was made to serve as a base line for any survey along the same that may be required in future.

The instruments used were a six-inch decimally graduated reiteration transit with three verniers, a 66 foot steel band chain, a standard 100 foot steel band used only for comparison, a clinometer for grade, a thermometer for ascertaining temperature of the chain, a Lugeol micrometer and its target rod for checking the chaining.

The above six-inch transit of Troughton and Simms read to °.004 and by inspection to °.002. The telescope is provided with a vertical circle reading to °.02, and designed principally as a finder when observing stars in the day time. Besides the diagonal eye-piece it has several other eye-pieces, all inverting. In general the power of 20 was found the most serviceable. It may be remarked that the inverting eye-piece always gives better definition than an erecting one. The little inconvenience arising at first from using the former by seeing objects upside down is very soon overcome. The inverting eye-piece has fewer lenses than the erecting one thus making it shorter, and the telescope more compact. Its use should be encouraged amongst surveyors.

Regarding the magnifying power of a telescope I may give a simple rule in use by French opticians "Double the number of millimetres contained in the aperture of an instrument to find the highest magnifying power usefully applicable to it."

The merit of this instrument lies chiefly in the fact that it is a reiteration and not a repeating instrument. In consequence, it has one clamp and one tangent screw less than the other. In making a traverse survey with a repeating instrument the azimuth of the back sight can be set off on the lower limb, then by loosening the upper clamp and turning to the foresight gives directly the azimuth thereof (plus or minus 180° when reckoning azimuth always forward), but this assumes that the verniers read exactly alike which in no instrument whatever is always the case. It will thus readily be seen that it is better to read the angle of deflection and deduce the azimuth therefrom than to read it directly on the limb. By leaving the lower clamp clamped changes the repeating into a reiterating instrument. Of the two instruments of equal workmanship, the latter would even be preferable from a mechanical point of view, being composed of fewer parts.

The telescope has an aperture of 1 9/16 inches, whereby Polaris can be observed during day time, although rarely at mid-day.

The decimal graduation of the instrument is a stride towards simplification in computation, and will in time undoubtedly supplant the graduation into minutes and seconds.

The strong spring resting against the tangent screw prevents any lost motion affecting the reading of the verniers. The instrument has three verniers. Having two or more verniers placed at equi-distant points on the limb, eliminates the eccentricity of the graduated circle, and tends to reduce the effect of errors in graduation. If the probable error of one vernier reading, be a certain quantity, then for the mean of two or three or more verniers it will be inversely as the square root of the number of verniers. It is well to compare the vernier at different divisions of the circle to ascertain whether it covers an even number of divisions, if not, from the mean of the excess or deficiency a constant is obtained which is to be applied to any subsequent reading proportional to the vernier reading.

The trussed tripod with its broad head, is to be commended too for its greater stability.

A centring tripod head is very serviceable and a saving of time when one is obliged to set up the instrument on loose shaly or rocky ground, which very frequently happens along the railway.

It has often been a matter of wonder to me, the apparent apathy of manufacturers or surveyors or both, to bring into more general use the three leveling screws instead of the four. Three points support a plane. In leveling with four screws, one of them is apt to get off, and never will contact be so uniform as with three.

It is not necessary to dwell upon the construction of the steel band chain, thermometer and clinometer. Of the first I would remark though, as I have on a previous occasion, that it is preferable for good work to have the end marks on the band itself than the ends of the handles being the same. The marks for convenience should be close to the handles. The distinctive feature of the Lugeol Micrometer is essentially the object glass cut into halves, which are displaced in opposite directions by a Micrometer screw. The targets or discs on the rod are fixed, and in taking a reading for distance the halves of the object glass are displaced so much, until the image of the upper disc as seen by one of the semi-lenses is covered by the image of the lower disc as seen by the other semi-lens. In the first form of this instrument a graduated circle was attached, upon which the actual angular measurement was obtained and by a table of natural tangents the distance, but the graduation of the circle could only be adopted for a particular focus, whereas the new and modified form of the Micrometer dispenses with the circle and simply shows the number and parts of a revolution of the Micrometer head, and from a table especially constructed for the individual instrument the distance is readily obtained by interpolation.

THE WORK.

Before beginning the survey proper it will be necessary to ascertain the latitude of the initial point, say within a minute, as the latitude enters into the computation of the azimuth. It may be readily obtained from the altitude of the sun, Polaris or other star at transit; or when having a sidereal pocket chronometer, by transit of a star across the prime-vertical (the same star observed both east and west when near the zenith is preferable); or by observing Polaris at any hour angle when table IV on the last page of the American Ephemeris, which gives the distance above or below the pole for every five minutes of hour angle, may be applied and the desired latitude found.

These four methods were used on the work to suit the circumstances at the time.

In azimuth work the, absolute longitude of the place does not form so important a factor as the latitude. Its importance is principally confined in determining the declination of the sun, when observing on that body. Good azimuth work can only be done by stellar observation, for which Polaris is almost exclusively used, and not by observing on the sun.

For elucidation of the formula employed (which is the one given in the Manual) for the determination of azimuth, the following is given:—

General equation in spherical trigonometry:—

$$\text{Cos } a = \text{Cos } c \text{ Cos } b + \text{Sin } c \text{ Sin } b \text{ Cos } A$$

$$= \text{Cos } c \text{ Cos } a \text{ Cos } c + \text{Cos } c \text{ Sin } a \text{ Sin } c \text{ Cos } B + \text{Sin } c \text{ Sin } B \text{ Sin } a \text{ Cot } A$$

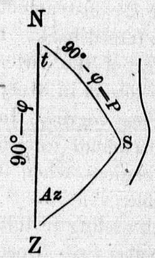
$$= \text{Cos } a - \text{Cos } a \text{ Sin}^2 c + \text{Cos } c \text{ Sin } a \text{ Sin } c \text{ Cos } B + \text{Sin } c \text{ Sin } B \text{ Sin } a \text{ Cot } A$$

$\div$ by Sin a Sin c

$$\therefore \text{Sin } c \text{ Cot } a = \text{Cos } c \text{ Cos } B + \text{Sin } B \text{ Cot } A$$

$$\text{hence Cot A} = \frac{\text{Sin } c \text{ Cot } a - \text{Cos } c \text{ Cos } B}{\text{Sin } B}$$

$$\text{and tan A} = \frac{\text{Sin } B}{\text{Sin } c \text{ Cot } a - \text{Cos } c \text{ Cos } B}$$



Referring to the triangle we have

$B=t$

$c=90°-\varphi$

$a=P$

$A=Az$

By substitution

$$\tan Az=\frac{\text{Sin } t}{\text{Cos } \varphi \text{ Cot } P-\text{Sin } \varphi \text{ Cos } t}$$

Multiplying by

$\tan P \text{ Sec } \varphi$

$$\tan Az=\frac{\tan P \text{ Sec } \varphi \text{ Sin } t}{1-\tan P \tan \varphi \text{ Cos } t}$$

which is the desired formula.

From my experience I place little reliance upon the rate of a pocket chronometer, subjected as it unavoidably is to many vicissitudes, and hence always observed for time when possible, before or after the one for azimuth. The time observation was made by observing Polaris and then another star in the same vertical plane. The Nautical Almanac or American Ephemeris furnishes a sufficient number of stars for this purpose. The reduction is made by means of the formula in the manual. Having thus his sidereal time well determined, with well adjusted instrument the surveyor can do good azimuth work, whatever the hour angle of Polaris.

Both the azimuth and time formulæ are to be highly commended.

The azimuth of the initial line having thus been determined the picket-man goes ahead to select the next station, having due regard for the next following sight (for the railway through the mountains is anything but straight), having selected the station, he drives in firmly a hub, wherever he holds the picket, which is not shod, but instead has a nail driven into the foot, projecting about a quarter of an inch and finely pointed. The instrument being carefully centred over one extremity of the initial line is turned to the right and cautiously brought up to the picket at the initial point, then clamped and the picket centred by the tangent screw. I emphasize the word "cautiously," for the instrument should never be turned past the picket and then turned back. I have so repeatedly made observations of the effect of the latter that I make the above statement. There is torsion in every instrument; in some to a greater, in some to a less degree. In the particular instrument under discussion, the maximum torsion was reached by three complete continuous revolutions, when it amounted to 0°·014, thereafter it was inappreciable.

