PROCEEDINGS

OF THE

ASSOCIATION OF

PROVINCIAL LAND SURVEYORS

OF ONTARIO,

AT ITS SECOND ANNUAL MEETING HELD AT TORONTO,
ON MARCH 1ST, 2ND, AND 3RD,

1887.

The Third Annual Meeting will be held at Toronto, on Tuesday, 21st of February, 1888.

PRINTED FOR THE ASSOCIATION
BY
C. BLACKETT ROBINSON, 5 JORDAN STREET,
TORONTO.

NOTICE.

Members are requested to examine the advertisements carefully, and it is hoped they will patronize those who advertise with us.

The attention of members is called to the list of Standing Committees as given on page viii. The duties of these committees are fully set forth in the "Report of the Provisional Executive Committee," page 20 of Proceedings for 1886.

PREFACE.

To the Members of the Association of Provincial Land Surveyors of Ontario:

THE Executive Committee herewith presents the Proceedings of the Association at its Second Annual Meeting, held in Toronto, on March 1st, 2nd, and 3rd, 1887.

The Proceedings of our Association at its first meeting were well received by our own members, and also by our exchanges.

Our very young association is manifesting great energy, and we urge upon all members to aid the officers and the several committees in carrying on the work of the Association.

We hope this Report will meet with your approval.

Respectfully submitted,

EXECUTIVE COMMITTEE.

CONTENTS.

ASSOCIATION OF

PROVINCIAL LAND SURVEYORS

OF ONTARIO.

ORGANIZED 23RD FEBRUARY, 1886.

Officers for 1887-88.

—:o:—

PRESIDENT.

George B. Kirkpatrick, P.L.S., Crown Lands Dep't, Toronto.

VICE-PRESIDENT.

John Galbraith, M.A., A.M., Inst. C.E., School of Practical Science, Toronto.

SECRETARY-TREASURER.

Willis Chipman, B.A.Sc., Brockville.

COUNCILLORS.

Matthew J. Butler, A.M. Inst.; C.E. M. Am. Soc. C.E., Napanee.
Villiers Sankey, P.L.S., 17 Toronto, Street, Toronto.
Peter Silas Gibson, B.Sc., C.E., M.Sc., Willowdale.

AUDITORS.

George Brockitt Abrey, P.L.S., Toronto.
Lewis Bolton, P.L.S., Listowel.

BANKERS.

Bank of Montreal.

STANDING COMMITTEES.

LAND SURVEYING.—V. Sankey (Chairman); A. Niven, W. R. Aylsworth, T. O. Bolger, R. Coad, T. H. Jones.

ENGINEERING.—M. J. Butler (Chairman); Prof. Galbraith, W. M. Davis.

DRAINAGE.—W. R. Burke (Chairman); H. B. Proudfoot, R. H. Coleman, J. L. Bowman.

LEGISLATION.—E. Stewart (Chairman); P. S. Gibson, A. C. Webb.

PUBLICATION.—J. McAree (Chairman); T. B. Speight, H. J. Browne.

ENTERTAINMENT, (Dinner Rooms, etc.)—F. L. Foster (Chairman) A. J. VanNostrand, H. D. Ellis.

INSTRUMENTS.—G. B. Abrey (Chairman); H. Wilson, Thos. Fawcett.

PROGRAMME OF THE

Association of Provincial Land Surveyors of Ontario

AT ITS SECOND ANNUAL MEETING, HELD IN TORONTO, MARCH 1ST AND 2ND, 1887.

NOTICE.—The Association will meet *pro forma*, on February 22nd, according to Article VII. of the Constitution, but will be adjourned for the transaction of business for one week.

BY ORDER OF EXECUTIVE COMMITTEE.

PROGRAMME.

Tuesday, March 1st—Morning, 10.30 o'clock.

Meeting of the Executive and all Standing Committees.
Arrangement of instruments exhibited.

Afternoon, 2 o'clock.

Reading of minutes of previous meeting.
Reading of correspondence and accounts.
Report of Secretary-Treasurer.
President's annual address.
Report of Committee on Land Surveying, P. S. Gibson, Chairman.
Report of Committee on Drainage, H. B. Proudfoot, Chairman.

Evening, 8 o'clock.

Report of Committee on Engineering, Prof. Galbraith, Chairman.
Paper—Solar Azimuths, John McAree.
Paper—Electric Lighting of Small Towns, F. F. Miller.
The Minto Provincial Drainage Scheme. (General Discussion.)

Wednesday, March 2nd—Morning, 9.30 o'clock.

Meeting of Committees.

Morning, 10 o'clock.

Report of Committee on Instruments, G. B. Abrey, Chairman.
Report of Committee on Legislation, G. B. Kirkpatrick, Chairman.
(As some very important changes are proposed in the Survey Act, all surveyors should attend this meeting to discuss fully this report.)

Paper—Assessment of Benefits in Drainage Surveys, Willis Chipman.
Paper—Trussed Beams, Prof. Galbraith.
Paper—Crown Surveys, Elihu Stewart.
Paper—Highway Bridges, M. J. Butler.
Paper—Mining in Port Arthur District, H. DeQ. Sewell.

Afternoon, 2 o'clock.

Report of Committee on Publication, Willis Chipman, Chairman.
Report of Auditors, G. B. Abrey and Lewis Bolton.
Paper—Micrometer Measurement of Distances, Wm. Ogilvie.
Discussion of Papers in last Annual Report.
Unfinished business.
Nomination of officers.
New Business.
Adjournment.

Full discussion after each paper.

Bring with you report of last meeting for reference.

Please attend all meetings promptly.

A meridian has been carefully laid down on the grounds of the Parliament Buildings for testing solars.

Annual Dinner at the Walker House on the evening of the second day.

To make the exhibition of instruments as complete as possible, the Committee requests each member to bring some surveying instrument to the meeting, or anything else that will be of interest to the profession.

The exhibition will continue both days.

Some interesting instruments have already been promised for exhibition.

If you have any matter referring to Land Surveying, Drainage, Engineering, Instruments, Legislation, or Publication to bring before the Association, communicate with the chairman of the committee to which the subject belongs, or to the secretary.

Annual subscription received at any time before April 1, 1887.

WILLIS CHIPMAN, *Sec-Treas.*

Brockville, February 1, 1887.

About three hundred programmes were mailed to the Land Surveyors of the Province.

ASSOCIATION OF

PROVINCIAL LAND SURVEYORS

OF ONTARIO.

MINUTES OF THE SECOND ANNUAL MEETING.

MARCH 1ST, 2ND, AND 3RD, 1887.

The Association met at 2 p.m. on Mar h 1st in the Canadian Institute, the rooms at the Parliament Buildings being in use by the Legislative Assembly.

The Association was called to order by President G. B. Kirkpatrick, at 2 p.m.

Before proceeding to the first order of business in the Programme, H. H. Stephens and H. D. Ellis were appointed Scrutineers to examine the ballots for officers for 1886–87.

Upon motion the minutes of last meeting, as printed in the Proceedings, were taken as read.

No correspondence or accounts of importance were read to the Association.

The Secretary-Treasurer presented his annual report, which, upon motion, was received.

The President then read his annual address.

In the absence of P. S. Gibson, Chairman of the Committee on Land Surveying, Villiers Sankey presented the report of this committee with the proposed amendments to the "Act respecting Land Surveyors and the Survey of Lands."

Upon motion the report was received.

The proposed amendments were then taken up section by section, and discussed by the Association—that part of the Act referring to plans being left over by the Committee.

The Report of Committee was then adopted by the Association.

Mr. Proudfoot, Chairman of the Committee on Drainage, presented his Report, with proposed amendments to the Ditches and Watercourses Act, and to that part of the Municipal Act that refers to drainage.

Part of the proposed amendments were adopted by the Association, and others were referred back to the Committee.

Report of the Scrutineers was then received and adopted.

Association adjourned at 6 p.m.

EVENING SESSION, 8 O'CLOCK.

Prof. Galbraith presented the Report of the Committee on Engineering, which, upon motion, was received.

J. McAree being absent, his paper on "Solar Azimuths" was left over.

F. F. Miller read a paper on the "Electric Lighting of Small Towns," illustrated with drawings and different types of lamps. A vote of thanks was tendered Mr. Miller.

The Minto Drainage Scheme was next discussed.

The Secretary read extracts from a circular, issued by the promoters of this scheme, to show its objects and the means of attaining them.

At the request of the Association, Mr. F. S. Dobson, of Harriston, addressed the meeting, explaining fully the proposed scheme. (See page 120 of this Report.)

Association adjourned at 12 o'clock.

WEDNESDAY, MARCH 2ND, 10 A.M.

The paper on "Solar Azimuths," by John McAree, was read by the Secretary in his absence.

Upon motion the paper was received.

G. B. Abrey, chairman of the Committee on Instruments, presented his report, which, upon motion, was adopted.

The Committee on Legislation presented no report.

A paper on the "Assessment of Benefits in Drainage Surveys" was read by Willis Chipman, which, upon motion, was received.

Prof. Galbraith next read a paper on "Trussed Beams," which was received upon motion.

Adjourned at 12 o'clock.

Resumed at 2 p.m.

The President expressed his opinion that it would be impossible to take up all the business remaining unfinished in one afternoon, and suggested the advisability of continuing the session another half day.

Moved by A. Niven, seconded by H. D. Ellis, "That another session be held on 3rd March, from 9 to 12 in the forenoon." Carried.

Several notices of motion were then given to come up for discussion at the adjourned meeting.

The paper of E. Stewart, on "Crown Surveys," was next presented, and received upon motion.

In the absence of H. DeQ. Sewell, his paper on "Mining in the Port Arthur District" was read by the Secretary.

Upon motion this paper was received.

The Secretary presented the Report of the Committee on Publication, which, upon motion, was referred back to the Committee.

The Auditors' Report, not being ready, was left over until the next day.

W. Ogilvie next presented his paper on the "Micrometer Measurement of Distances," which, upon motion, was received.

The unfinished business was left over until the next day.

The President then called for nominations of officers.

ELECTION OF OFFICERS.

Mr. Niven moved that Mr. G. B. Kirkpatrick be re-elected president of the Association for the ensuing year. He thought, he said, that it would be a very good thing to keep Mr. Kirkpatrick in office for at least another year. The Association now had things in fairly good running order, and might hope to have them even more perfect by next year. Besides, when they had a good man in office he believed the best thing they could do was to keep him there.

Mr. Sankey seconded the nomination, and remarked that the personal experience which he had had with Mr. Kirkpatrick during the year made him feel that if they were to change presidents now

when the Association was about half way through its process of firmly establishing itself, as it were, the result would be serious. No better man than Mr. Kirkpatrick could be found, for reasons in general, to fill the office; and no man so good could be found, in the matter of getting legislation enacted on behalf of the Association.

There was no other nomination, and Mr. Kirkpatrick was re-elected chairman amid hearty applause. He acknowledged the compliment by remarking :—

"I am sure, gentlemen, I need not do more than return you my thanks for the honour conferred on me. I did, myself, think that it might be better to have a new president every year, but since you have decided otherwise, I shall be happy to continue to do all in my power to advance the interests of the Association. I thank you again for the honour you have done me."

Prof. Galbraith nominated Mr. Nevin for vice-president: "My reason for doing so," he said, "is, that there is no work attached to the office. It is simply an honorary position; and I think that as this is a Land Surveyors' Association it would be better that the gentlemen who fill the most honourable positions in its gift should be practising surveyors. I have not practised myself for seven or eight years, and I would very much prefer to see men who are in active practice filling positions of this kind.

Prof. Galbraith's motion was seconded, and Prof. Galbraith was then himself re-nominated for the office of vice-president, a ballot to be taken on the nominations during the month next ensuing after the meeting.

Mr. Klotz then moved that Mr. Willis Chipman be re-elected secretary-treasurer during the ensuing year. He remarked :—

"If there is any officer in the Association who deserves election by acclamation it is Willis Chipman. He is the father of the Association. He does not look very fatherly (laughter), but, nevertheless, I don't think we can deprive him of that credit. He has worked more than anybody else in getting up the Association and bringing it to its present state of activity, and I hope that he will be elected by acclamation." (Applause.)

Mr. C. F. Myles seconded the motion, and the president, in putting it, said :—

"I can only add that I agree with Mr. Klotz that it would be simply a loss to this Association if we were to lose the services of Mr. Willis Chipman. He has been the life and soul of it, to my knowledge, and I don't think we can possibly do better than re-elect him, and give him a hearty vote of thanks for his services in the past."

Mr. Willis Chipman was then re-elected secretary-treasurer. He acknowledged the election by remarking :—

"I thank you sincerely for your very hearty vote of thanks, and for my re-election to the office of secretary-treasurer. I have worked

very hard during the year for the Association, and so have all the officers. We have done much more work than those who have not been officers can imagine. I will do next year, as I did last year, all in my power to promote the interests of the Association." (Applause).

The following were then nominated as councillors for the ensuing year:—

M. J. Butler, A.M.I.C.E., M.A.S.C.E.	Napanee.
H. B. Proudfoot	Clinton.
Elihu Stewart	Collingwood.
Villiers Sankey	Toronto.
P. S. Gibson	Willowdale.
W. R. Aylsworth	Deseronto.
John McAree, D. T. S.	Toronto.