Next the three veriners are read, noting each reading in full, not only the one, and giving the decimals of the other two. Such extreme precaution would not be necessary were it not for the continuous and varying change of azimuth. Each vernier should be read under the same condition of light, that is shaded; the microscope well adjusted and over the contact of vernier and limb, the reading should be taken leisurely, not hurriedly, for in the latter case contact will apparently be where in reality it is not, for it takes a moment or so for the eye to adjust itself to read accurately.

The verniers having now been read and recorded the instrument is unclamped and continued turning to the right, to the forward picket, and the readings there taken; then the telescope is inverted, the instrument turned to left to first picket, read, then continued to left to forward picket. Thus twelve readings are taken at each station, six for foresight and six for backsight; the mean of the latter subtracted from the mean of the former gives the deflection, which is reckoned to the right and up to 360°. This method of using the instrument was found to give the best results.

Besides the discrepancies that may arise from centring over station, pointing, inaccurate vernier readings, or torsion, there is another one: that caused by the disparity of distance between the fore and backsight, whereby it is necessary to change the focus of the telescope. If the tube move not parallel the line of collimation will be changed and thus affect the true deflection. Unless the difference of distance was large I preferred not changing the focus.

The instrument was always centred over the small hole left in the hub by the sharp point of the picket. Before removing the instrument to the next station, the picket to serve as back-sight was always set by myself. It was about 18 inches long with a tapering head whereon a small cross to distinguish it, it was planted near the hub and accurately in line with the plummet string and forward picket (on the hub).—

Some sights were very short, less than three chains. The tunnels are mostly all on curves and in many artificial illumination had to be resorted to for picket and cross-hairs. A day's good work would be to occupy 25 stations.

I have found by experience that, starting with an observation on Polaris for azimuth, and thereafter occupying say 100 stations, the azimuth of the last course deduced from the deflections, allowing for convergance of meridians, will be more nearly the true value than one obtained by direct observation of the sun for that course. Nevertheless solar observations were frequently taken, simply as checks on the work, especially when the weather was unfavorable for observing Polaris, but never for determining the absolute azimuth of a line.

Micrometer readings were taken at each station as a check upon the chaining. The bases on the Micrometer target rod were 10 and 15 links. The opal glass targets were found to serve their purpose well, being visible when judiciously used or turned for any position of the sun. In using the Micrometer it was found convenient to rest it upon the top of the instrument. In this as with the other instrument uniformity of use was adhered to, viz., forward motion to contact, read, then past and back to the other contact, thus destroying the effect of lost motion if any between the two readings. The readings were read continuously from one end of the scale, and not from the middle both ways.

The difference between the two readings gives twice the number of revolutions, from which the distance is deduced. For long sights the operation would be repeated. It might have been remarked that at the beginning of the survey a base line of 30 chains (the longest available there) was carefully measured and divided into 5 chain spaces, at the end of each of which numerous Micrometer readings were taken from one extremity of the base, which served the purpose of constructing a table from which the value of any subsequent reading could be taken by inspection. At the close of the survey a redetermination was made to ascertain whether any change had taken place by use. In this redetermination readings were taken including and excluding lost motion (if any). I subjoin the three tables, also a list of readings taken at random out of the field books and their corresponding chained distances. During the survey three errors in chaining were detected by the Micrometer, one of a chain plus, one of a chain minus, and the other having been read from the wrong end of the chain 45 instead of 65 links.

Theoretically better results would be obtained if the target rod were held horizontal and at right angles to the line of sight thereby elliminating differential refraction, but the difficulty of eesuring the latter condition combined with the greater inconveenience of visibility along a wooded shore line, or say on a line cut through the woods renders this method impracticable.

My method of bringing the discs to contact has been to hold the telescope not quite in the plane of the rod so that when the discs overlap a small portion of each will not be covered and the discs being of opal glass this is distinctly seen by the differenc of color, and perfect contact becomes known when the upper and lower edges appear as straight lines. This manner is more expeditious than taking readings of lower and upper edge contact, and fully as accurate.

Were the focus the same for all distances then the distances would be exactly proportional to the revolutions of the Micrometer, but as the focus changes so must the proportion.

It is therefore important, that in constructing a table from a measured base line, to focus the instrument well for each reading at the different divisions of the base line, and when at work afterwards to observe the same precaution, so that the distances deduced will correspond with the tabular ones using a stadia with two targets together with a telescope provided with a diaphragm carrying two parallel threads, one fixed and the other moveable by a Micrometer, for determining distances, the distance determined is from the object glass of the telescope, whereas in the Micrometer under discussion the distance is increased from the inside focus of the object glass.

To make a comparison of the relative value of the Lugeol micrometer with stadia work, as above referred to, I quote from the report of the Northern Boundary Commission on the delineation of the forty-ninth parallel of latitude, in which work the topography was filled in by Stadia measurements:

"The work, in 1874, was all done by experienced assistants, and under the ordinary circumstances to be met on the plains, that is, a high wind and 'boiling' of the air on three days out of five. The error is seen to be about $\frac{1}{400}$. This I take to be the greatest accuracy that can be expected for a whole season's work, when the party is so pressed for time that it cannot lie over on windy days . . . . As the result of our experience, then, the average accuracy of surveys with the Stadia is $\frac{1}{300}$, under good circumstances we may expect $\frac{1}{400}$, and on selected days, with great care, $\frac{1}{1000}$ can be obtained. This shows that this method is available for surveys for maps of a scale of $\frac{1}{10000}$ or about six inches to the mile. . . . General Comstock, in charge of the Lake Survey, states that . . On rough and broken ground the stadia was equal to the chain in precision, and on bad ground was superior."

From a comparison of my actual distances with those obtained by the micrometer there results a probable error of links in half a mile, or about 1 in 700, under ordinary atmospheric circumstances, none especially bad. This assumes the chained distances as absolute. The superiority of the Lugeol over the stadia is thus very apparent, and especially when we consider its greater adaptability for exploratory work on rivers or lakes, for which purpose it is most earnestly recommended.

The temperature of the chain was generally taken four times per day, and the corrections made from the standard of 60° F.

Chaining is apparently a simple operation, but to chain accurately over shaly, or broken rock or loose gravel ballast requires the utmost care to insure good results. When obliged to chain off an embankment the plummet was invariably used.

The largest correction for grade as determined by the clinometer was one-tenth link per chain, this was only on a short distance on the heavy grade (4½%) on the west slope of the Rocky Mountains. A table for grade corrections was prepared so that the necessary quantities could be taken out by inspection.

The topography was noted by the assistant who had charge of the chaining. Azimuth readings were taken on prominent mountain peaks, also their elevation, and in both positions of the instrument. This latter should be made an invariable rule by surveyors, that is to use the instrument first circle right and then circle left, for it, to a great extent, eliminates instrumental deviations.

A word about the detemination of the position and heights of mountains. As very few mountains rise as simple cones above the earth's surface presenting a well defined peak whatever the direction of sight, the difficulty arises of identifying the point at the summit sighted at one station when occupying another station, for the purpose of determining its position in Azimuth. When more than two stations have been occupied and Azimuth readings taken, after plotting the same carefully the probable position of the summit will be the centre of gravity of the intersections of the lines of sight. But a more serious obstacle is the fact that frequently we are so close under the mountain that we can not really see its highest peak, and it is found in consequence that where several determinations of the altitude have been made from different stations, after making due allowance for the difference in level of the stations yet the results differ, and probably by a 100 feet or even more, and the reason is attributable to the cause just referred to. In such cases, having due regard to the Azimuth results, the highest altitude obtained is most likely to be the best result for the true value.

Refraction should always be considered in order to convert apparent to true angular altitude.

It must be borne in mind that in this survey the mountains were of secondary consideration, the geographical position of the railway being the primary one. Had it been otherwise their triangulations would have been made from peak to peak at high elevations, and the horizon swept by the telescope and the relative altitudes more readily obtained.

OBJECT GLASS OVER STATION.