Moved by Otto J. Klotz, seconded by John McAree, "That the sum of $40 be voted to the Secretary-Treasurer as a small remuneration for his services and personal expenditures he has incurred in connection with his office." Carried.

Mr. Timson, of Toronto, one of the oldest mathematical instrument makers in America, and who claims to have made the first solar compass for Mr. Burt, was then introduced to the Association, and greeted by the President.

The Association adjourned at 5.30 p.m., when an hour was spent in examining the instruments exhibited.

THURSDAY, MARCH 3RD.

MORNING SESSION, 9 TO 12.

President took the chair at 10 o'clock; over thirty members present.

Moved by V. Sankey, seconded by H. D. Ellis, "That the Committee on Survey Act be instructed to enquire into the Registry Act, with a view of amending those portions thereof that relate to registered plans, and that a special committee of three be named by the chairman." Carried.

The chairman then appointed V. Sankey, P. S. Gibson and G. B. Abrey, with V. Sankey as convener, to enquire into said Act.

H. B. Proudfoot presented his amended report on "Drainage Acts," which, upon motion, was adopted.

The Report of the Committee on Publication was then presented, and, upon motion, was received and adopted.

The Report of the Auditors was then presented, and, upon motion, received and adopted.

Ruyter Sherman and E. Walter Rathbun, articled pupils, were proposed as associate members, and were elected as such by ballot.

Moved by M. J. Butler, seconded by A. Niven, and

Resolved, "That, in the opinion of this Association, the bonus to be paid by any articled pupil to the surveyor to whom articled shall not be less than $200." Carried.

Moved by Willis Chipman, seconded by Otto J. Klotz, "That sub-sec. 1 of Article X. of the Constitution be repealed, and that the following be substituted therefor:—

"The fee for membership for active members and associate members shall be $3 per year, payable in advance; and that the Secretary be instructed to prepare ballots, as per Article VIII. of the Constitution." Carried.

Moved by Wm. Ogilvie, seconded by G. B. Abrey, "That the draft of the Bill attached to this motion, respecting the appointment of 'Boundary Commissioners,' be referred to the Legislative Committee; and a copy of this draft be embodied in the Annual Report for the consideration of the members of this Association, in order to a thorough discussion of the matter at the next annual meeting." Carried.

Moved by C. F. Miles, seconded by H. W. Selby, "That the thanks of this Association be tendered to Messrs. Foster and Potter, of this city, for the fine exhibit of instruments displayed during the present session of this Association, and that a copy of this resolution be forwarded to these gentlemen." Carried.

An hour was then spent in discussing some difficult problems arising in practice.

The Association adjourned at 12.30 p.m.

CIRCULAR No. 9.

RESULT OF ELECTIONS.

For Vice-President:

Professor Galbraith	57
Alexander Niven	23

Amendment to Constitution:

For	62
Against	10

For Councillors:

Villiers Sankey	51
M. J. Butler	46
P. S. Gibson	43
J. McAree	33
H. B. Proudfoot	31
E. Stewart	27
W. R. Aylsworth	15

I therefore declare the following officers elected:—For Vice-President, Professor Galbraith; for Councillors, V. Sankey, M. J. Butler, P. S. Gibson. I also declare the Amendment to the Constitution carried.

(Signed) WILLIS CHIPMAN,
Secretary.

MEMBERS IN ATTENDANCE AT THE SECOND ANNUAL MEETING.

Abrey, G. B.
Aylsworth, W. K.
Aylsworth, C. F.
Bolton, Lewis.
Bowman, G. L.
Bowman, H. J.
Bray, Edgar.
Browne, H. J.
Burke, Wm. R.
Butler, M. J.
Bazett, Edward.
Brown, W. A.
Campbell, D. S.
Chipman, Willis.
Coad, Richard.
Colman, R. H.
Casgrain, J. P. B.
Davis, Wm. M.
Davidson, W. S.
Ellis, H. D.
Esten, H. L.
Fawcett, Thomas.
Foster, F. L.
Galbraith, Prof.
Gaviller, Maurice.
Hanning, C. G.
Jones, T. H.
Kirkpatrick, G. B.
Klotz, O. J.
McAree, John.
Miller, F. F.
Myles, C. F.
Murphy, C. J.
Niven, Alexander.
Ogilvie, Wm.
Proudfoot, H. B.
Rathbun, E. W.
Sankey, Villiers.
Selby, H. W.
Speight, T. B.
Stewart, E.
Sanderson, D. L.
Stephens, H. H.
Sherman, R.
Tyrrell, J. W.
Unwin, Charles.
VanNostrand, A. J.
Vicars, John.
Wheelock, C. R.

REPORT OF THE SCRUTINEERS.

We have examined the ballots, and found the following officers elected for 1886-87:—President, G. B. Kirkpatrick; Vice-President, Prof. Galbraith; Executive Committee, M. J. Butler, Prof. Galbraith, Villiers Sankey; Secretary-Treasurer, Willis Chipman (by acclamation); Auditors, G. B. Abrey, Lewis Bolton. Two ballots were rejected, but they would have made no difference in the final count.

H. D. Ellis,
H. H. Stephens.

Toronto, March 1st, 1887.

REPORT OF THE SECRETARY-TREASURER.

Mr. President,—The undersigned Secretary-Treasurer begs leave to submit the following report on the business of the Association during the first year of its existence.

We began with a paid-up membership of twenty-five, which has now* increased to seventy—seventy surveyors, live men, fully awakened to the benefits of organization.

* January 1st, 1887.

Our membership is not confined to Ontario alone, as we have one member from the Province of Quebec, two members from Manitoba, and one member from the North-West Territories, representing a territory from Montreal to Regina, a distance of nearly eighteen hundred miles.

Regina, Winnipeg, Rat Portage, Port Arthur, Chapleau, Ottawa and Montreal, along the line of the C. P. R.; Parry Sound, Bracebridge, Gravenhurst, Haliburton, Penetanguishene and Collingwood, north of Toronto; and nearly every city and town in the southerly part of the Province has one or more representatives. Hamilton, Kingston, Peterboro', Pembroke, Cobourg and Owen Sound are the chief cities and towns not represented.

The Provisional Executive, appointed by the Association to conduct the business of the Association until the election of the officers, arranged for publication of Constitution and By-laws with their report, and several professional papers, which we hope met with your approval. We also solicited advertisements from bridge companies, instrument manufacturers, and dealers in engineers' and surveyors' stationery, etc., our success in which is due to the exertions of Mr. McAree.

After the election of the officers of the Association by letter-ballot, in March, 1886, the Standing Committees were struck by the Executive.

During the year two meetings of the Executive were held in Toronto, the first resulting in the President's circulars of August 2nd, 1886. The second meeting was held on December 10th and 11th, at which the first draft of a programme was adopted. We had at our meeting last year prophets who foretold pecuniary embarrassment if anything like a report were published. I have, therefore, attempted to be as economical as possible with the funds of the Association, and can report, at the end of the first year, a substantial surplus instead of a deficit.

Arrangements were also made this year with the Grand Trunk Railway, the Canadian Pacific Railway, and the Northern and North-Western Railways, by which members attending the General Annual Meeting were granted reduced rates for the return trip.

A statement of receipts and expenditure of the Association to January 1st, 1887, is appended.

WILLIS CHIPMAN,
Secretary-Treasurer.

STATEMENT OF RECEIPTS AND EXPENDITURES OF THE ASSOCIATION OF PROVINCIAL LAND SURVEYORS OF ONTARIO, 1886-87.

RECEIPTS.

1886-87.	To fees, 1886-87—seventy at $3	$210 00
"	" Advertisements	47 00
	Total	$257 00

EXPENDITURE.

1886.				
Feb.	By Preliminary Circulars and Postage	$7 00		
"	" Advertisements in *Mail* and *Globe*	6 00		
"	" Stationery	2 00		
				15 00
Mar.	" Letter-heads, Ballots and Envelopes	$8 25		
"	" Circulars, Postage and Stationery	5 75		
				14 00
"	" Sketching and Lithographing	$21 50		
"	" Printing 700 Proceedings	68 40		
June	" Postage, Freight, Stationery, etc.	8 90		
				98 80
"	" Minute Book and Lettering			2 00
"	" Ohio Reports, Duties and Postage, etc.			6 85
"	" Michigan " " "			6 30
"	" Indiana " " "			5 60
Dec.	" Circulars, Postage, etc.			2 40
"	" Balance December 31st, 1886			106 05
	Total			$257 00

REPORT OF AUDITORS.

The undersigned Auditors beg to report as follows:—That we have examined the books and accounts of the Secretary-Treasurer, W. Chipman, Esq., and have annexed to this report a statement showing the amount of receipts and expenditures, which shows a balance on hand of $106.05. We find vouchers for $103.90, being for printing and engraving. The balance of the expenditure, viz., $47.10, there are no vouchers for, being for postage, duty, freight, stationery, etc., for which Mr. Chipman could not very well obtain vouchers.

All of which is respectfully submitted.

G. B. Abrey,
Lewis Bolton,
Auditors.

REPORT OF COMMITTEE ON LAND SURVEYING.

Mr. President,—The Committee on "Land Surveying" beg to report as follows:—

The necessity of having the Surveyors' Act amended being of the most vital importance, a meeting of the Committee was called on December 10th and 11th, 1886, to discuss and extend the amendments, as proposed by the Board of Examiners, as drawn up at the meeting held in October. This meeting of the Committee was attended by seven members and several other surveyors, and the whole Act was taken up, section by section, and a draft of the Act, as now amended, is presented herewith.*

* Not printed in these Proceedings.

Your Committee have endeavoured to get at all the necessary changes, but find that, in order to make the amendments entire and perfect, the greatest amount of personal experience from all parts of the Province should be brought to bear on the subject.

In view of the fact that the consolidation of the Provincial Acts is to be completed this year, your Committee would strongly urge that every effort be used to put the Act in as perfect a shape as possible, and that the Committee on Legislation be instructed to bring the same before the proper authorities.

(Sgd.) VILLIERS SANKEY,
For Chairman.

REPORT OF DRAINAGE COMMITTEE.

The Committee met pursuant to notice on 10th December, 1886. The following members were present:—H. B. Proudfoot, Clinton, Chairman; W. R. Burke, Ingersoll; J. L. Bowman, Berlin; R. H. Coleman, Toronto. This being the first meeting of the Committee, the principal business of the Committee was the consideration of correspondence addressed to the Secretary of the Association in response to the circular from the President on the subject of the revision of the Drainage Acts.

After the fullest discussion the following amendments,* which we have had printed, and copies of which are attached hereto, were adopted by the Committee, and, on being submitted to the Executive, were approved by them, and which, with the correspondence relating thereto, we now submit to the Association.

Carried as amended.

On behalf of the Committee,

H. B. PROUDFOOT,
Chairman.

REPORT OF COMMITTEE ON ENGINEERING.

MR. PRESIDENT AND GENTLEMEN,—As Chairman of the Committee on Engineering, I see by the programme of our meeting that I am expected to make a report. There are reports and reports. The present one belongs to the latter class. After describing as fully as the nature of the case will permit what the Committee on Engineering has done, I shall attempt briefly to outline what it has not done. To perform this task properly would require the patient determination of

* These amendments are not printed in these Proceedings.

the German *savant*, who cheerfully and enthusiastically devotes his life to collecting the materials for the preface and introduction of the work which is to make for him name and fame among a remote posterity, sublimely unconscious of the fact that men are mortal and that he is but a man. Gentlemen, such being the case, I think that you will agree with me in considering it better that I should, before undertaking an apparently endless task, give you facts relative to what we have done. We have never had a meeting, we have never—but I see that I am diverging from the straight and narrow path. In endeavouring to tell you first what we have done, I seem to be irresistibly impelled to dilate on the greater, but to you less important, part of our subject, viz., what we have not done. Let me make one more attempt; we have done—nothing. My ideas seem to be getting vague. Whether the statement just made is a successful attempt to do what I set out to do, I cannot tell; I leave you to judge. Affirmative and negative no longer appear to possess positive meaning; but, again, the idea occurs to me, why should they? What is there affirmative in positive, or what is there positive in negative? Questions such as these it is not for us to settle; I leave them to the Committee on Legislation. Having thus cleared the way, it now becomes me to describe, in an equally lucid manner, a few of our sins of omission. As Chairman of this Committee I feel that I ought to have proceeded somewhat in this way. I should have carefully prepared an estimate of the travelling expenses of the various members of the Committee to Toronto, adding ten per cent. for contingencies, such as circulars, postage, etc. I should then have drawn upon our affable Secretary-Treasurer for the amount, and notified each member of the Committee that I was ready to pay his travelling expenses if he would kindly consent to putting in an appearance at our Committee meeting. No, I fear that would have been proceeding without due caution. Before sending out this notification, I would have waited until the Secretary had accepted my draft, and then proceeded as above. I am sorry to confess, gentlemen, that I did none of these things. I feel that I merit heavy condemnation. I can make no defence of my conduct. I can only state my reasons, and leave myself in your hands. I had no confidence in our Secretary-Treasurer's willingness to honour my draft. The cause of this want of confidence I cannot explain; it seemed to be a part of my nature which impelled me with irresistible force to act as I did. I feel that in justice to that worthy officer I should at least have afforded him this opportunity to forward the interests of the Association. You all suffer in consequence of this want of action and want of confidence on my part. Otherwise I feel certain that we should have had a brilliant report to offer you, teeming with life and enthusiasm.

Another course was open to me. I might have written to the members of the Committee, and asked them to come to Toronto, or to any other city, town, township, concession, section, block, gore, common, lot, or parcel of land which might seem to them, each and several, all and singular, more or less centrally situated and better adapted as a place for a committee meeting than the aforesaid city of

Toronto. This I did not do; my reasons I must for ever conceal. I have already put the Secretary-Treasurer in a condition bordering on insanity; but my reputation for discretion would be irreparably destroyed if I were to do or say anything to ruffle the feelings of a numerous and athletic committee.

Still a third course was open apparently. Some of you may ask why I did not write to the various members of the Committee, and by dint of much importunity extort from them promises to furnish papers for the annual meeting. This seemed even to myself a proper mode of proceeding, but fuller consideration dispelled the idea. I reflected that such a proceeding could not under any possible stretch of the imagination be considered a committee *meeting*, and committees are nothing if they don't meet.

I felt, again, that our Secretary would attend to the matter of getting papers. He attended to me. The consequence is that to-morrow you will be inextricably wound up in a mass of complicated and involved formulas, formulas which might be endured with some show of interest if relating to the trussed turkeys to be discussed, I believe, by this Association to-morrow evening at the Walker House, but which under any other circumstances—I mean the formulas, not the turkeys,—should only be looked upon with disgust and horror by every well-regulated mind. Indeed I feel that the members of this Association, as the time for the reading of that paper approaches, would be perfectly justified in considering it to be about the approximate time to take their greatest elongation from the place of meeting for the purpose of setting up the instrument I was going to say, but that would hardly express my idea; I should rather say, for the purpose of indulging in permissible, in fact I might say necessary, refreshment.

My worthy colleague, Mr. Butler, has also been approached with success by our indefatigable Secretary, and I feel sure that his paper on "Highway Bridges" will go far to make up for the deficiencies of our Committee, aud relieve it to a great extent from the odium which it has in every other respect so justly incurred.

Gentlemen, my task is done. It has been by no means a light one. Defending one's colleagues and oneself from anticipated charges of neglect of plain duty is not a pleasant occupation. My greatest apprehension is that perhaps I have said too much. Perhaps it would have been the part of wisdom to have glossed over our deficiencies, and never mentioned our breaches of trust. However, the time for regret is past. What is done is done, and the Committee on Engineering for the year 1886-87 now give up their trust, and ask to be sentenced quickly, and receive a quick discharge.

Respectfully submitted,

J. GALBRAITH,
Chairman Engineering Committee.

REPORT OF COMMITTEE ON INSTRUMENTS.

MR. PRESIDENT AND GENTLEMEN,—It would seem to be the duty of every Committee to bring in a report to this meeting, and, if a Committee has no report to bring in, then I take it they should put it in writing, stating the fact.

Now, as Chairman of the Committee on Instruments, I would say that many of that Committee reside away from the city, and it was inconvenient to get an attendance as a committee here; besides, there was not much for them to do except see that some one should prepare a paper, to be read at this meeting, pertinent to the subject of which they had charge, and also to have as good a collection of instruments present for exhibition as possible, and some minor matters.

I wrote to all the members of the Committee soliciting a paper on the subject of "Instruments," but could not get any one to prepare one, and I regret to say none has been prepared, though the field is open, wide, and an interesting and useful one.

Next I solicited the members of the Committee and the mathematical instrument makers of our own city, Messrs. Hearn & Harrison, of Montreal, and some five of the principal makers of instruments of the States to send an exhibit. As you see, our own city makers have come with a fine show. In these glass cases may be found all the necessaries of our profession, together with many of the luxuries of our requirements and desires as well; and I hope that these exhibitors may be well reimbursed by increased sales for their trouble in showing so fine an exhibit.

The other makers found it too much bother to attend at this time, but many of the American makers invited gave encouragement, and promised to come with a full outfit at a future time. I made enquiries of the Customs, and learned that foreign exhibitors would be required to pay the full amount of the duty (25 per cent.) on entering, then enter into a bond, and, on exportation of the exhibit, and proof of the same being furnished the Customs Department at Ottawa, that Department would refund all excepting 25 per cent. of the duties paid; that is, it would cost the foreign exhibitors 2½ per cent. of the invoice value of the instruments exhibited in the way of duties, over and above some charges and the trouble, etc. Also, the exhibition would require to be made in a bonded warehouse; but our obliging collector at this port agreed to bond any room or building which we might desire for the purpose of exhibition, so that no inconvenience from that source might occur. I also see in this room that many of the members of the Association have brought for exhibition their instruments, and I see they range from the oldest to the newest designs. I shall have pleasure in describing some novelties and others that I have myself brought, as well as giving a general description of the other exhibits; and I presume the other members of the Association that have brought instruments will explain their usefulness and their beauties also.

G. B. ABREY, P.L.S.,
Chairman.

REPORT OF LEGISLATIVE COMMITTEE.

This Committee had nothing to report.

REPORT OF COMMITTEE ON PUBLICATION.

MR. PRESIDENT,—We, your Committee on Publication, beg leave to report as follows:—

We received tenders for printing our first Report of Proceedings, accepting that of C. Blackett Robinson, the lowest tender, at the rate of ninety-five cents per page. The lithographing and designing of the two cuts cost us $21.50, but are, we think, interesting features of the Report.

For advertisements we charged $8 per full page and $5 per half page.

Of the 700 Reports printed we sent 200 to the Michigan Society, receiving in exchange 75 copies of their Report for the years 1884 and 1885, the Report of 1886 not yet being printed. To the Ohio Society we sent 110 copies, receiving in exchange 75 copies of their Report, and to the Indiana Society we also sent 110 copies, receiving in exchange 75 copies.

About 300 copies of our Report were distributed among the Provincial Land Surveyors throughout the Province. One copy of each of the State Reports above mentioned was sent to each member of the Association.

Your Committee would advise the following charges for advertisements in the next volume of Proceedings: full page, $6; half page, $3.50; for a less space, at the rate of 25 cents per square inch.

Your Committee would also impress upon the members the advisiability of patronizing those who advertise with us, as the amount raised from this source is nearly half the cost of publishing the Report of Proceedings.

WILLIS CHIPMAN,
Chairman.

PRESIDENT'S ADDRESS.

Gentlemen of the Association of Provincial Land Surveyors of Ontario:

In welcoming you to our Second Annual Meeting, permit me, in the first place, to congratulate you on the successful inauguration of a society, the want of which has long been felt, and which, I am convinced, has been a serious loss to our profession as a whole. Union and co-operation are magical watchwords in other branches of work, and the time has come when, if we wish to succeed in elevating and

advancing the profession of a land surveyor, we must unite, and no longer remain isolated and unknown to one another. A general advance in knowledge is taking place all along the line, the facilities for education for men about to enter on the life of a surveyor are unsurpassed anywhere. I need only mention the Ontario School of Practical Science in Toronto, the Royal Military College at Kingston, and the Engineering School at McGill University in the city of Montreal to illustrate this, and if we do not, as a body, advance with the rest we shall find ourselves hopelessly overmatched and dragged down from the position which a well-educated and practical set of men should occupy in the community.

STATISTICS.

I find that from the year 1784 to the present time there is a record of the appointment of six hundred and ninety-seven land surveyors for the Province. Of these I have a record of two hundred and sixty as dead, leaving three hundred and seventy-two to be accounted for. Of these I estimate that about two hundred and fifty are in the practice of their profession, whilst others have, since their appointment, entered the sacred ministry, the legal profession, the medical profession, the civil service, banking and loan companies, or, lastly, have attained high eminence as engineers, and are to-day chief engineers of some of our leading lines of railway. Our Association numbers seventy-five active members, and I would urge upon each and all the desirability of getting their brethren throughout the Province to fall into line, and join the Association not only for their own sake but for that of the profession at large. I am persuaded that by no other means can we, as a body, either improve our own condition, cultivate a spirit of *esprit du corps*, or properly fulfil the multitudinous duties required of a surveyor in these days. The time has gone by when with a compass and Jacob's staff a surveyor was considered to be fully equipped for his professional duties. At the present time every surveyor should be a well-read man : the subjects on which his opinion is often asked are varied. He should be able intelligently and composedly to give evidence in our courts of law, to stand his ground before the cross-examination of the opposing counsel, to understand the law of evidence, and to be able, impartially, to sift the wheat from the chaff in the conflicting statements made to him when getting up a case, Again, he should be thoroughly versed in municipal law so as to be able to advise and assist municipal councils in relation to roads and bridges, ditches and watercourses, and to aid in educating public opinion up to the point of appreciating the advantages to be derived by individuals and municipalities in availing themselves of the provisions for securing permanence to the limits of their lots, for the drainage of their swamp lands, and such like improvements ; in a word, he has to combine the practical with the scientific.

In this connection I would urge on our young surveyors the wisdom of losing no opportunity of acquiring information and of preserving it for use about their fields of operation. Much valuable information has been lost forever from the unsystematic way in which surveyors

have kept their notes in the past. In the public surveys the field notes of late years will compare favourably with those of any country, but in those of private surveys there is room for vast improvement. A systematic survey of the Dominion, similar to that of the Ordnance Survey of Great Britain and Ireland, is among the possibilities of the near future, and our surveyors, from their training, should be the men to whom to entrust the work.

I am glad that an Exhibition of Instruments forms one of the features of our meeting, and I bespeak a careful examination of them as marking the great advance in that line in modern times.

As an interesting specimen of the past I transcribe a letter written in the last century by the Surveyor-General in response to His Excellency's, the Right Honourable Guy, Lord Dorchester, Governor-General of the Province of Quebec, Order-in-Council of January 4th, 1791, to report a list of the instruments remaining in the office of the Surveyor-General, or in the hands of the several Deputy Surveyors. It is as follows:

[Copy.]

"QUEBEC, 31st January, 1791.

"SIR,—In answer to yours of the 28th inst., requiring me to furnish the Land Committee with a list of the instruments remaining in the Land Surveying Office and in the hands of the several Deputy Surveyors, I have to inform you that, as no allowance of instruments has ever been made to the Land Surveyor-General of the Province of Quebec, of course, there are no instruments appertaining to his office, those made use of in his department being the private property either of himself or of his deputies, and of the number in their possession I can only mention such as were commissioned out from London by me about six years ago, and sent me by Messrs. Watson and Keshleigh, being six of the best improved horizontal theodolites, for the following gentlemen, viz.: Mr. O'Hara, at Gaspé; Mr. Vondevenlden, Chaleur Bay; Mr. McCarthy, St. Thomas; Mr. Frey, Detroit; Mr. Aitkins, Kingston, and one for my son, grooved with cross-levels. Three more were likewise sent out by me when in England two years ago, and are at present in the hands of Mr. Depincier, Mr. Pennoyer, and Mr. Bedard. The whole of these instruments have circular protractors of the same divisions and dimensions of the instruments, with spar bar needles, agate cap'd, and I have now ordered out three more for Messrs. B. Germain, Bouchette, and Plamondon. Exclusive of these, there are many other good instruments belonging to the Deputy-Surveyors, Mr. Chewett having, at some expense, provided himself with two sets, and Messrs. William Fortune and Jones with one good one each, also Mr. J. McDonald, and I have seen some at Montreal in the hands of Messrs. Papineau and Delisle.

"I am not aware that any further instruments are at present wanted in my department, but that, in a great measure, depends on the nature of the work to be performed, and persons employed, as I should be loth to trust in any unskilful hands my capital set of instruments, consisting of all sorts necessary for carrying on a general sur-

vey, or making astronomical observations, made by the best artists in London. They have already been proved by me in settling the longitudes and latitudes in the northern district of North America, as inserted in the Philosophical Transactions, and with which Mr. Sproule and Mr. Wright ascertained the longitude and latitude of Gaspé and Isle of Anticosti. As they were much deranged by being removed from their boxes by Mrs. Holland, to prevent their being carried off by the Americans, while she and her family were their prisoners in the year 1776, I was under the necessity of taking the principal ones with me to England, where they underwent a thorough repair in Mr. Ramsden's hands, except a quadrant of the old construction, which was left in my office, where it has been nearly ruined.

"I have the honour to be, Sir,

"Your most obedient servant,

"(Sgd.) SAMUEL HOLLAND,

"Hon. Hugh Finlay." "*Surveyor-General.*

Ordered to lay on the table.

Another point to which I would draw the attention of the Association is the great want of a compilation of decisions of the courts on the various land cases which have come before them. Such a work would be invaluable, and I commend it to your consideration whether an attempt should not be made to have one compiled. Similar works are in existence in the United States. In the "Engineers' and Surveyors' Manual," by M. McDermott, C.E., published in Chicago in 1879, I have noticed that there is a chapter devoted to "Geodetical Jurisprudence," which contains a large number of decisions of the Supreme Courts of several States. I may add that the author is an old Provincial Land Surveyor of this Province.

I would suggest, too, that efforts be made to procure biographical sketches of the early surveyors, with photographs of them when possible, and that this be made a feature in our Association reports. Many, no doubt, are not to be had; but, with care, I am satisfied that we may rescue a goodly number from oblivion. During the last year I have obtained photos of several of our old surveyors, which are at the disposal of the Association.