Table 1.

Distance.	Micrometer Readings. 15 link base.		Revolutions.	Equivalent for 1 chain.
Chs				
1			38.5400	38.5400
2			19.2700	38.5400
3			12.8467	38.5400
4	0.353	19.623	9.6350	38.5400
5	2.280	17.696	7.7080	38.5400
6	3.566	16.412	6.4230	38.5380
7	4.484	15.495	5.5051	38.5360
8	5.174	14.807	4.8168	38.5340
9	5.710	14.272	4.2813	38.5320
10	6.139	13.845	3.8530	38.5300
11	6.488	13.497	3.5045	38.5490
12	6.779	13.207	3.2140	38.5680
13	7.026	12.962	2.9682	38.5870
14	7.237	12.752	2.7576	38.6060
15	7.420	12.570	2.5750	38.6250
16	7.582	12.409	2.4134	38.6140
17	7.726	12.267	2.2708	38.6030
18	7.853	12.141	2.1440	38.5920
19	7.967	12.029	2.0306	38.5810
20	8.070	11.927	1.9285	38.5700
21	8.161	11.836	1.8374	38.5860
22	8.243	11.753	1.7546	38.6020
23	8.319	11.677	1.6790	38.6180
24	8.388	11.607	1.6097	38.6340
25	8.451	11.543	1.5460	38.6500
26	8.511	11.485	1.4874	38.6720
27	8.566	11.432	1.4331	38.6940
28	8.617	11.383	1.3827	38.7160
29	8.665	11.337	1.3358	38.7380
30	8.710	11.294	1.2920	38.7600

Table 2.

Distance.	Revolutions. 15 lks. base.	Revolutions. 10 lks. base.
Chs		
1	38.3650	25.6450
2	19.1825	12.8225
3	12.7883	8.5483
4	9.5912	6.4112
5	7.6730	5.1290
6	6.3962	4.2758
7	5.4825	3.6650
8	4.7972	3.2069
9	4.2642	2.8506
10	3.8390	2.5665
11	3.4891	2.3270
12	3.1988	2.1331
13	2.9523	1.9690
14	2.7414	1.8284
15	2.5580	1.7020
16	2.4006	1.6009
17	2.2594	1.5068
18	2.1339	1.4231
19	2.0216	1.3482
20	1.9225	1.2850
21	1.8321	1.2229
22	1.7489	1.1673
23	1.6728	1.1166
24	1.6031	1.0701
25	1.5400	1.0265
26	1.4788	.9862
27	1.4241	.9497
28	1.3732	.9158
29	1.3259	.8842
30	1.2800	.8540
31	1.2375	.8265
32	1.1988	.8006
33	1.1625	.7764
34	1.1283	.7535
35	1.0950	.7320
36	1.0684	.7158
37	1.0395	.6965
38	1.0122	.6782
39	.9862	.6608
40	.9650	.6480

Table 3.

Distance.	Revolutions. 15 lks. base.	Revolutions. 10 lks. base.
Chs		
1	38.3225	25.6425
2	19.1612	12.8212
3	12.7742	8.5475
4	9.5806	6.4106
5	7.6645	5.1285
6	6.3910	4.2752
7	5.4780	3.6645
8	4.7933	3.2064
9	4.2607	2.8501
10	3.8370	2.5660
11	3.4875	2.3278
12	3.1959	2.1339
13	2.9510	1.9697
14	2.7402	1.8290
15	2.5570	1.7035
16	2.3986	1.6007
17	2.2575	1.5065
18	2.1321	1.4228
19	2.0199	1.3480
20	1.9200	1.2835
21	1.8265	1.2228
22	1.7435	1.1672
23	1.6677	1.1165
24	1.5982	1.0699
25	1.5325	1.0275
26	1.4755	.9852
27	1.4209	.9487
28	1.3701	.9149
29	1.3229	.8833
30	1.2805	.8515
31	1.2408	.8247
32	1.2021	.7989
33	1.1656	.7747
34	1.1314	.7519
35	1.1005	.7310
36	1.0744	.7137
37	1.0454	.6944
38	1.0179	.6761
39	.9918	.6588
40	.9710	.6450

In these tables no second interpolations were made, which in a rigorous computation would be applied. Table I. was deduced at commencement of survey, when the instrument was new, and Tables II. and III. at close of survey. With Table II. there is right and left motion of screw to contact "not past;" with Table III. there is right and left motion of screw to contact the reading taken, then turned "past" and reversed, to eliminate lost motion, if any, in head of screw. A careful redetermination of the target rod at the end of the survey showed the wood to have shrunk longtitudinally, on the 15-link base, one-thirtieth of an inch, and on the 10-link base, one-fiftieth of an inch. To compare Tables II. and III. with Table I. the small correction resulting therefrom should be applied.

Table 4.

Stations.	Chained Distance.	Micrometric Distance.	Stations.	Chained Distance.	Micrometric Distance.
	Chains.	Chains.		Chains.	Chains.
39–40.......	10.375	10.388	376–377.....	3.625	3.613
98–99.......	9.948	9.959	672–673.....	4.669	4.673
113–114.....	3.750	3.754	701–702.....	15.665	15.676
178–179.....	14.623	14.650	714–715.....	22.217	22.188
182–183.....	25.043	25.024	735–736.....	13.508	13.481
211–212.....	19.026	19.000	798–799.....	35.508	35.494
254–255.....	4.835	4.814	1020–1021...	7.822	7.824
262–263.....	4.146	4.145	1030–1031...	3.485	3.481
347–348.....	11.315	11.341	1045–1046...	10.468	10.402
355–356.....	16.620	16.598	1062–1063...	27.939	27.966

Table IV. gives a number of distances as measured by the steel band, and the ones as deduced from the micrometer readings. They have been taken at random out of a number of field books. There were very few long sights on the whole survey, and there were a few instances when the heat was so great that the micrometic readings could not be depended upon on account of the apparent unsteadiness of the targets. The table represents, I think, what may be expected of this form of micrometer under ordinary favorable circumstances, including care in reading. Reducing the measurements to the standard of 40 chains, then from the residuals we find the probable error of one measurement of 40 chains to be $+$ ·058 chains, say 6 links per 40 chains.

The actual and micrometric distances in the above table agree better, undoubtedly, than if the measurements were made over hills and rough ground, where reduction to the horizontal would be necessary, and errors would arise from differential refraction. But over very rough ground I would place more reliance upon the micrometer than upon ordinary chaining. It must be remembered, however, that on the survey the micrometer was only used as a check for bulk errors, and when used on exploratory surveys (as used by me to Hudson's Bay, in 1884) for determining the absolute distance and no chaining is done, more readings and additional care are taken, and its merits are more fully realized.

In the determination of the heights of mountains the following problem occurred on the above-described traverse:

Given the altitude (angular) of a point C above two given points A and B not on the same level, but height of B over A known, also horizontal distance between them, and the angle CAB.

To find the height of C and distance:

Set $AB'=b$.

$BB'=AA'=d$.

angle $CAD=\theta$.

angle $CBD'=\varphi$.

angle $CAB=a$.

We have (after construction of figure, passing horizontal planes through A and B and joining EB.)

E the intersection of the traces of the vertical plane CAB and the oblique plane CEA the oblique plane CEA on the horizontal plane $D'A'B$, and $EA'=d \text{ Cot } \theta$.

In triangle $EA'B$ are given EA', $A'B$, and angle $EA'B$; hence are found EB, angle $A'EB$ or $D'EB$ and EBA'. In triangle $ED'B$.

$$D'E : D'B :: \text{Sin } D'BE : \text{Sin } D'EB$$

$$\therefore \text{Sin } DB'E = \frac{D'E}{D'B} \text{ Sin } D'EB$$

but

$$\frac{CD}{AD} = \frac{CD'}{ED'} = \text{tan. } \theta.$$

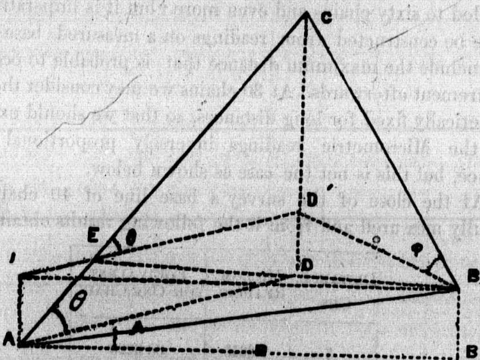
and
$$\frac{CD'}{BD'} = \text{tan. } \varphi.$$

$$\therefore \quad \frac{D'E}{D'B} = \frac{\text{tan. } \varphi}{\text{tan. } \theta}$$

whence

$$\text{Sin } D'BE = \text{Sin } D'EB \frac{\text{tan. } \varphi}{\text{tan. } \theta}$$

and thence in same triangle $D'B$ is found, also ED' and consequently CD', CD and AD obtained.



ADDENDUM, APRIL 1887.

Nearly the whole of the above article was written while out in the field. I have just prepared a more extensive table for a comparison of micrometric with chained distances.

In order to cover the whole of the survey, and the various conditions of the atmosphere and times of the day the first four courses were taken out of every one of the 21 field books, and in several instances one or two more making together 87 readings and distances. Of all these courses none were rejected, so that whatever resultant or inference may be obtained therefrom will be a very fair representative of the whole work.

Subtracting the micrometric from the chained distances we find 41 plus residuals and 46 with minus sign, showing that the same are nearly distributed.

From the continuous sinuosity of the railroad the distances of the greater number of courses are short. This tends to aggravate the probable error of a determination from the uncertainty of centering Micrometer over station. (The manner in which this was done has already been described.) The greater number of the short distances were read on the ten-link base, the others on the fifteen-link base of the target rod. The time of survey was from the middle of May to the middle of July.

Using a twenty-link base, measurements may be readily extended to sixty chains and even more; but it is imperative that a table be constructed from readings on a measured base line so as to include the maximum distance that is probable to occur for measurement afterwards. At 30 chains we may consider the focus as practically fixed for long distances, so that we should expect to find the Micrometric readings inversely proportional to the distance, but this is not the case as shown below.

At the close of the survey a base line of 40 chains was carefully measured and from it the following results obtained.

Distance. Chs.	Microm. Reading.	Equivalent for One Chain.
5	7·6645	38·3225
10	3·8370	38·3700
15	2·5570	38·3550
20	1·9200	38·4000
25	1·5325	38·3125
30	1·2805	38·4150
35	1·1005	38·5175
40	·9710	38·8400

This disparity is undoubtedly attributable to differential refraction between the upper and lower discs, but with a properly constructed table its effect will in a great measure be eliminated and not affect the deduced distance.

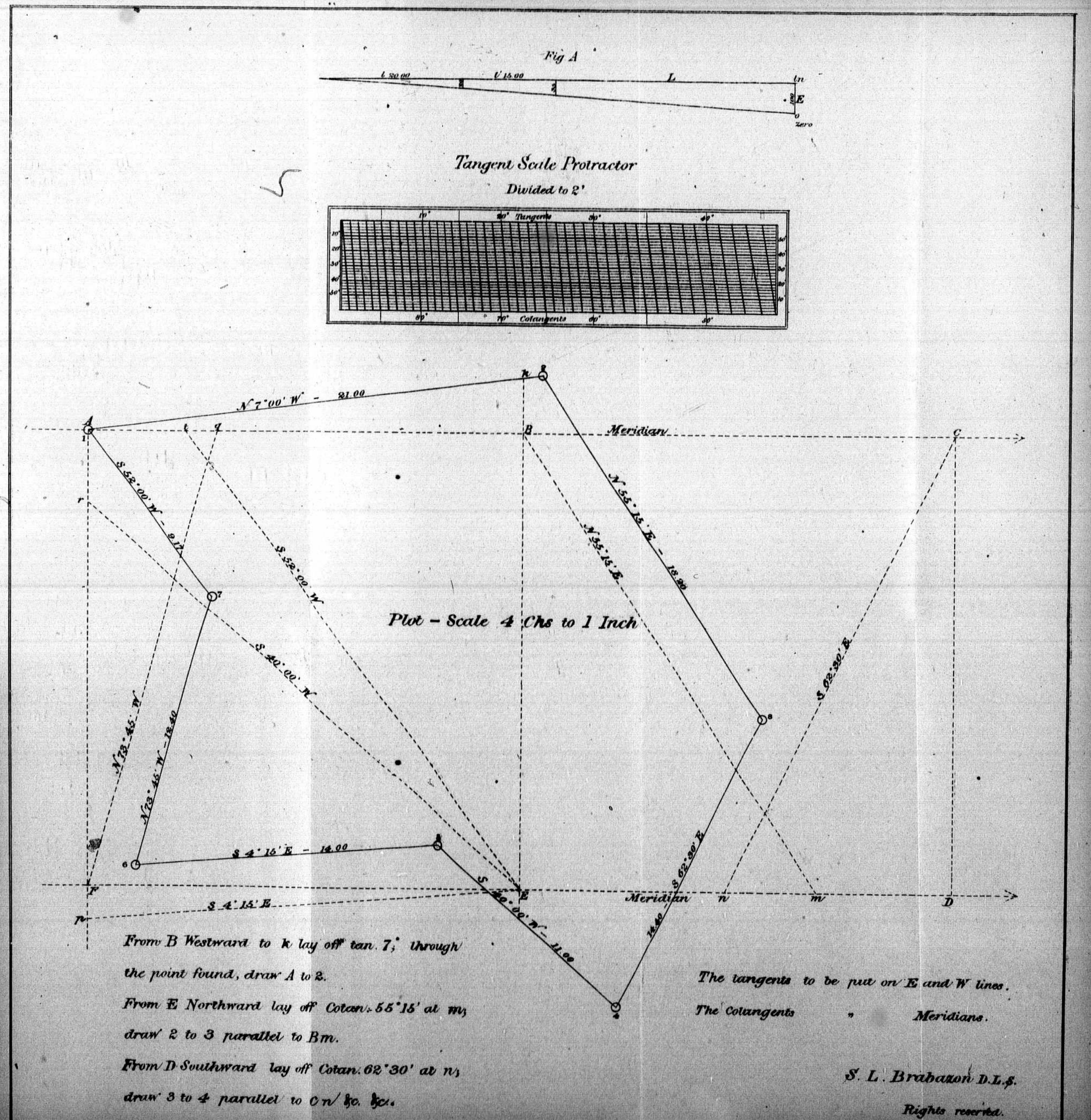
Micrometer Reading.	Micrometer Distance.	Chained Distance.	Residual.	Residual reduced to base of 40 Chains.	v v	Micrometer Reading.	Micrometer Distance.	Chained Distance.	Residual.	Residual reduced to base of 40 Chains.	v v
4·0485	9·518	9·502	—·016	—·067	·0045	2.11	12.208	12·127	—·081	—·270	·0729
2.462	15.686	15.693	+.007	+.016	.0003	5.012	5.128	5.126	—.002	—.015	.0002
1.994	19.349	19.376	+.027	+.055	.0030	6.19	4.148	4.150	+.002	+.019	.0004
8.015	3.201	3.185	—.016	—.208	.0432	5.612	4.579	4.584	+.005	+.045	.0020
1.945	19.830	19.791	—.039	—.078	.0061	7.40	3.469	3.480	+.011	+.130	.0169
2.389	16.164	16.184	+.020	+.050	.0025	2.225	11.575	11.554	—.021	—.073	.0053
4.276	9.012	8.999	—.013	—.057	.0032	3.37	7.635	7.623	—.012	—.064	.0041
4.7295	8.150	8.144	—.006	—.030	.0009	2.455	10.487	10.466	—.021	—.080	.0064
4.028	6.385	6.383	—.002	—.013	.0002	1.471	17.556	17.481	—.075	—.170	.0289
4.68	5.494	5.489	—.005	—.037	.0014	1.62	15.923	15.918	—.005	—.013	.0002
4.76	8.097	8.100	+.003	+.015	.0002	2.124	12.128	12.143	+.015	+.049	.0024
3.269	11.798	11.816	+.018	+.062	.0038	2.708	9.506	9.514	+.008	+.034	.0012
3.448	11.181	11.205	+.024	+.085	.0072	2.990	12.906	12.929	+.023	+.071	.0050
2.074	18.605	18.630	+.025	+.054	.0029	5.984	6.441	6.443	+.002	+.013	.0002
9.925	3.880	3.891	+.011	+.113	.0127	2.288	16.872	16.873	+.001	+.002	.0000
2.917	13.229	13.283	+.054	+.162	.0262	.894	43.362	43.298	—.064	—.058	.0034
1.792	21.537	21.636	+.099	+.184	.0339	5.65	4.548	4.586	+.038	+.331	.1096
6.43	3.994	4.013	+.019	+.190	.0361	1.2995	19.907	19.809	—.098	—.196	.0384
5.855	4.388	4.385	—.003	—.027	.0007	6.225	4.126	4.134	+.008	+.077	.0059
1.40875	27.474	27.555	+.081	+.121	.0146	6.652	3.860	3.866	+.006	+.062	.0038
8.057	4.783	4.781	—.002	—.017	.0003	2.2875	16.876	16.854	—.022	—.054	.0029
7.636	5.047	5.055	+.008	+.063	.0040	6.385	6.037	6.035	—.002	—.013	.0002
3.765	10.234	10.220	—.014	—.055	.0030	2.575	15.000	14.988	—.012	—.032	.0010