If there is time, I would suggest a discussion of a practical nature as to the lasting quality of the posts planted in the early days when left to a state of nature; what timber is most durable for posts; what kind of soil they will stand longest in; also, is the number of rings of growth in a healthy tree over a blaze an absolute and unfailing proof of the age of a survey? To such questions as these all can contribute their share of information, and some reliable data may be obtained.

As an interesting contribution to the history of our profession, I have made some extracts from the old documents of record in the

Department of Crown Lands. I find that in the year following the cession of Canada by France to Great Britain, by the Treaty of Paris in 1763, a report of the Committee of Council for Plantation Affairs sets forth the propriety of appointing a Surveyor-General of Lands in the Colony of Quebec, to which is added "an estimate of the expenses attending general surveys of his Majesty's dominions in North America for the year 1764." An Order in Council was passed on February 10th, 1764, approving thereof, and Captain Samuel Holland was duly appointed. He nominated and appointed John Collins as the first Deputy-Surveyor-General, on September 8th, 1764, and his commission as such was issued by his Excellency Guy Carleton, Governor-General of Quebec, May 2nd, 1775. He was further empowered by his Excellency Frederick Haldimand, Governor-General of Quebec, on May 17th, 1784, to administer the oaths directed by law as well as the oath of allegiance. Captain Holland also nominated and appointed Philip R. Frey to be one of the Deputy-Surveyors of lands in the upper district of the Province of Quebec, on December 22nd, 1784, who was duly sworn in at Detroit, on March 30th, 1785. He was appointed to conduct surveying operations at Detroit and Niagara on the 19th January, 1785, by Captain Holland. Copies of these documents are appended, as follows:

EXTRACT FROM SURVEYOR LETTERS, D., PAGE 27.

[Copy.]

To the King's Most Excellent Majesty:

MAY IT PLEASE YOUR MAJESTY,—We, your Majesty's Commissioners for Trade and Plantation, beg leave humbly to represent to your Majesty that, in the consideration of measures proper to be pursued for the dividing, laying out and settling such parts of your Majesty's American dominions as it is expedient for your Majesty's service to grant as soon as possible, in order that your subjects may avail themselves of the advantages which such settlement will produce to the trade, navigation and manufacturing of this kingdom, we find ourselves under the greatest difficulties arising from the want of exact surveys of those countries, many parts of which have never been surveyed at all, and others so imperfectly that the charts and maps thereof are not to be depended upon, and in this situation we are reduced to the necessity of making representations to your Majesty, founded upon a little or no information, or of delaying the important service of settling these parts of your Majesty's dominions.

For these reasons it is our duty humbly to recommend to your Majesty in the strongest manner that no time should be lost in obtaining accurate surveys of all your Majesty's North American dominions, but more especially of such parts as, from their natural advantages, require our immediate attention.

To effectuate this purpose, we would humbly submit to your Majesty whether it may not be expedient that for the present, and with a view to this temporary service, your Majesty's dominions upon

the continent of North America should be divided into a Northern and Southern District, with a Surveyor-General of Lands to be appointed for each to act under such instructions as he shall receive from time to time from this Board.

If your Majesty shall be graciously pleased to approve what we here propose, we doubt not but speedy orders will be given for carrying this measure into execution, and we beg leave humbly to lay before your Majesty, for your consideration, the annexed proposals offered us by Captain Samuel Holland, who has great knowledge of the northern parts of America, and who has not only distinguished himself as a brave and active officer, and able engineer in your Majesty's service, but also as a skilful surveyor, in the accurate map he has made of the settled parts of your Majesty's Colony of Quebec; and we beg leave to observe to your Majesty that these proposals appear to us to arise entirely from Captain Holland's zeal for your Majesty's service, as he desires no additional emolument, being well satisfied with your Majesty's gracious intention of appointing him to the office of Surveyor of Lands in your Majesty's Colony of Quebec.

We are further humbly of opinion that the extraordinary expenses which he proposes for this service are perfectly reasonable and necessary; but we humbly recommend that two sets of instruments mentioned in his estimate should be allowed, lest the work should be interrupted by any accident happening to any of them.

All which is most humbly submitted.

(Signed) HILLSBOROUGH.
ED. ELLIOTT.
ORWELL.
BAMBER GASCOYNE.

4th February, 1764.

[Copy.]

AN ESTIMATE OF THE EXPENSES ATTENDING GENERAL SURVEYS OF HIS MAJESTY'S DOMINIONS IN NORTH AMERICA FOR THE YEAR 1764.

	£	s.	d.
To an allowance for a Deputy-Surveyor at Quebec, during the time the Chief Surveyor is employed in making surveys in other parts of the northern district	100	0	0
To 2 assistant surveyors, to be employed in the general survey, at 7*s.* per day each	254	10	0
To 1 draughtsman at 5*s.* per day	91	5	0
To an additional of 1*s.* 8*d.* per day, and to 1 sergeant £1 1*s*; 10*s.* one corporal, and 6*d.* per day to 12 private men, to assist in such survey, as camp, colour and chainmen, and to make signals along shore and on the tops of mountains	155	2	0
To extraordinary expenses for horses and guides, etc.	100	0	0
To an allowance for two sets of proper instruments for the surveyor of the northern district	416	15	0
	1,117	12	0

AT the Court of St. James', the 10th day of February, 1764.

Present—The King's Most Excellent Majesty in Council.

Upon reading at the Board a report from the Right Honourable the Lords of the Committee of Council for Plantation Affairs, dated the 4th of this instant, in the words following, viz.:

"Your Majesty, having been pleased by your Order in Council of the 21st of December last, to refer unto this committee a representation from the Lords Commissioners for Trade and Plantations, proposing that accurate surveys should be made of your Majesty's North American dominions, but more especially of such parts as, from their natural advantages, require immediate attention, and to effectuate this purpose they submit whether it may not be expedient, and with a view to this temporary service, that your Majesty's dominions upon the continent of North America should be divided into a Northern and Southern District, with a Surveyor-General of Lands to be appointed for each, to act under such instructions as he shall receive from time to time from the said Lords Commissioners, the said Lords Commissioners did at the same time humbly lay before your Majesty a memorial they received from Captain Samuel Holland, whom they represent as a person of great merit, containing proposals for carrying a survey of the northern district into execution, together with accounts and estimates of the several particulars necessary for that service, which the said Lords Commissioners conceive to be very reasonable. The Lords of the Committee, in obedience to your Majesty's said order of reference, this day took the said representation of the Lords Commissioners for Trade and Plantations, and likewise the several proposals contained in the said memorial of Captain Holland, into their consideration, and are humbly of opinion that it will be for your Majesty's service that the proposals of the said Lords Commissioners, and likewise those contained in the memorial of Captain Samuel Holland, should be carried into execution as soon as conveniently may be."

His Majesty took this day the said report into consideration, and was pleased with the advice of his Privy Council to approve thereof, and accordingly to order, as it is hereby ordered, that the Lords Commissioners of his Majesty's Treasury do cause the several proposals contained in the representation of the Lords Commissioners for Trade and Plantations, and likewise those contained in the memorial of Captain Holland (copies whereof are hereunto annexed), to be carried into execution, except such parts thereof as relate to the appointment of soldiers, and furnishing an armed vessel and boats for the aforementioned service, with respect to which his Majesty hath this day given the necessary directions to the Lords Commissioners of the Admiralty and to the Secretary at War.

(Signed) PHIL. SHARPE.

QUEBEC INSTRUCTION BOOK 5, PAGE 9.

[Copy.]

Samuel Holland, Esq., Surveyor-General of his Majesty's Province of Quebec, and the Northern Districts.

To John Collins, Esq.—Greeting:

By virtue of the power and authority to me given by his Majesty, I do, by these presents, nominate, constitute and appoint you to be my Deputy Surveyor-General for the admeasuring, surveying, setting out of roads and lands in the Province of Quebec, agreeable to my instructions hereunto annexed, with power to the said John Collins to do, execute and perform, by himself or the Assistant Deputy or Deputies, all things whatsoever belonging to the said office, to have, hold, exercise and enjoy the same during our pleasure, together with the salary granted by Parliament, and a moiety, or half part, of all salaries, fees, perquisites, profits and advantages thereunto belonging or appertaining to the said office, subject to further instructions in the premises, and for so doing this shall be your deputation.

Given under my hand and seal at Quebec, this eighth day of September, in the fourth year of the reign of our Sovereign Lord, George the Third, one thousand seven hundred and sixty-four.

(Signed) SAMUEL HOLLAND.

QUEBEC INSTRUCTION BOOK 5, PAGE 11.

[Copy.]

PROVINCE OF QUEBEC.

COMMISSION FROM HIS EXCELLENCY GENERAL CARLETON TO J. COLLINS, AS DEPUTY-SURVEYOR-GENERAL, MAY 2ND, 1775.

Guy Carleton, Captain-General and Governor-in-Chief in and over the Province of Quebec and the territories depending thereon in America, Keeper of the Great Seal of the said Province, Vice-Admiral of the same, and Major-General of his Majesty's forces, commanding the Northern District of North America, etc.

To all to whom these presents shall come, sendeth greeting:

Know ye, that being well assured of the loyalty, prudence and integrity of the Honourable John Collins, of the City of Quebec, in the Province aforesaid, Esq., and one of the members of his Majesty's Council for the said Province, and having had experience during the course of many years' service, of his capacity and abilities in the execution of the office of Deputy-Surveyor-General of lands of the said Province, I have thought fit to constitute and appoint, and do, by these presents, constitute and appoint him, the said John Collins,

to be Deputy-Surveyor-General of lands in and for the said Province of Quebec, to have, hold, exercise and enjoy, the office of Deputy-Surveyor-General of lands aforesaid, unto him, the said John Collins, during pleasure, together with such fees as shall hereafter be allowed, or appointed by me, or other of his Majesty's Governors-in-Chief, or Lieutenant-Governor, or other Commander-in-Chief of the said Province for the time being, by and with the consent of His Majesty's Council for the same, to be taken in respect of the execution of the said office.

Given under my hand and seal at arms, at the Castle of St. Louis, in the City of Quebec, this second day of May, in the fifteenth year of his Majesty's reign, and in the year of our Lord one thousand seven hundred and seventy-five.

(Signed) GUY CARLETON.

By his Excellency's command.

(Signed) GEO. ALLSOP.

QUEBEC INSTRUCTION BOOK 5, PAGE 1.

[Copy.]

George the Third, by the Grace of God, King of Great Britain and the Territories thereunto, Defender of the Faith, and so forth.

To our trusty and well-beloved the Honourable John Collins, of the District of Montreal, in the Province of Quebec, Esq.—Greeting:

Know you that we have thought fit to empower you, and we do hereby give and grant unto you full power and authority, to tender and administer unto all persons whom it may concern, the oaths directed by law, and the declaration followeth, that is to say, I, do promise and declare that I will maintain and defend to the utmost of my power the authority of the King in his Parliament, as the Supreme Legislature of this Province, and to receive from such persons their subscriptions, severally, to the oaths and declarations, and what you shall do herein, you are here to make return into the office of our Clerk of the Council for our said Province, together with this Writ.

Witness our trusty and well-beloved Frederick Haldimand, our Captain-General and Governor-in-Chief of our said Province of Quebec, at our Castle of St. Louis, in our City of Quebec, the seventeenth day of May, in the year of our Lord 1784.

(Signed) FREDERICK HALDIMAND.

By his Excellency's command,

(Signed) ALEXANDER GRAY, a C. C.

LETTER BOOK, NASSAU, NO. 2, PAGE 4.

[Copy.]

By Samuel Holland, Esq., Member of the Legislative Council and Surveyor-General of the Province of Quebec, etc.

To Philip R. Frey, Gentleman:

By virtue of the power and authority to me given by his Majesty I do hereby constitute and appoint you to be one of the Deputy Surveyors of Lands, for making surveys in the Upper District of the Province of Quebec; authorizing and requiring you to execute and perform the office of a Deputy Surveyor, agreeable to the orders and instructions hereunto annexed, or to be annexed, by his Excellency the Governor or Commander-in-Chief, or from the Courts of Judicature, or from me, or from the Deputy Surveyor-General of this Province, hold, exercise and enjoy the same during pleasure, together with the fees and advantages thereunto belonging or appertaining; and you are to make your surveys agreeable to the justice and the rules of the science of surveying.

Enregistered in the Register of Detroit, page 59, by me.

WM. MONFORTON,
Recorder.

Given under my hand and seal at Quebec, this twenty-second day of December, one thousand seven hundred and eighty-four.

(Signed) SAMUEL HOLLAND.

I, Philip Frey, do solemnly swear on the holy Evangelists of the Almighty God that I will act impartially and do justice between man and man, as far as my knowledge doth extend in the science of surveying.

Detroit, 30th March, 1785.
Before me, date as above.

ALEX. MACOMB, C.P.

(Signed) PHILIP R. FREY,
Deputy Surveyor for the Upper District of the Province of Quebec.

Enregistered in the Register of Detroit, page 59, by me.

WM. MONFORTON,
Recorder.

LETTER BOOK, NASSAU, NO. 2, PAGE 5.

[Copy.]

NEAR QUEBEC, 19th January, 1785.

DEAR SIR,—You will perceive by the joined instructions that I have appointed you for Niagara and Detroit, as the business in our Department, at the place of your abode, is for the present but little,

and would not afford the fixed allowance of 4s. h. c. per day. I thought best to name you for both places, to which you will, I hope, agree to, as, at Niagara, your presence shall be much wanting in laying out the lots. As I had no time to make out copies of your instructions for the commanding officer, you must make out two, and transmit them as soon as possible.

Your theodolite I shall send by the first opportunity to your friend, Mr. Mackeown, at Montreal, who has promised me to send it up to you by the first batteaux.

Mr. Jenkin William, our solicitor and Clerk of Council, is arrived last night, by the way of New York from London. I received several letters by him, among others one from William Smith, Esq., late Chief Justice of New York, and now appointed in that capacity in this Province. He tells me that he will come out next spring with our Viceroy, Sir Guy Carleton; he thinks that settlers will flash in the Province from all quarters of America, and will make work enough for surveyors. By another letter it seems my friend, Smith, will bring out another code of laws, and Sir Guy will have full instructions to improve the Province and encourage new settlers; so I hope Detroit will have soon another appearance, and the most likely spot to find a comfortable climate. My son, Jack, is sailed with Captain Bouchette to the West Indies to visit his relations; my son, Henry, has exchanged from half-pay to the 70th Regiment with Lieut. Finley in the 44th Regiment by paying the difference. By a fall out of my cariole I have hurt my head and eyes so much that I scrawled this in much pain, so you must excuse me, and believe me, with the greatest sincerity,

My dear Sir,
Your most obedient humble
Servant and friend,
(Signed) SAMUEL HOLLAND.

MR. PHILIP FREY,
Detroit.

On the 24th July, 1788, the Province of Quebec, which had up to that time been divided only into two districts, was further divided into the Districts of Lunenburgh, Mecklenburgh, Nassau, Hesse and Gaspè, with the first four of which we are at present only interested as covering what is now the Province of Ontario. The proclamation by Lord Dorchester is appended:

PROCLAMATION.

DORCHESTER, G.

George the Third, by the Grace of God, of Great Britain, France, and Ireland, King, Defender of the Faith, and so forth.

To all our loving subjects whom these presents may concern.—Greeting:

Whereas our Province of Quebec stands at present divided only into two Districts, and, by virtue of two certain Acts or Ordinances,

the one passed by our Governor and the Legislative Council, in the twenty-seventh year of our reign, and the other in the present year, provision is made for forming and organizing one or more new Districts.

Now, therefore, know ye, that our Governor of our said Province, by the advice and consent of our Council of our said Province, and in pursuance of the Acts and Ordinances aforesaid, hath formed, and doth hereby form, the several new Districts hereinafter described and named, to wit, the *District of Lunenburgh*, bounded on the east by the eastern limit of a tract lately called or known by the name of Lancaster, protracted northerly and southerly as far as our said Province extends; and bounded westerly by a north and south line intersecting the mouth of the River Gananoque, now called the Thames, above the rifts of the St. Lawrence, and extending southerly and northerly to the limits of our said Province, therein comprehending the several towns or tracts called or known by the names of Lancaster, Charlottenburgh, Cornwall, Osnabruck, Williamsburgh, Matilda, Edwardsburg, Augusta, Elizabethtown; and also one other District, to be called the *District of Mecklenburgh*, extending within the north and south bounds of our said Province, from the western limits of the said District of Lunenburg as far westerly as to a north and south line intersecting the mouth of a river now called the Trent, discharging itself from the west into the head of the Bay of Quinté, and therein comprehending the several towns or tracts called or known by the names of Pittsburg, Kingstown, Ernestown, Fredericksburg, Adolphustown, Marysburg, Sophiasburg, Ameliasburg, Sydney, Thurlow, Richmond and Camden; and also one other District, to be called the *District of Nassau*, extending within the north and south bounds of our said Province, from the western limit of the last mentioned District so far westerly as to a north and south line intersecting the extreme projection of Long Point with the Lake Erie on the northerly side of the said Lake Erie; and also one other District, to be called the *District of Hesse*, which is to comprehend all the residue of our said Province in the western or inland parts thereof, of the entire breadth thereof, from the southerly to the northerly boundary of the same; and also one other District, to be called the *District of Gaspè*, and to comprehend all that part of our said Province, on the southerly side of St. Lawrence, to the eastward of a north and south line intersecting the north-easterly side of Cape Cat, which is on the southerly side of the said river, of which all our loving subjects are to take due notice, and govern themselves accordingly.

In testimony whereof we have caused these our letters to be made patent, and the great seal of our said Province to be herewith affixed.

Witness our trusty and well-beloved Guy, Lord Dorchester, Captain-General, and Governor-in-Chief of our said Province, at our castle of Saint Louis, in our City of Quebec, the twenty-fourth day of July, in the year of our Lord one thousand seven hundred and eighty-eight, and of our reign the twenty-eighth.

(Signed) GEO. POWNALL,
Secretary.

On the 17th February, 1789, Rules and Regulations for the conduct of the Land Office Department were published. Under these, Land Boards were appointed for each of the above districts, whose duties (among others mentioned) were to receive applications for grants of land, to enquire into the loyalty of the petitioner, and, if satisfied thereof, to give to every such petitioner a certificate to the Surveyor-General, or Deputy-Surveyor for the District, who was bound, within two days, to assign the petitioner a single lot of about two hundred acres, describing the same with due certainty and accuracy. Additional Rules and Regulations for the conduct of the Land Office Department were published August 25th, 1789.

Copies of aforesaid certificates are hereto appended:

[Copy.]

SINGLE LOT.

No.

Certificate of the Board appointed by his Excellency the Governor for the District of in the Province of Quebec, under the Rules and Regulations for the conduct of the Land Office Department, dated Council Chamber, Quebec, 17th February, 1789.

The bearer , having on the day of , preferred to this Board a petition addressed to his Excellency the Governor in Council for a grant of acres of land in the Township of in the District of . We have examined into his loyalty and character, and find him duly qualified to receive a single lot of about two hundred acres, the oath of fidelity and allegiance directed by law having this day been administered to him by the Board, in conformity to the fourth article of the Rules and Regulations aforementioned.

Given at the Board at , this day of , one thousand seven hundred and .

To , Acting Surveyor for the District of .

CERTIFICATE OF THE ACTING SURVEYOR.

No.

I assign to the bearer , the Lot, No. , in the Township of , in the District of , containing acres , chains , which lot he is hereby authorized to occupy and improve. And having improved the same, he shall receive a grant thereof to him and his heirs, or devisees, in due form, on such terms and conditions as it shall please his Majesty to ordain. And all persons are desired to take notice that this assignment, and

all others of a similar nature, are not transferable by purchase, donation, or otherwise, on any pretence whatever, except by an act under the signature of the Board for the District in which the lands are situated, which is to be endorsed upon this certificate.

Given at , this day of , one thousand seven hundred and .

Acting Surveyor for the District of

Also copy of a letter, dated July 7th, 1788, from John Collins, Deputy-Surveyor-General, to Philip Frey, Deputy-Surveyor, Niagara, publishing the appointment of different surveyors in each of the four Districts, to receive claims and applications for land from the American Loyalists and others; also copies of two letters to Mr. Philip Frey, from Deputy-Surveyor Collins, dated 31st July, 1788; also copy of instructions to Mr. Frey, from Mr. Collins, dated May 20th, 1790.

LETTER BOOK, NASSAU, NO. 2, PAGE 10.

[Copy.]

SURVEYOR-GENERAL'S OFFICE, QUEBEC,

7th July, 1788.

SIR,—It being the command of his Excellency the Governor-General, that the American Loyalists and others, admitted to become citizens of this Province, have portions of land assigned to them with dispatch and with as little trouble and expense to themselves as possible, notice is hereby given that Mr. William Chewett, at Lake St. Francis, and Mr. Patrick McNiff, at the Ottawa or Grand River, Mr. James and Hugh McDonell, at the vacant lands between Elizabethtown and Pittsburg, Mr. Alexander Aitkin, at Kingston or Toronto, and Mr. Philip Frey, at Niagara or Detroit, all Deputy-Surveyors, and now on the business of surveying at or near the respective places aforementioned, have authority to receive claims and applications for the purposes above mentioned, to be transmitted to me for his Lordship's consideration, and that the same Deputy-Surveyor will, upon his Lordship's approbation, have orders from this office to ascertain to the settlers their several respective apportionments in either of the Districts of Lunenburg, Mecklenburg, Nassau or Hesse.

(Signed) JOHN COLLINS, D.S.-G.

MR. PHILIP FREY,
Deputy-Surveyor, Niagara.

LETTER BOOK, NASSAU, NO. 2, PAGE 10.

[Copy.]

SURVEYOR-GENERAL'S OFFICE,
31*st July*, 1788.

SIR,—Inclosed you have a general instruction for your Government in laying out lands in future, and also a copy of his Excellency Lord Dorchester's commands in Council of the 7th inst., both of which you will please to attend to. My former letters respected a particular account of your settlement, and a plan of the same, which I now beg leave to repeat, that you send it this office by the first safe conveyance. Let your plan include the whole settlement from the head of the Lake Ontario to Detroit. I expect his Excellency Lord Dorchester will soon visit the Western country. In that case you will give his Lordship every necessary information he may require respecting carrying on the settlement in that quarter. The Surveyor-General being absent from this Province makes it necessary you appoint some agent here to present your accounts and receive your money. Let your accounts be proved, and all the vouchers for money paid by you accompany them.

I wish you health, and am with regard,
Your most obedient servant.

(Signed) JOHN COLLINS, D.S.-G.

MR. PHILIP FREY,
Deputy-Surveyor, Niagara.

LETTER BOOK, NASSAU, NO. 2, PAGE 15.

[Copy.]

QUEBEC, 31*st July*, 1788.

I enclose you a copy of a late Report in Council on the business of surveys, and in furtherance of that economy which ought to be considered by all the officers of the Crown, and especially in our department, in which the expenditures have been so considerable. I add that you will use your directions in carrying your field work to no greater extent than will be necessary for your returning such a proportion as will enable the Surveyor-General to issue out of it returns for specific quantities in future directed to be granted, and suffice for the Patentee's laying out his grant with competent certainty, equal safety to himself and the Crown. It is under this idea that the actual survey of only one line along the water directed to be actually run from and to fixed boundaries, except when number of settlers ready to begin to work, and in danger from their want of knowledge in surveys of commencing in concession, may make it requisite to give the first concession a road, or rather the second concession a front line, with so much of the exterior side lines of the township and the breadth by the subdivisions

of the first concessions, as will guide those grantees in extending the side line of their own lots to the road in the rear of that concession, dividing it from the second as in the first; one grant will thus be made to connect with other prior in time. There must be the due care to ascertain the two capital stations for the breadth of the township, and to blaze healthy trees for the purpose; several of them should be distinguished by marks, and their bearing and distances from the precise spot.

A blaze through the rind and lettered, cut into the wood by such an instrument as is used by coopers in marking casks, I am told has been opened or boxed after eight years and shown the letters perfectly fresh and legible.

PHILIP FREY, ESQ. JOHN COLLINS.

LETTER BOOK, NASSAU, NO. 2, PAGE 33, 34.

[Copy.]

SURVEYOR-GENERAL'S OFFICE,
QUEBEC, 20*th July*, 1790.

Instructions to Mr. Philip Frey, Deputy Surveyor of the District of Nassau:

SIR,—His Excellency having been pleased to direct that the Land Board of Nassau employ the Surveyor of their district, with ten men, to survey and mark the front lines of townships from the eastern boundary of their district to Toronto, and to carry the side line of each township one mile well marked, at such time as may best fall in with their general arrangement of the summer business of their district, if other more necessary work will admit of it.

You are to proceed to the execution of these services at such time and agreeable to such instructions as the Land Board of your district may direct, reporting to this office protractions of the work when finished.

You are directed to keep a journal and field book, writing whatever is observable for its singularity and value towards the public utility as water-falls, minerals, quarries, the quality of the land and timber, etc., etc.

And I am charged to apprise you that besides your return to me of a map and field book, you do also account for the time to be spent on it in a journal to be kept for the purpose with such minuteness and certainty as will enable you to answer questions respecting the business upon oath, if the same should be required.

There must be very strict attention paid to economy in the whole service, and the hands dismissed as soon as they can be spared; and as the accounts will all be subject to audit, you will take care to furnish the documents that will be expected in justification of every article of charge. It is not, however, his Lordship's intention by

any small savings to disappoint the useful end for which these surveys are commanded; but there must be a responsible discretion exercised in the expenses both of the time and the means.

And you are on the receipt of these instructions to communicate the same to the Land Board of your district for their information, and that they may be the better enabled to direct such further particulars as their local knowledge and experience may suggest.

I am with regard, Sir,

Your most obedient servant.

(Signed) JOHN COLLINS, D.S.G.

Approved by his Excellency Lord Dorchester,

31*st May*, 1790.

(Signed) HENRY MOTZ.

The following appears to have been the method adopted in carrying out surveys under this *régime*. Each Land Board had one or more Deputy-Surveyors attached to them, who performed surveys as directed by them, as the following extract from the Land Board of Nassau shows:

"Land Board for the District of Nassau, held at Niagara the 6th June, 1791.