Microm. Reading.	Microm. Distance.	Chained Distance.	Residual.	Residual reduced to base of 40 Chains.	v v	Microm. Reading.	Microm. Distance.	Chained Distance.	Residual.	Residual reduced to base of 40 Chains.	v v
4.524	8.519	8.514	—.005	—.024	.0006	6.65	3.862	3.864	+.002	+.021	.0004
5.266	4.880	4.878	—.002	—.016	.0003	2.46	10.467	10.503	+.036	+.137	.0188
3.401	7.566	7.565	—.001	—.005	0000	8.054	3.186	3.193	+.007	+.089	.0079
5.028	5.112	5.099	—.013	—.102	.0104	1.925	13.385	13.384	—.001	—.003	0000
4.047	6.357	6.355	—.002	—.013	.0002	2.246	17.187	17.119	—.068	—.158	.0250
1.660	23.264	23.291	+.027	+.046	.0021	1.91	20.194	20.239	+.045	+.089	.0079
4.295	8.972	8.958	—.014	—.062	.0038	1.79	21.561	21.490	—.071	—.132	.0174
4.885	7.890	7.881	—.009	—.046	.0021	1.5965	24.199	24.201	+.002	+.003	.0000
2.349	10.963	10.925	—.038	—.141	.0199	1.929	19.995	20.055	+.060	+.120	.0144
4.156	6.188	6.205	+.017	+.110	.0121	5.911	4.346	4.324	—.022	—.209	.0437
6.369	4.032	4.040	+.008	+.080	0064	7.374	3.481	3.475	—.006	—.070	.0049
1.734	22.262	22.217	—.045	—.081	.0066	1.54	16.762	16.695	—.067	—.159	.0253
3.206	8.024	8.039	+.015	+.074	.0055	1.602	24.116	24.208	+.092	+.152	.0231
6.595	3.894	3.893	—.001	—.010	.0001	4.925	7.825	7.822	—.003	—.015	.0002
2.415	15.989	15.894	—.095	—.252	.0635	1.512	25.569	25.640	+.071	+.110	.0121
.813	47.684	47.640	—.044	—.037	.0014	3.345	11.528	11.543	+.015	+.052	.0027
6.857	3.744	3.751	+.007	+.075	.0056	2.936	13.143	13.090	—.053	—.160	.0256
3.402	7.563	7.534	—.029	—.154	.0237	1.872	20.608	20.626	—.018	+.085	.0012
5.755	4.464	4.465	+.001	+.009	.0001						.9799
3.45	7.458	7.426	—.032	—.170	.0289						
.953	40.677	40.505	—.172	—.170	.0289						
7.736	4.977	4.984	+.007	+.056	.0031						
4.068	9.472	9.462	—.010	—.042	.0018						

Hence the probable error of a single micrometric determination of 40 chains $= \pm^{ch} .07$.

Microm. Reading.	Microm. Distance.	Chained Distance.	Residual.	Residual reduced to base of 40 Chains.	v v	Microm. Reading.	Microm. Distance.	Chained Distance.	Residual.	Residual reduced to base of 40 Chains.	v v
4.524	8.519	8.514	—.005	—.024	.0006	6.65	3.862	3.864	+.002	+.021	.0004
5.266	4.880	4.878	—.002	—.016	.0003	2.46	10.467	10.503	+.036	+.137	.0188
3.401	7.566	7.565	—.001	—.005	0000	8.054	3.186	3.193	+.007	+.089	.0079
5.028	5.112	5.099	—.013	—.102	.0104	1.925	13.385	13.384	—.001	—.003	0000
4.047	6.357	6.355	—.002	—.013	.0002	2.246	17.187	17.119	—.068	—.158	.0250
1.660	23.264	23.291	+.027	+.046	.0021	1.91	20.194	20.239	+.045	+.089	.0079
4.295	8.972	8.958	—.014	—.062	.0038	1.79	21.561	21.490	—.071	—.132	.0174
4.885	7.890	7.881	—.009	—.046	.0021	1.5965	24.199	24.201	+.002	+.003	.0000
2.349	10.963	10.925	—.038	—.141	.0199	1.929	19.995	20.055	+.060	+.120	.0144
4.156	6.188	6.205	+.017	+.110	.0121	5.911	4.346	4.324	—.022	—.209	.0437
6.369	4.032	4.040	+.008	+.080	0064	7.374	3.481	3.475	—.006	—.070	.0049
1.734	22.262	22.217	—.045	—.081	.0066	1.54	16.762	16.695	—.067	—.159	.0253
3.206	8.024	8.039	+.015	+.074	.0055	1.602	24.116	24.208	+.092	+.152	.0231
6.595	3.894	3.893	—.001	—.010	.0001	4.925	7.825	7.822	—.003	—.015	.0002
2.415	15.989	15.894	—.095	—.252	.0635	1.512	25.569	25.640	+.071	+.110	.0121
.813	47.684	47.640	—.044	—.087	.0014	3.345	11.528	1[illegible]543	+.015	+.052	.0027
6.857	3.744	3.751	+.007	+.075	.0056	2.936	13.143	13.090	—.053	—.160	.0256
3.402	7.563	7.534	—.029	—.154	.0237	1.872	20.608	20.626	—.018	+.085	.0012
5.755	4.464	4.465	+.001	+.009	.0001						.9799
3.45	7.458	7.426	—.032	—.170	.0289						
.953	40.677	40.505	—.172	—.170	.0289						
7.736	4.977	4.984	+.007	+.056	.0031						
4.068	9.472	9.462	—.010	—.042	.0018						

Hence the probable error of a single micrometric determination of 40 chains = ±^{ch} .07.



Microm. Reading.	
4.524	8.
5.266	4.
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1.660	2
4.295	8
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A TANGENT SCALE PROTRACTOR.

By S. L. Brabazon, D. L. S.

The accompanying cut is an illustration of a Tangent Scale Protractor of 5 inches radius divided to 2′. By its use the necessity for the tedious calculations of latitude and departure is obviated without sensible loss of accuracy, and it is quite as expeditious as the circular protractor.

It is merely the common tangent scale laid off on opposite sides of a rectangle in length equal to radius or tangent of 45°, with diagonal lines drawn across it from each division, commencing at zero above, to the division next beyond the corresponding one below (as, from the 9th above to the 10th below); in fact it is entirely analgous in principal and construction to the plain diagonal scale.

Common railroad profile paper is very convenient for making it upon as there are parallel lines, thirty to the inch and these with the diagonals divide the degree into thirty parts or 2′. If the divisions above and below were half degrees, the half degree would be divided into thirty parts or single minutes. The plain diagonal scale will give readily $\frac{1}{200}$ or ·005 inches. The length of the tangent of 2′ for a radius of 1 inch is ·0006 inches, this multiplied by 5 for a 5 inch scale gives ·003 inches; then if the tangent scale was engine divided in ivory or metal, angles might be laid down with no greater error than 3′, and the average error less than 2′.