"Present—Colonel Gordon, Commanding Upper Posts, Lieut.-Colonel John Butler, Robert Hamilton, John Burch, Robert Kerr, John McNabb, Lieut. Bruyers, R. Engineers.

"The Board having met, Col. Gordon laid before them several letters and instructions from headquarters for their guidance, which were read, also a paper signifying the appointment of Mr. Jones as Deputy-Surveyor for this District, who was sworn by the Board for that purpose. Instructions were given to the Surveyor to proceed in laying out the town of Lennox."

The Deputy-Surveyors were appointed by the Surveyor-General, as the foregoing extracts from letters show.

The following certificate of the examination of a Deputy-Surveyor about this period will be of interest, also the oath of office to be taken by Surveyors, also the commission, as a Deputy-Surveyor for the Province of South Carolina, of Wm. Fortune, admitted a Deputy-Surveyor for the Province of Quebec, July 4, 1788.

EXTRACT FROM LETTERS RECEIVED, VOL. I., P. 41.

Pursuant to an Order from His Excellency John Graves Simcoe, Esquire, Lieut.-Governor and Commander-in-Chief of the Province of Upper Canada, etc., etc., etc.

I have examined Mr. Lewis Grant previous to his being appointed one of the Surveyors of the said Province, relative to his knowledge in the Theory and Practice of Surveying and Drawing, viz.:

In the necessary parts of arithmetic.

In the necessary parts of geometry and trigonometry.

In the necessary parts of surveying, such as:

Viz.—Surveying a regular or irregular field by the circumferentor or chain, and finding the content of the same.

Surveying a small river on the ice, and protracting the same, by the theodolite and traverse table.

Surveying a large river, intersecting its opposite side, and protracting the same by the theodolite and traverse table.

Surveying and laying out a township, regular or irregular, and protracting the same, by the theodolite traverse table and sector.

In fixing a meridian, and finding the variation of the compass.

In finding the latitude by the sun's meridian altitude.

In levelling, for the purpose of making aqueducts, etc., etc.

(Signed) W. CHEWETT,
Actg. Sur.-Gen.

Examined during the 25th, 26th, and 27th Aug., 1792.
Grand River, in the County of Stormont, 27th Aug., 1792.

LETTERS RECEIVED, VOL. I., P. 98.

OATH TO BE TAKEN BY ALL DEPUTY-SURVEYORS.

I do solemnly swear that I will be true and faithful to the trust reposed in me as Provincial Deputy-Surveyor, and most carefully attend to the interests of the Crown in the performance of the different duties I shall be engaged in.

That I will strictly observe the ordinances, rules, and regulations now in force, or which may be hereafter established for the administration of the Land Granting Department, that I will punctually execute with fidelity and despatch whatever orders and instructions I may from time to time receive from the Governor, Lieut.-Governor, or Person administering his Majesty's Government

and the Executive Council of this Province, the Surveyor-General thereof, and every other my superior officer, in all matters respecting the duties of my office, that I will keep exact and regular journals and records of all my transactions therein, perform the services I shall be employed upon without unnecessary delay or expense, and make faithful reports on my return of all useful discoveries which I may meet with in the course of my surveys, and that I will at all times and upon all occasions honestly and conscientiously discharge the several functions of a Deputy-Surveyor with the strictest diligence, impartiality and justice.

So help me God.

LETTERS RECEIVED, VOL. I., P. 142.

Sir Egerton Leigh's Deputation to Mr. Wm. Fortune. } South Carolina.

To all whom these Presents shall come, I, Sir Egerton Leigh, Baronet, Surveyor-General of his Majesty's Province of South Carolina, send greeting:

Know ye that I, the said Sir Egerton Leigh, reposing especial trust and confidence in you, William Fortune, in your knowledge, skill, and ability in the Art of Surveying, have made, nominated and ordained, deputed and appointed, and by these presents do make, nominate, ordain and appoint you, the said William Fortune, to be my lawful Deputy-Surveyor for the Province of South Carolina, to have, hold, use, exercise and enjoy the said office of Deputy Surveyor, together with all fees, perquisites and profits whatsoever thereunto belonging, which in and by an Act, entitled: "An Act to ascertain the Fees of the Surveyor-General for the time being, and his Deputies, etc.," passed the thirteenth day of April, 1733, are appointed, limited and ascertained, observing the said Act, and the instructions herewith given you, and such other lawful orders and directions as from time to time ye shall receive from me.

This Deputation to continue during pleasure.

In witness whereof, I have hereunto put my hand and seal the 5th day of May, in the Year of our Lord one thousand seven hundred 73, and the thirteenth year of his Majesty's reign.

(Signed) EGERTON LEIGH.
Surveyor-General.

The above William Fortune was duly qualified as a Deputy-Surveyor, this 7th day of May, 1773.

(Signed) J. SIMPSON.

The division of the Province of Quebec into the Provinces of Upper and Lower Canada took place in 1791. The following is the Proclamation :

LETTERS RECEIVED, VOL. I, P. 192, 193.

DIVISION OF THE PROVINCE OF QUEBEC.

ALURED CLARKE.

George the Third, by the Grace of God, of Great Britain, France and Ireland, King, Defender of the Faith, etc.

To all our loving subjects whom these presents may concern.—Greeting:

Whereas we have thought fit, by and with the advice of our Privy Council, by our Order of Council, dated in the month of August last, to order that our Province of Quebec, should be divided into two distinct Provinces, to be called the Province of Upper Canada and the Province of Lower Canada, by separating the said two Provinces, according to the following line of division, viz.:

"To commence at a stone boundary on the north bank of the Lake St. Francis, at the cove west of Point-au-Bodet, in the limit between the Township of Lancaster and the Seigneurie of New Longueuil, running along the said limit in the direction of north thirty-four degrees west, to the westernmost angle of the said Seigneurie of New Longueuil; thence along the north-western boundary of the Seigneurie of Vaudreuil, running north twenty-five degrees east until it strikes the Ottawa River, to ascend the said river into the Lake Tamiscaming; and from the head of the said lake by a line drawn due north until it strikes the boundary-line of Hudson's Bay, including all the territory to the westward and southward of the said line, to the utmost extent of the country commonly called or known by the name of Canada."

Witness our trusty and well beloved Alured Clarke, Esquire, our Lieutenant-Governor and Commander-in Chief of our said Province of Quebec, Major-General commanding our forces in North America, etc., etc., etc., at our Castle of St. Louis, in the City of Quebec, this eighteenth day of November, in the year of our Lord 1791, and in the 32nd year of our reign.

(Signed) A. C.

(Signed) HUGH FINLAY,
Acting Secretary.

The Province of Upper Canada was divided, the following year, into nineteen counties, viz.:—Glengarry, Stormont, Dundas, Grenville, Leeds, Frontenac, Ontario, Addington, Lennox, Prince Edward, Hastings, Northumberland, Durham, York, Lincoln, Norfolk, Suffolk, Essex, Kent. And the first Provincial Parliament met at Niagara on the 17th day of September, 1792, John Graves Simcoe being Lieutenant-Governor, in the 32nd year of George III. Chapter viii. of

the Statutes passed the first session of this Parliament altered the names of the four districts from Lunenburgh, Mecklenburgh, Nassau and Hesse, into the Eastern, Midland, Home and Western Districts.

The Land Boards were abolished by Order-in-Council, dated November 6th, 1794, and it was directed that all applications for land should be made to the Lieutenant-Governor-in-Council. And from that time surveys were made under direct instructions from the Surveyor-General, in pursuance of the Proclamation of his Excellency Lieutenant-Governor Simcoe, dated February 7th, 1792, the first clause of which says that the Crown lands "are to be run out and marked by his Majesty's Surveyor or Deputy-Surveyor-General, or under his sanction and authority."

I trust I have not wearied you in giving this page out of our early history, but I confess it has a certain fascination for me, and if time and opportunity permit I may perhaps trespass on your attention for another page.

In closing, allow me to express a hope that you may have a pleasant and profitable time in listening to the papers on the agenda and in the discussions to follow; and that, with the Divine blessing, we may meet next year with an increased membership, our Association, like a vigorous young sapling, adding an annual ring, with the sap of youthful life pulsating in every pore, ever widening in interest and prospering in every department.

GEORGE B. KIRKPATRICK,
President of the Association of Provincial Land Surveyors of Ontario

Toronto, March 1st, 1887.

Mr. O. J. Klotz—I would move that the hearty thanks of this convention be tendered to the President for his interesting and able address. There is one point he has touched upon, concerning which I would like to make a few remarks, and that is in regard to the compilation of the Decisions of the Courts of Ontario regarding our surveys. I had hoped that I would be able to present here to-day a book that has been issued by the Michigan Association. It is a book for use by surveyors, a manual, in fact, of surveying, with an appendix containing all the decisions that have been made in the United States courts in regard to surveys. I think that a similar compilation might be made by this Association. We have plenty of men who are fully competent to undertake the work, and carry it out successfully. I would suggest that a committee should be appointed to take this matter in hand. That is, however, an after consideration. In the meantime I would move that a hearty vote of thanks be tendered our President for the very able and interesting address with which he has favoured us.

The resolution was seconded by Mr. Niven, and carried unanimously.

PAPERS.

[*This Association is not responsible as a body for any opinions expressed in its Papers by Members.*]

CROWN SURVEYS.

By ELIHU STEWART,
P.L.S., Collingwood.

Mr. President, Vice-President and Gentlemen,—It has often occurred to me that the reports of surveyors, as found in the Crown Lands Departments of Ontario and Quebec would furnish material for a very interesting work on pioneer life in these Provinces.

In no other quarter can we find so much reliable information concerning the physical appearance of the country in what might be called its infancy; but, in addition to this, we can glean both from what is actually stated in these reports, and also from what is fairly deducible from them, a vast amount of information concerning the early settlers in what are now our most prosperous districts. It is not too much to say that he who has read over those early reports carefully has had a glimpse of life as it existed along the St. Lawrence and the lakes when the wilderness region to the north was a veritable terra incognita, known only to the trader and the Indian. These records are intensely interesting to the members of our profession, inasmuch as, in addition to the information they contain concerning the country in those early days, they are the autobiographies of many of our professional brethren now passed to another colony. And as we read of their trials and difficulties and privations in the discharge of their duty, in the forest region along the great lakes, where now vast cultivated fields and hamlets, and towns and cities stand; where now is heard the shrill whistle of the locomotive and the happy song of free labour, but where then was only heard the dull, monotonous Indian drum, or the wild animals of the forest, we realize how similar their experience to that of the surveyor in our northern regions to-day. But it is not my intention at this time to dwell on this phase of the subject, but to say something that may be of practical benefit to the younger members of the profession, who may be entrusted in the future with the execution of such work by the Department.

It is now the usual practice to have this work done during the summer season; and any surveyor, suspected as likely to be employed, will, long before the time of receiving his instructions, have the offer of any number of applicants, who will be anxious to aid him in the performance of his work. It seems to be the general opinion of those who have never been engaged on this work that it is a mere pastime,

a sort of perpetual picnic, very closely allied with the pleasure indulged in by so many during the summer holiday season. I need not say here that this idea will scarcely survive three days' actual experience.

The surveyor should take with him two good chainmen, capable of keeping the notes, a good cook, and an assistant, capable of taking charge when the surveyor may not be able to do so. As for the other men, he can generally get them near the work, unless he is going very far from settlement. In any case do not take men who have had no experience of pioneer life. The difficulties met with by the party in charge may arise from various causes, but difficulties, and many of them, will always appear, and the surveyor will have to use his best judgment and exercise all his ingenuity to overcome them. Very frequently these will arise from defection in some of the party, and often the men you expected most from will be the first to become dissatisfied. Then, in many cases, the greatest difficulty will be found in getting to the township, and after reaching it your ingenuity will be taxed in order to comply with the instructions, and, at the same time, succeed in getting in the necessary supplies. All information that it is possible to get should be obtained in advance, or you will have the mortification of finding, when it is too late, that you could have reached the work and conducted the whole survey much more advantageously if you had proceeded on an entirely different plan. I would emphasize the necessity of having good men accustomed to such work and familiar with the hardships which they will encounter, and, in this connection, I will trespass on your time by relating my own experience some years ago.