To use it, all that is necessary are two lines at right angles to each other; a square—side equal to radius of protractor—is perhaps the most convenient arrangement, or several of them as on the accompanying plot, but the operator will soon discover the best way of working. To give the protractor fair play the distances should be laid down with a vernier or a diagonal scale, to prevent errors increasing, and so put the method in this respect as nearly as possible on a par with that by latitude and departure, but this would be seldom if ever necessary in practical use.

Traverse surveys have generally a closing error which must be corrected. This error is the distance from the termination of the last course to the zero point of the survey. Represent the line joining these points by E, the periphery of the survey by L, the courses by l, l', l'', etc. (see Fig. A) and the correction for each distance by e, ${}_1e$ e_2 etc., then $e=\frac{E'l}{L}$, $e_1=\frac{El'}{L}+e$

Example $L=100$ chs, $E=1.00$ ch, $l=20$ chs $l'=15$ chs

$E=\frac{1\times 20}{100}=20$ lks, $e_2=\frac{1\times 15}{100}+20=35$ lks

or $e_1=\frac{E.\,(l+l')}{L}-\frac{1\times 35}{100}=35$ lks. to be laid off parallel to E.

Directions for Preserving Natural History Specimens.

By Professor John Macoun, F. L. S., Geological Survey of Canada.

MAMMALS.

All mammals should be skinned by the simplest method, which is that employed by all amateurs. Split the skin from vent to throat and the underside of the legs. The whole leg should be skinned but the lower part of the bone left after cutting or scraping off the flesh. The head should be completely skinned and care taken to not injure the eyelids or the lips. After being skinned the head should be cut off, carefully cleaned, the eyes and brain being taken out and rolled up with the skin. Common dry salt is an excellent preservative for large skins as it assists in drying up any flesh or fatty matter that may still adhere to the skin. Small mammals can be treated in the same way as birds or reptiles.

REPTILES.

Frogs, toads, lizards and snakes are usually placed in strong alcohol, care taken to prick their skins so that the fluid may penetrate to every part. My plan is to carry the alcohol in a stone jug or tin can and pour it into a glass jar as it is wanted. Carbolic acid or some other substance should be put in the liquor to make it disagreeable or even poisonous as without this it is liable to be *spilled* when being carried from place to place. Small mammals when placed in alcohol keep well if the skin is cut on the belly to admit the spirit.

BIRDS.

Birds require considerable care in skinning and a few practical lessons are almost necessary before commencing. A bird the size of a robin is the best for a beginner. The feathers from the breast-bone to the vent should be blown apart or separated with the hand and the skin slit. Then press back the skin till the joints of the legs are uncovered. Sever the upper joints from the body draw out the leg and scrape off the flesh. Now detach the body at the vent being careful not to injure the tail. Draw back the skin on the back until the wings are reached and treat them as the legs. After this draw back the skin to the middle of the skull and sever it from the body at this point. Scoop out the brains and eyes and put in poison and cotton then draw back the skin to the natural position on the head and poison and stuff the skin at the discretion of the operator.

The best poison for bird skins is dry arsenic but any druggist will prepare a bottle of arsenical soap which can be applied with a brush and is less dangerous than the dry mineral. No bird skin is safe without being poisoned.

PLANTS.

All flowering plants and ferns should be gathered when dry. If the plants be short the whole should be placed on the sheet. No specimen should be longer than sixteen inches. All herbaceous plants should be taken up by the root of which at least a part should be left adhering to the specimen. Characteristic sections should be cut from shrubs and trees showing leaves and where necessary others with flowers and fruits. Grasses and sedges should have roots and be doubled on the sheet so as to conform to size. Specimens should remain on the drying paper until perfectly dry but the papers overlying them should be changed every day for four days. Wet paper can be dried in the sun or by a fire. Hot papers dry plants much quicker than cold ones.

Mosses, liverworts and lichens besides being treated as above can be dried and put into bags and at any time afterwards dampened and made into specimens to suit the collector. All of the lower forms should be collected in fruit if possible. The coarser sea-weeds may be dried in the rough and not washed as the salt of the sea-water prevents them becoming brittle. The finer kinds should be kept in sea-water until wanted and then washed in a shallow dish of fresh water and afterwards floated on cards or stiff paper, care being taken to spread with a pin the specimens on the card beneath the water so that the finer branches may be evenly distributed. These cards should be laid on the usual driers and each sheet covered with fine muslin which must remain until the specimens are dry. In drying they should be treated like phenogams.

MINERALS.

Specimens of minerals should be dressed to a certain size. They should be oblong, the breadth being about two-thirds of the length. Each collector should have his own opinion about the size he wants. Angular "chunks" which are knocked off hap-hazard any where and at any time may be brought to camp but all should be dressed before being packed away. Minerals when showing good chrystals are to be kept so as to show the chrystal to the best advantage, but when these are not a feature of the specimen it should be dressed as above.

Natural History Specimens without a card giving date of collecting, collector and locality, are valueless and therefore every specimen should be ticketed at the latest when being packed away.

REPORT

Of Committee to Enquire into the Best Means for having a Uniform System of Map-making in the Various Departments of the Government.

The principal departments in which maps are made from original surveys are the Railways and Canals Department, the Public Works Department and the Department of the Interior, with its two surveying branches, the Technical Branch, and the Geological Survey.

Maps of all surveys must in the first place be made on some integral scale of the unit of measure used in the field work.

Hence ensues a difference at the outset in the scales employed by the different departments.

The surveys of the Public Works and the Railways and Canals Departments are chiefly made in connection with engineering works, in which the one hundred feet chain is the unit of measure. The plans of Railways and Canals, Harbours, Rivers, &c., made by the departments charged with that work are made on an integral scale of their unit—100 feet—such as 50, 100, 200, 300, 500, 2,000 feet to the inch, varying according to the area covered by the survey and the amount of detail in the field work.

In the surveys of Dominion Lands made under the Technical Branch of the Department of the Interior, the sixty-six feet chain is used, this being the most convenient unit of length for laying out the areas which are always expressed in square miles or in aliquot parts of square miles. The standard scale for plans of township and other surveys of Dominion Lands is forty chains, or ½ mile to the inch, plans of traverses being made ¼ mile to the inch. For their scale for larger maps, six miles to the inch, or multiples thereof are used, this being a natural scale for a unit of one township (very nearly six miles square.) The six mile scale moreover makes it possible to put the whole width between two successive initial meridians on one sheet of convenient size, the initial meridians being a natural division of a country like the North-West, devoid of topographical or natural boundaries.

In the exploratory surveys of the Geological Survey the unit of measure is of course the mile. In prosecuting the work of this department in unsurveyed regions, it has always been necessary to make topographical surveys concurrently with the Geological examinations, and even in settled districts many of the old township surveys were so roughly executed that it has since been found necessary to resurvey, not only the geographical features, but also the concession and lot lines.

As this work has been going on for forty-five years, a vast amount of valuable material has been accumulated. The late Sir William Logan, Director of the Survey, was an enthusiastic surveyor and geographer, and he collected all the maps relating to Canada which he could possibly secure. Among the material which he accumulated in this way, may be mentioned copies of all Crown Lands surveys and explorations, admiralty charts, railway surveys, maps of counties published by private enterprise, surveys made by the military authorities, hydraulic surveys, etc.

The scales which have been principally adopted for the publication of the maps of the Geological Survey have been 4 English statute miles to an inch or multiples and sub-multiples of this, namely, ½, 1, 2, 4, 8 and 16 miles to an inch. The great Geological and Topographical map of Canada, engraved on copper plates and published by Sir William Logan in 1863, is on a scale of 25 statute miles to an inch. This beautifully executed piece of work was compiled with great care by the late Mr. R. Barlow, and it has formed the basis for many other maps which have since been published. The copper plate index map in the atlas accompanying the "Geology of Canada, 1863," is on a scale of 125 miles to the inch. Most of the maps published by the Survey have been lithographed by hand, but a few have been produced by the photo-engraving process. The polyconic projection has been used in all cases. Formerly the size of each sheet was made to suit the area to be covered, but of late years the Geological Survey wishing to show geological and topographical features with minuteness and not desiring specially to show the general geographic relation of one part of the country to another, adopted the four mile scale, and a system has been commenced of making the 4 mile sheets of a uniform size of 18 by 12 inches, no matter what might be the geographical nature of the area included; it thus some times happens that a whole sheet shows nothing but a small point of land.