In the spring of 1875 I was instructed to survey the Township of Machar, in the Huron and Ottawa District; and, though I had then some experience in similar work, I was verdant enough to imagine that I had secured three first-class axemen, when the same number of robust shantymen signified their willingness to accompany me. I engaged them in the Town of Collingwood, and, with them and a few others, I left by the first boat of the season for Parry Sound. On arriving there I again found, after some difficulty, a couple of men with teams, who agreed, for the sum of $6 each per day, to take loads as far as it was possible for them to go. After three days of travelling we arrived at a point on the Rosseau and Nipissing road exactly where now stands, in all its lordly magnificence, that excellent hostelry, known by the expressive, if not euphonious, name of the Bummer's Roost. At that time we had passed some eight miles beyond the limits of settlement. Here we unloaded the waggons and dismissed our teamsters, this being the nearest point on the road to the beginning of the work. I might say, however, that, even before this, the three stalwart shantymen who, before starting from town, had expressed a longing for just such work as we had experienced, and were only desirous that it should continue longer than I anticipated, had begun to show signs of mutiny, but no open revolt had yet been proclaimed. After making a *cache* near the roadside, and leaving what we could not carry with us, we started eastward through the woods with our packs. We had not gone far before we met a newly

surveyed line, by which we were able to locate our position and calculate accurately the distance to where our work would commence. This was Saturday afternoon, and I was greatly cheered by the really excellent conduct, as well as the cheerfulness exhibited by the whole party, and the three men above referred to especially, during the evening of that day and the whole of the day following. We, of course, like good Christians, rested on Sunday, and, like the Lotos-eaters, they seemed to wish it always Sunday afternoon. Monday morning came, and, as I remember it, it was a glorious day. The weather was all that we could wish. It was about the 24th of May, neither too hot in the day time or too cold at night, and the flies had not yet made their appearance; but for some reason all the cheerfulness seemed to have departed with the Sabbath from the three stalwarts, on whose magnificent physical appearance I had looked with so much pride as they paced the streets of Collingwood; their loads, they said, were too intolerable to be borne, and they began to wish themselves in a decidedly torrid climate if they ever engaged with another surveyor. However, we finally reached the corner of the township where our work was to begin, and, I might also say, my greatest difficulties. In a day or two more it was necessary to send for more supplies, and I accordingly despatched two of these men, who, after arming themselves sufficiently for protection against the bears and wolves that then infested that region, and taking along our dog to give them timely warning of the approach of these animals, they marched, I am bound to say, cheerfully away. The distance they had to travel was not great, but it was dark of the second day before they staggered into camp thoroughly exhausted, with about enough supplies to last two days longer. I might say just here that our cook had been somewhat startled by hearing the bark of a dog about ten o'clock of the second day; and it leaked out afterwards that these two worthies had found themselves so fatigued with their heavy loads of perhaps thirty pounds each about that time that they had to spend the remainder of the day resting within a mile of the camp, and, lest the dog should return and frighten the cook by the thought that an evil beast had devoured them, they tied him securely to a tree during the time they were resting from their burdens. This state of affairs continued for a couple of weeks longer, when the flies came to our relief, and I was compelled (however reluctantly you may imagine) to part with the invaluable services of these men. I succeeded, however, in replacing them by good men from the neighbouring settlement, and completed the work without further serious inconvenience. I merely relate this bit of experience as one of many that might be cited to show the mistake frequently made by taking inexperienced men for such work. The work from beginning to end is the most arduous imaginable, and no member of the party can escape it. I do not know how many times I have made the firmest resolution not to carry a pack. I would have my party complete, and there would seem, on the start, no need that I should engage in that pastime. I have often freqnently fortified myself in this resolution by not taking a packstrap for myself, but in every case, before the

first day was over, I had succeeded by some means to load myself with all I could possibly manage. By the way, I would ask those of you who have engaged to any extent in this amusement, if you did not find it conducive to meditation and reflection. If I were a moralist, and wished to induce men to think seriously of their past life, I would encourage them to engage in this work, and if sixty pounds will not do it, increase it to seventy-five or one hundred, and if this has not the desired effect, the subject is beyond hope. Perhaps some of you may not understand me on this point. Well, gentlemen, if that be the case, I can only recommend you to engage in the exercise I have mentioned, and, if you do not, before the first day is over, recall to memory more of the scenes of your innocent boyhood days, when you were free from such burdens as this, your experience will be different from mine, and I fear the reason will be your load has not been as heavy.

Next perhaps in importance to having good men comes *equipment*. Every surveyor starting on this work should be thoroughly supplied, not only with what instruments, chains, axes, etc., he will be sure to require, but with a small extra supply in case of accident. He will need to exercise his judgment in this case, so as to have all he will probably require, and at the same time keeping the whole outfit as light as possible. Thin tents, small axes and brush hooks, a small grindstone, cooking utensils, all tin, instead of heavier articles, are a few instances that I would observe in this connection. With regard to supplies, I have found that it is quite as economical to have a variety of articles as to adhere to the old system of taking only flour, pork and tea, and much more satisfactory to the party. In addition to the above I would recommend beans, sugar, dried apples, raisins, and a number of other articles in small quantities, which will readily suggest themselves. But of the staple articles, such as flour, bacon, dried apples, tea, and beans, it is well to have an ample quantity within easy distance of the work, so as to prevent the annoyance of running short before the work is finished. The cost of a few hundred pounds of these articles, even if not required, is very little compared with that of having to get a fresh supply from a distance; besides, if any are left, they can generally be disposed of to settlers in the vicinity at little loss to the surveyor.

With regard to the instruments best adapted for the Crown surveys in Ontario, in addition to the transit or theodolite and needle compass, I have found the solar instrument very valuable. A good micrometer also is of great service in the traverse of the numerous lakes nearly everywhere met with in the northern part of the Province, where the work is generally located.

The chainmen should be furnished with small books for use in the field, and every evening the notes taken during the day should be copied into a large book always kept in tent. This book I have found it convenient to have properly ruled and paged before leaving for the work. An index plan should also be made in the front of it, and on this can be marked the exact length of each line as soon as entered on its proper page. This will be convenient as the work proceeds,

as at a glance it can be seen what has been done, and how the measurements are coming out.

It is also necessary to keep this additional record in case any of the small books should be lost or become illegible through rough usage. It also greatly facilitates the work of making out the returns for the Department, as these will be an exact copy from the book, and entered in the same order.

With regard to the system adopted in these surveys by the Ontario Government I have little to say, but it has frequently occurred to me that a thorough exploration of the country in advance of survey would be in the public interest. I believe this plan is being adopted with respect to the North-Western part of the Province, and I would suggest the advisability of extending it to the districts north of Lakes Huron and Superior. The objects aimed at should be to furnish information as to the portions best suited for agricultural purposes, so that the country would be saved the unnecessary expense of surveying land incapable of settlement, and intending settlers the trouble of exploring such tracts.

Of the character of the territory itself I would like to say something to awaken an interest in it, if possible, on the part of our people, who to-day know as little of our possessions in that direction as if they were in the wilds of Africa.

It cannot truthfully be called a land remarkably well adapted throughout for the agriculturist, though a large part of it will yet be found productive. It possesses not the rich vegetable deposit of portions of the North-Western prairies, but it has an immense advantage over them in the excellence of its water in the greatest abundance, and also in the possession of its timber, while for beauty of scenery there is no comparison.

When paddling up some of those placid inland lakes, lying so still in their undisturbed solitude, I have often thought that it would well repay some of our tourists to forego at least one trip to the sea-side to look at such magnificent natural scenery lying almost at their doors. There is nothing in it awe-inspiring or majestic on account of vastness, such as may be seen on the Upper Saguenay or in the mountains of the west; but there is a weird, quiet beauty made up of the gorgeous foliage of the woods sloping down from the surrounding hills until it meets the glassy lake below, and is reflected by it, so that at a short distance away you can scarcely discern the dividing line between them.

The surveyor sees the country at the greatest disadvantage, except in respect to its natural scenery. The difficulties surrounding him are apt to create a prejudice in his mind, in which part of the blame of his troubles are very often rightly or wrongly attributed to the district in which he is engaged. In proof of this I might point to the many unfavourable reports made by the surveyor regarding townships both in the older and younger parts of the Province, which have since found favour in the eyes of the agriculturist, and become the homes of prosperous farmers, and though we can hardly hope that this territory will ever take a foremost place among the rich agricultural districts of the world, there is no reason to despair of its occupying on this

continent a position similar to that of Norway and Sweden to the continent of Europe, or that of Scotland to the British Isles.

At the close of Mr. Stewart's paper, Mr. Aylesworth moved, and Mr. Burke seconded, a resolution tendering him the thanks of the Association.

DISCUSSION.

The Chairman then invited discussion, remarking for his own part as follows:—I think I can quite agree with Mr. Stewart that a man's report is very often tinged by the success he has met with in making his survey. I know of several cases where the reports have made out lands to be thoroughly useless, which have since been divided into townships and settled. There is one I remember, the township of Russell, of which the report said, "Will never be settled for a century to come." It is not many years since that report was made, and the township is well settled now. The unfortunate man that wrote that report was probably up to his knees in water during a good part of the time that he was on his survey. (Laughter.) Then, as to the county of Kent, if we read old Mr. Riordan's reports, we find that he was above his knees in water during a good deal of the time he spent on that survey. He had to take quinine for medicine, and between quinine and water he found it almost impossible to get on; and, yet, these townships are to-day the garden of that part of the country.

Mr. Abrey—I might say that I myself have made some very bad reports on townships, since settled, but the fact that they are settled does not alter my opinion of them.

The Chairman—A man convinced against his will is of the same opinion still.

Mr. Stewart—I am very much obliged for the vote of thanks which the Association has tendered me. It was scarcely complimentary to the Association to present such a paper as I have read, but I hoped it would create discussion. I think one point deserves being discussed somewhat. I mean the reference I made to the idea of the Government sending out exploratory surveyors to ascertain the quality of land before sending a surveying party over it. In many cases the quality of the land is not known until the report of the final surveyor is made, and we are often surveying districts almost useless, while we are leaving out large districts that are really good for settling.

The Chairman remarked, with regard to Mr. Stewart's suggestion, that a good deal of money had been spent on exploratory surveys, and the result had not been encouraging. All they could do was to send surveyors where they had information that good land was to be found. This policy had been pursued for the last five or six years with success.

Mr. Stewart—I don't wish to prolong discussion, but would mention that the exploring parties sent out by the Government before sales are made, might be combined with such exploring survey parties as I have suggested.

Mr. Abrey remarked that such a policy as that suggested had been pursued in regard to Manitoulin, and had been found to answer.

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SOLAR AZIMUTHS.

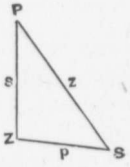
By JOHN McAREE,

D.T.S., Graduate School Practical Science, Toronto.

WHILE the method by observation of *Polaris* is undoubtedly the best for obtaining the direction of the meridian to the greatest degree of attainable accuracy, it has certain inconveniencies which should preclude its use generally in certain kinds of work where a ready method of finding the azimuth to a fair degree of accuracy, and checking it by an observation at any time during the day, is of greater importance than extreme accuracy. We say "should preclude its use," because the necessary azimuths can, in such cases, be obtained by observations of the sun. In many kinds of engineering and topographical surveying, for example, the refined method by *Polaris* is not needed, and in the land surveys of our northern and north-western country, the limitations as to the cost of the survey, and the physical character of the field, make great accuracy practically unattainable. From these considerations the method of finding the meridian by the sun should be more generally used than it is; at any rate surveyors should have such an acquaintance with it as to be able to use it whenever a proper occasion presented itself.

In the month of May, 1886, the writer, with a view to finding out for himself the degree of accuracy that could be obtained by this method, determined the azimuth of a line by a series of twenty-five observations of the sun's altitude: these observations were made with the common theodolite, reading to single minutes, the vertical arc being a semicircle only; with, of course, only one vernier, the eccentricity would not be eliminated. It was the intention to find the azimuth of the same line by observations on *Polaris* on a number of nights; but the work had to be suspended when only one determination had been made, and could not be resumed until a very short time ago, when the point could not be recovered. The work was resumed in February, 1887, when a series of 23 observations were made. Before giving the results of these observations, I will, in order to make this paper a little more complete, introduce a short discussion of the spherical triangle which is solved in the problem of finding the sun's azimuth by observing his altitude, with a view of discovering the most suitable form of triangle, viz., the form in which an error in the altitude, in the declination, or in the latitude used, will have the least effect on the value of the resulting azimuth.

In the annexed diagram of the spherical triangle in question, let the angles be denoted by capital letters, and their opposite sides by the corresponding small letters. Let P denote the pole, Z the zenith, and S the place of the sun.



We then have these fundamental equations of spherical trigonometry:

$$\cos z = \cos s \cos p + \sin s \sin p \cos Z \quad (a)$$
$$\sin z \cos P = \sin s \cos p - \cos s \sin p \cos Z \quad (b)$$
$$\sin z \sin P = \sin p \sin Z \quad (c)$$
$$\sin z \cos S = \sin p \cos s - \cos p \sin s \cos Z \quad (d)$$
$$\sin s \sin Z = \sin z \sin S \quad (e)$$

Now P is the hour angle which is usually denoted by t; Z is the azimuth usually denoted by A; S is called the parallactic angle; z is the polar distance; s is the colatitude, and p is the zenith distance or coaltitude. Let ϕ denote the latitude, δ the declination, and h the altitude. With this notation, and, remembering that the sine of an angle is equal to the cosine of its complement, the equations (a), (b), (c), (d) and (e) become transformed into the following:

(a) becomes $\sin \delta = \sin \phi \sin h + \cos \phi \cos h \cos A$ (1)
(b) " $\cos \delta \cos t = \cos \phi \sin h - \sin \phi \cos h \cos A$ (2)
(c) " $\cos \delta \sin t = \cos h \sin A$ (3)
(d) " $\cos \delta \cos S = \cos h \sin \phi - \sin h \cos \phi \cos A$ (4)
(e) " $\cos \phi \sin A = \cos \delta \sin S$ (5)

1st. To find the error in the azimuth due to a small error in the *latitude*, differentiate equation (1), considering ϕ and A as the only variables; thus we find:

$$d A = d \phi \left(\frac{\cos \phi \sin h - \sin \phi \cos h \cos A}{\cos \phi \cos h \sin A} \right)$$

$= d \phi \sec \phi \cot t$, by (2) and (3), or $d A\phi = d \phi \sec \phi \cot t$: (6) where $d A\phi$ is the error in the azimuth corresponding to a small error $d\phi$ in the latitude.