The scales then, of the Geological Survey, and the Dominion Lands Surveys are conformable, but it appears impossible to adopt any uniform scale to include the other departments.

For maps on a larger scale showing large tracts of country, each department, having special objects to serve, chooses a scale suited to its own purposes.

One great object always aimed at by a compiler of a map for the use of the public, is to so choose his scale that the resulting map shall be of such a size as to be easily handled, either in one sheet or in a number of sheets, and that each sheet shall be as nearly as possible a complete map in itself. Hence a map of Ontario is made on a different scale from a map of Manitoba, and a map of the whole Dominion on a different scale from either.

In regard to geographical names in new districts about to be mapped for the first time, the practice of the Geological Survey has been to adopt in each case the correct Indian name, or if no such name can be ascertained, to give a name suggestive of something characteristic of the place, or of the time when the survey was made. Greater accuracy and uniformity in the spelling of Indian names would be very desirable.

W. F. KING,
ROBERT BELL.

MEMORIAL

SENT TO THE MINISTER OF THE INTERIOR, MARCH, 1886, SETTING FORTH THE BENEFIT OF A COAST AND GEODETIC SURVEY FOR CANADA.

The Honorable the Minister of the Interior:

SIR,—The following Memorial is respectfully submitted for your consideration by the Association of Dominion Land Surveyors.

The Dominion has arrived at that stage when the wants of the country demand a more exact system of survey than has been in vogue in the past. With the increase in the value of real property—the boundaries of which in the older Provinces are in most cases entirely dependent for their stability on the durability of a piece of wood, a few marks on trees or the testimony of a few of the oldest inhabitants, thus often leading to expensive litigation, of which the result is dependent mainly on the preponderance of evidence on one or the other side, which may be, and is often wrong—increases also the necessity for such a survey. Now were the boundaries—especially those of large areas, such as concessions, townships and counties—connected with, and defined by a geodetic survey, similar to that made by the countries mentioned herein, all doubt as to their true position would be forever set at rest. Also the demands for marine purposes of more accurate charts of our coast, and waters, show that an accurate coast and geodetic survey of the country is urgently needed.

The question of the value and utility of a survey of this kind has been so settled by almost every civilized nation, that it is hardly necessary to advance further proof of the fact, but for information the following may be presented. It is stated by an eminent American engineer that "if the State of Massachusetts had had a good topographical map in 1836, some $20,000,000 would probably have been saved in its public railway expenditure."

Mr. Sandford Fleming, in his report to the Minister of Public Works, dated the 5th of April, 1879, says: "If the railways of Ontario had to be established *de novo*, a careful study of the requirements of that Province would enable any intelligent engineer of ordinary experience to project a new system, which at one-half the cost would far better serve the public, would meet every demand of traffic, would more fully satisfy every expectation and which would not result in disappointment and loss to those who have been induced to invest their means in that which has proved to many an unprofitable undertaking." The railways of Ontario have cost, according to official returns, nearly one hundred and eighty millions of dollars. If they could have been constructed at one half the cost, the other half of this enormous expenditure may be assumed to be a wholly unnecessary outlay, if a well-considered and less costly system would have equally met the wants of Ontario. The excessive expenditure can only be considered as superfluous, and so much of it remains permanently unremunerative as to be hopelessly wasted. If public money, the public debt might have been so much the less, or other interests might have been served and developed to the extent of the increased expenditure. If private money, obtained from parties at a distance on fair promises, or on prospects represented as encouraging, there is staring the investors in the face the deplorable and impregnable fact, that much of it will be absolutely lost."

If to-day a railroad is projected in England preliminary surveys such as we are obliged to make are not necessary. From the plans provided by the ordnance survey, the lengths and grades of any proposed line can be laid down with sufficient accuracy to enable a final location to be made.

These plans are also very valuable in determining drainage areas; water supply; boundary lines between estates; reclaiming tidal lands, and materially assist in equitable assessment of real estate for taxes.

The surveys of this kind which have been made by other countries may be summarised as follows:

First and foremost is the Ordnance Survey of Great Britain and Ireland, covering nearly 111,000 square miles, which was begun in 1784 and is now nearing completion. The original scale is one inch to the mile, but afterwards six inches to the mile was adopted. Then comes the great Trigonometrical Survey of India, inaugurated at the beginning of the present century by Colonel Lambton, and which is still in progress, and of which the beneficial results have been inestimable. Belgium, with an area of about 10,000 square miles, will have 450 sheets when the survey is completed. The scale adopted is $\frac{1}{20000}$ and the contour lines are one metre apart.

In Prussia, since 1849, new and more perfect methods have been introduced into the government topographical surveys.

In Baden a new map was commenced in 1874, on a scale of $\frac{1}{25000}$, and with contour lines 10 metres apart.

In Saxony the original survey was commenced in 1780 and completed in 1806, on a scale of $\frac{1}{12000}$ and a new map was finished in 1870.

Russia, with its enormous territory, about twice the size of the United States, including Alaska, has been for many years actively engaged in prosecuting geographical surveys.

Norway, although a comparatively poor country, has set itself on having a good topographical map, on a scale of $\frac{1}{100000}$ and its work merits praise.

Sweden, similarly, is prosecuting such work and has one half thereof completed.

Bavaria in 1868 completed her map in 112 sheets.

Würtemberg has also a map, on a scale of $\frac{1}{50,000}$, of which a new edition is in progress.

Austria has completed a new map, comprising 715 sheets.

In Switzerland a new map of 546 sheets is being issued.

Denmark has a survey in progress.

The great map of France is comprised in 276 sheets.

Italy is being mapped on a scale of $\frac{1}{50000}$.

Spain has been engaged since 1838 on a new survey, and Portugal since 1856.

On this continent surveys of a high order of precision have been made by the United States government along the coast of the United States and along the great lakes. They have also been made over many of the States and Territories of the far west, including Nevada, Colorado, Utah, New Mexico, Montana, Idaho, and part of Arizona.

Several States have made similar surveys of their territory, including Massachusetts, California, New Jersey and New Hampshire, and in other States they are in progress.

All the foregoing surveys both in Europe and America are based upon a triangulation. The necessity of such work is proved by experience and is so settled that it can no longer be considered an open question.

A similar survey of Canada especially of the more thickly populated part and her ocean shore line must and will be made, as a natural consequence of her continued developement.

The loss of a single vessel with her cargo through ill defined rocks or reefs, or inadequate and unreliable charts would be sufficient to pay for thousands of square miles of survey.

The United States coast and Geodetic Survey has already made a number of connecting links into Canada for our future use.

Already surveys of more or less precision are being made, and a general Coast and Geodetic survey is pre-eminently one to be undertaken by the Federal Government.

In a work of such proportions as a survey of this kind would ultimately assume, it is primarily essential that a well matured and carefully considered scheme be first laid down upon which to develope the whole work, and being guided by the experience of other countries it is evident that a primary triangulation is necessary as a ground work for all detail surveys.

For the initiation of the work, and that a beginning may be made in this much needed survey, the following scheme is respectfully submitted :

That the work should be conducted under the direction of the Department of the Interior, which is provided with the expensive instruments required in work of this nature, and is well able to undertake such a survey from the fact, that it has in its employ a number of surveyors who are qualified by the examination provided by the Dominion Lands Act to undertake extensive Topographical and Governing Surveys, thus rendering it unnecessary to apply to the Imperial Government for scientific men to prosecute such work; and also from the fact that very exact surveys of this nature have already been conducted by that Department in the North-West Territories.

A survey of this sort is most urgently needed in the older Provinces, and in consideration of the fact that an early survey of the Gulf of St. Lawrence has been promised, the work might be initiated there by a Trigonmetrical and intermediate coast, and sounding survey with all necessary tidal observations, as the same would be invaluable as an aid to navigation. The Department of the Interior being in possession of the instruments required for such work, a comparatively small yearly expenditure would suffice for extensive field operations.

A chain of primary triangulation along the St. Lawrence River and Gulf, also the Great Lakes would provide a basis for the extension of the survey into the interior of the different Provinces, as the same become necessary, and could readily be connected with the United States Lake Survey.

In consideration of the foregoing facts your memorialists respectfully submit that it is to the interest of the country at large that a Trigonometical Survey such as is suggested should at once be begun.

And as in duty bound your memorialists will ever pray.

Signed on behalf of the D. L. S. Association.

THOMAS FAWCETT,
President.

GRAVENHURST, 25th March, 1886.

MEMORIAL

SENT TO THE MINISTER OF THE INTERIOR, FEBRUARY, 1886, REGARDING RAILROAD RIGHT OF WAY SURVEYS IN THE NORTH-WEST TERRITORIES.

To the Honorable the Minister of the Interior:

The memorial of the undersigned Committee of the Dominion Land Surveyors Association respectfully sheweth:

That, whereas it is necessary in connection with all surveys for Railroad lines in the North-West Territories, that certain surveys be made to determine the boundaries of portions of sections required for Right of Way, and that certain plans of the same and books of reference should be produced to enable the Department of the Interior to describe such parts of Government sections as may be required for the above mentioned purpose, by metes and bounds, in the issue of Crown Patents for the same.

And whereas it appears that in many cases the necessary surveys are made and plans and books of reference prepared by persons who are not duly licensed Dominion Land Surveyors and against whom there is no recourse in the event of mistakes being made.

Your memorialists therefore respectfully submit that an injustice would be done to Dominion Land Surveyors should the Department of the Interior accept any plans, from which descriptions are required to be taken for Crown Patents or other Government deeds, unless the same are signed and sworn to by a duly licensed Dominion Land Surveyor who is under bonds to the Government for the correctness of his work.

Your memorialists therefore respectfully ask that the Department may take such action as they may see fit to notify all Railroad Companies in the North-West Territories other than the Canadian Pacific Railway Company; that all plans and books of reference of Right of Way surveys from which the Department will have to take descriptions for Crown Patents or other deeds, must be signed by a duly licensed Dominion Land Surveyor who is under bonds to the Government, and that all such plans and books of reference shall be filed in the Record Office of the department of the Interior.

And your memorialists as in duty bound will ever pray.

Signed on behalf of the Committe.

THOMAS FAWCETT,
D. T. S.

GRAVENHURST, Ontario, 24th day of February, 1886.

LETTER.

Accompanying Memorial on Railroad Right of Way Surveys.

Sir, Ottawa, February, 1886.

I have the honor to forward herewith, for your consideration, a memorial, prepared by a committee of the Dominion Land Surveyors' Association, appointed at their last annual meeting, held in Ottawa, on the 16th and 17th inst.

In connection with the above I would respectfully submit the following facts, for your information. It is the custom of the railway companies in the North-West to have their Right of Way Surveys made by their Engineers, who also prepare the plans of the same and necessary books of reference. These plans and books of reference are filed in the Department of Railways and I believe the custom now is for the Department of the Interior to refer to them for any necessary descriptions for patents, etc.

In the Province of Manitoba and also in the older provinces they are required by law to have their Right of Way Surveys made by a duly qualified Land Surveyor and the plans must be signed by him. The General Railways Act also provides that plans of right of way must be signed by a duly qualified surveyor, but in so far as railway companies in the North-West Territories are concerned they avoid this, owing to the fact that most of their right of way is acquired from the Government, and as the Department of Railways accepts plans signed by their engineers, and the description furnished from these plans are accepted by the Department of the Interior, there is therefore no recourse against the engineer who signs them, as he is not a commissioned officer and his work is not done under any bonds to the Crown for its proper fulfilment.

The Association of Dominion Lands Surveyors feels, that aside from the legal aspect of the case, all surveys of Dominion Lands in the North-West Territories upon which the Department depends for description etc., should be performed by those who are duly licensed by the Department for the Surveys of Dominion Lands, and who give bonds for the correct fulfilment of their work. They therefore respectfully ask that some action be taken by the Department to protect them in this, to them important matter.

I have the honor to be,

Sir,

Your obedient servant,

THOMAS FAWCETT,

President D.L.S. Association.

To the Hon.

The Minister of the Interior,

Ottawa.

TRUE TO THE LAST.

A Reminiscence of Moosejaw in 1883.

DRAMA IN ONE ACT.

Scene—In the Beautiful Garden of Chateau d'Or,

Alphonse—Good morning Mademoiselle Zelia! Enjoying the balmy breezes laden with the richest perfumes; invigorating nature for MILES and MILES around.

Zelia—Yes, dear Alphonse, invigorating it is, but were it not for your noble mind my spirit would have, ere this, left this frail frame. Ever since I met that hateful Lieutenant Crapaud at the masquerade his visage haunts me. The next day being ASHE-Wednesday I went to vespers and was somewhat relieved. O, would that the day of your v[illegible]tory address at the Ecole Polytechnique were near, and you e[illegible]pon the practice of your profession, then shall those holy bon[illegible]ite two hearts that beat in one; then shall we sit in our cosey little cottage and SING of love and joy, vieing with the chattering birds in the GARDEN.

Alphonse—Hush, Zelia! There comes Madame Gumbean and HER-MAN, the white-haired veteran who has seen more service than any other in the French army. He has conquered the SNOW of Russia and the burning sands of the Sahara. I revere him. His son, an ERNEST young man, is following in his footsteps.

Zelia—Come, dear Alphonse, let us take this winding path to the Aquarium. See these tiny little things sporting themselves midst corals and shells—some not BIGGER than a sou. Wonderful! Have you ever been inspired by the beauties of nature, especially when brought together by the devices and ingenuities of man?

Alphonse—Yes, dearest love, oftimes when sitting in yonder arbor, absorbed in deep reverie, methinks my spirit leaving me and soaring to the sublime, and there, peering through the thin WEBB of the future, behold you Queen of the Fairies.

Zelia—Alphonse, let me embrace thee, thou KING of my heart, with an intellect as great as it is modest.

Alphonse—But, hark! I hear the DRUM-MOND fife. We must be wending our way homeward, Zelia.

Zelia—O, let us linger here till evening, till nature assumes its sombre garb. Let us dwell under the canopy of heaven, studded with diadems of adamantine lustre, then shall bright Selene hear our vows of eternal love.

Alphonse—We will remain. See, the Duke's household is one by one repairing to their cottages after the day's work; here the gardener turns off the FAWCETT and lets nature sprinkle the lawn with dew; there the TRAINOR of the Duke's Arabian steeds drives them to the stables; the old grandmother, invalided so that they must WHEELER, is also retiring, and the children's donkey gives a good-night BRAY—the good old soul.

Zelia—In the stillness of evening no sounds are heard but the babbling brook, the playing fountain and the chirp of the cricket.

Alphonse—But why so pale?

Zelia—I think I see the form of Lieutenant Crapaud approaching.

Crapaud—Good-evening, Mademoiselle Zelia. Why, here so late!

Alphonse—No impertinence.

Crapaud—Sir!

Alphonse—Sir!

And an instant later they were in mortal combat. (*Zelia faints.*) The struggle was short and decisive. Alphonse's sword had with him remained *True to the Last.*

Alphonse carried Zelia to a coupe and rapidly drives to the Hotel DE Ville, where she soon recovers and helps him bandage his only wound (on the arm) with COTTON, the soldier's soothing vademecum, and washes the KLOTZ of blood from his garments, saying, "These are KLOTZ of honor." The next train sped them to the sea shore, where they embark in the Parisian, soon crossing the briny deep, and are now in Moosejaw, N. W. T., where he toils hard and earnestly as D. L. S. for his wife and country.

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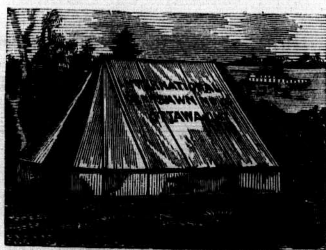

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