2nd. To find the error in the azimuth corresponding to a small error in the *declination*, differentiate equation (1), considering δ and A to be the only variables; thus we find:

$$d A = d A\delta = -d \delta \left(\frac{\cos \delta}{\cos \phi \cos h \sin A} \right)$$

which by (3) becomes $d A\delta = -d \delta \sec \phi \operatorname{cosec} t$ (7); where $d A\delta$ is the error in the azimuth due to the small error $d \delta$ in the declination.

Lastly, to find the error in the azimuth corresponding to a small

error in the *altitude*; differentiate (1), considering h and A to be the only variables thus, $d\,A = d\,Ah = d\,h \left(\frac{\sin\phi\cos h - \cos\phi\sin h\cos A}{\cos\phi\cos h\sin A} \right)$

$= d\,h\,\frac{\cos\delta\cos S}{\cos\phi\cos h\sin A}$ by (4), or $d\,Ah = d\,h\sec h\cot S$ (8), by (5); where $d\,Ah$ is the error in the azimuth corresponding to a small error $d\,h$ in the altitude.

The following Tables* have been computed by the help of equations (6), (7) and (8), showing the error in the azimuth for an error of 1′ in the latitude, declination and altitude respectively, for different values of the latitude, declination and hour angle. North declination is taken to be positive.

I.—Table of Errors in Azimuth due to Errors in Latitudes and Declination.

Hour.	For an Error of 1′ in Declination.			For an Error 1′ in Latitude.		
	Latitude 40°.	Latitude 50°.	Latitude 60°.	Latitude 40°.	Latitude 50°.	Latitude 60°.
11h. or 13h...	5.05′	6.01′	7.72′	4.87′	5.80′	7.46′
10h. or 14h...	2.61	3.11	4.00	2.26	2.70	3.46
9h. or 15h...	1.85	2.20	3.24	1.30	1.56	2.00
8h. or 16h...	1.51	1.80	2.30	0.75	0.90	1.15
7h. or 17h...	1.35	1.61	2.07	0.35	0.37	0.53
6h. or 18h...	1.30	1.56	2.00	0.00	0.00	0.00

II.—Table of Errors in Azimuth due to an Error of 1′ in the Altitude.

Hour.	Latitude 40°.			Latitude 50°.			Latitude 60°.		
	Decl'n −20°.	Decl'n 00°00′.	Decl'n 20°.	Decl'n −20°.	Decl'n 00°00′.	Decl'n 20°.	Decl'n −20°.	Decl'n 00°00′.	Decl'n 20°.
11 or 13h.....	.....	4.8′	.....	5.9′	5.8′	5.7′	6.00′	7.6′	7.58′
10 or 14h.....	2.3′	.....	1.8′	.....	.....	.....	.....	3.8	.....
9 or 15h.....	.....	1.4	.....	1.9	1.9	.....	2.6	.....	2.5
8 or 16h.....	1.1	.....	0.87	.....	.....	1.6	.....	2.00	.....
7 or 17h.....	.....	0.88	.....	.....	1.3	.....	.....	.....	.....
6 or 18h.....	.....	.....	0.80	.....	.....	1.2	.....	.....	1.7

*Suggested by similar tables in "Theory and Practice of Surveying," by Prof. J. B. Johnson, C.E., of Washington University, St. Louis.

The most important inference from the above table, or from equations (6), (7) and (8) is, that the further from the meridian the sun is, when observed for azimuth, the less effect will errors in the latitude, declination and altitude have on the azimuth deduced. Table I. applies also to azimuths found by the solar compass.

To return to the subject of the observations: the first series were taken about the middle of May, 1886, and consisted, as already stated, of twenty-five observations. The observations were taken chiefly in the forenoon, none nearer the meridian that 2h. 10m.; the average hour angle being about 3h. 7m.

The probable error of the mean of the twenty-five observations was 20″, and the probable error of any one observation was 1′.

The maximum deviation from the mean was 3′ 12″. Five observations gave a result that differed 2′ or more from the mean; while ten differed 30″ or less from the mean; the mean differed from the value of the azimuth given by one observation of *Polaris* at elongation by 1′ 30″.

The second series of observations, twenty-three in number, were taken February 14th to 25th, 1887, with a four-inch reiterating transit-theodolite, D. L. pattern, reading to 36″. The observations were taken in the forenoon chiefly, and none nearer to noon than 1¼h., while the greater number were taken when the sun was more than two hours from the meridian. The probable error of the mean was 20″; the probable error of any one value was 1′ 26″; the maximum deviation from the mean was 6′ 42″. Thirteen observations gave values differing less than 1′ from the mean, and seven differed less than 30″ from the mean. By rejecting three of the worst observations, the remaining twenty gave a probable error of the mean of 10″, and the probable error of any one observation of 53″, while the maximum deviation from the mean was 2′ 18″.

The mean of the azimuths differed by 1′ 30″ from the azimuth found by one observation on *Polaris* at elongation.

In neither series of observations were any extraordinary precautions taken with the instrument; while both attempts were those of an amateur in this particular kind of work. The time required for a complete observation—circle right and circle left—is from 6 to 10 minutes.

The method of observing was that first described, as far as the writer is aware, in Captain Deville's "Astronomic and Geodetic Calculations," and given in the *Dominion Manual of Land Surveys*. The sun's image is brought tangent to the wires in opposite sectors of the system with circle right and circle left respectively. The mean of the two readings of the horizontal and vertical limbs gives the sun's position free from instrumental errors. To avoid errors, and always get the image in the proper sector of the wires, it is advisable to adopt a certain programme of observing and adhere to it. Suppose, for example, that for "circle right" we always keep the image in the two (apparent) right hand sectors; then for "circle left" we must keep it on the (apparent) left; and keeping the image in the (apparent) lower right hand sector in the forenoon, and in the upper in the

afternoon; then, for circle right, we shall always use the tangent screw to the horizontal limb, and the tangent to the vertical circle for circle left; we can thus discern, on an instant's reflection, the proper screw to be used. By strictly adhering to this programme, we shall complete our observations in the shortest time, and with the least liability to error.

I have given above the results of a number of observations in which the sun's azimuth was calculated from his observed altitude, and I think I cannot more suitably conclude than by giving the result of a series of solar observations taken with a similar object in view, with a solar instrument, by Prof. J. B. Johnson, C.E., of Washington University, St. Louis. The account is given by Prof. Johnson in the Journal of the Association of Engineering Societies, volume 5, No. 2, December, 1885, from which I take the liberty of quoting. Prof. Johnson says:

"In order to determine just what accuracy was possible with a Fauth Solar Attachment on a Buff and Berger transit, I spent two days in making observations on a line whose azimuth had been determined by observations on two nights on *Polaris* at elongation, the instrument being reversed to eliminate errors of adjustment. Forty-five observations were made with the solar attachment on October 24th, 1885, from 9h. to 10h. a.m., and from 1h. 30m. to 4h. p.m., and on November 7th 42 observations between the same hours.

"On the first day's work the latitude used was that obtained by an observation on the sun at its meridian passage, being 38° 39′, and the mean azimuth was 20″ in error. On the second day, the instrument having been more carefully adjusted, the latitude used was 38° 37′, which was supposed to be about the true latitude of the point of observation, which was the corner of Park and Jefferson Avenues in this city. It was afterwards found that this latitude was 38° 37′ 15″ as referred to Washington University Observatory, so that when the mean azimuth of the line was corrected for this 15″ error in latitude, it agreed exactly with the stellar azimuth of the line, which might have been 15″ in error. On the first day all the readings were taken without a reading glass, there being four circle readings to each result. On the second day a glass was used.

"On the first day the maximum error was 4′, the average error was 0.8′, and the probable error of a single observation also 0.8′. On the second day the maximum error was 2.7′, the average error 1′, and the probable error of a single observation was 0.86′. The time required for a single observation is from 3 to 5 minutes. I believe this accuracy is attainable in actual practice, as no greater care was taken in the care or handling of the instrument than should be exercised in the field."

DISCUSSION.

Professor Galbraith—I should like to hear the experience of some gentleman who has used the solar compass. I have had no experience myself with it. I set to work in the grounds of the Parliament Buildings to find the azimuth of a fixed line. I used the

method of Mr. McAree as one method, and determined also by a chronometer, which I obtained from the observatory. The instants of the observations were noted by some of my students, and I simply observed the azimuths or readings of the horizontal circle. I remember the greatest difference among the four observations taken was a little over a minute—a minute and about 4 or 5 seconds. The mean of the results differed by not more than one-half minute from the extreme. The succeeding Saturday I took observations by the altitude and azimuth method. This was a great deal more precise than the other. The extreme limits were between 30 and 40 seconds in this set of observations. The mean of the four observations in this last set differed by only 1 second from the mean of the four observations in the first set. The probable error of any single observation of the second four was 14 seconds, and of the mean 7 seconds. The probable error of the finally adjusted observation was not greater than 6 seconds. I might explain what the probable error is, because it is likely to be misunderstood. By saying that the probable error is 6 seconds you do not mean that the error may not be more. You don't mean anything more than that it is probable. To give you an idea:—From all these observations the mean of the whole was not a minute astray. The probabilities are 999 to 1 against its being more than a minute astray. Calculating in the same way the chances against the mean being 10 seconds astray would be 4 to 1. So when I called the error 6 seconds, I meant that the error was equally likely to be greater or less than that amount. If you were to take a bet on it, the real error is just as likely to be within that amount as outside of it. The probable error is generally attached to an observation to show the degree of precision of it. It therefore gives a degree of confidence in it. If you say that the probable error of an observation is 20 minutes, and the probable error of another is 10 seconds, you recognize the fact that the second observation is very much more accurate than the first.

A Member—It depends upon the instrument.

Professor Galbraith—Yes. I change the lower plate each time in order to even up the effects of any irregular graduation.

Mr. Butler—Mr. President, I have not had any experience myself, but in the Journal of the Engineers of St. Louis, Prof. J. B. Johnston gives the results of some of his experiments. The results he arrives at is that, taking one observation of the Fauth Solar Attachment, the variation is not greater than a minute, and the apparatus used was very simple.

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MICROMETER MEASUREMENT OF DISTANCES.

By WILLIAM OGILVIE,

Provincial Land Surveyor, Ottawa.

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 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 micrometers and the uses to which they have been applied, and very probably many of them know more.

I may, however, classify the micrometers 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 movable, or both might be movable. 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; 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 is 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, 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 proportionately. Another objection to this form is, at long distances the projected 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 any one 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 refracting 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, where there was no check on the distance determined by it; the other on a survey where 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 distance 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 circum-

ference 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 revolutions 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 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, they are the ratio of the tangent of each angle to radius.

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 while 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, where 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 results of measurements on a ten link base. The discs were pieces of wood painted a bright red, as they had a snow background. 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 half feet above the surface. My object in placing them in this way was to determine approximately by observing on them, on 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 is the mean of two independent chainings differing by six-tenths of a link.

February 19th.—Thermometer 26°; sky cloudy; a little snow falling; 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.	
rd'g	v	vv	rd'g	v	vv	rd'g	v	vv	base.	chs.
1=8′ 10.2″	−.7	.49	1=8′ 11.7″	+2.2	4.44	1=8′ 10.5″	+2.3	5.29	1	42.018
2=8 10.2	−.7	.49	2=8 09.2	−.3	.09	2=8 06 5	−1.7	2.89	2	42.135
3=8 11.7	+.8	.64	3=8 09.2	−.3	.09	3=8 07.5	−.7	.49	3	42.252
4=8 11.2	+.3	.09	4=8 08.7	−.8	.64	4=8 08.7	+.5	.25		
5=8 11.2	+.3	.09	5=8 08 7	−.8	.64	5=8 07.7	−.5	.25	mean	42.135
mean 8′10.9″	E = ±.67		mean 8′09.5″	E = ±1.28		mean 8′08.2″	E = ±1.51			
	E_0 = ±.20			E_0 = ± .40			E_0 = ± .47			

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.	
rd'g	v	vv	rd'g	v	vv	rd'g	v	vv	base	chs.
1=8′ 08 ″	+ .2	.04	1=8′ 08.″	−1.2	1.44	1=8′ 07.8″	−.5	.25	1	42.286
2=8 06.2	−1.6	2.56	2=8 08.7	−.5	.25	2=8 07.5	−.8	.64	2	42.162
3=8 08.5	+ .7	.49	3=8 09.2	0.0	.00	3=8 08 7	+.4	.16	3	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
mean 8′07.8″	E = ±1.29		mean 8 09.2″	E = ±.95		mean 8′08.3″	E = ±.58			
	E_0 = ± .40			E_0 = ±.30			E_0 = ±.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.	
rd'g	v	vv	rd'g	v	vv	rd'g	v	vv	base	chs.
1=8′ 08 5″	+1.3	1.69	1=8′ 01.2″	+1.6	2.56	1=8′ 07.5″	+.9	.81	1	42.330
2=8 06.8	− .4	.16	2=8 00 7	+1.1	1.21	2=8 06.5	− .1	.01	2	43 006
3=8 07.5	+ .3	.09	3=7 59 0	− .6	.36	3=8 06.2	− .4	.16	3	42.386
4=8 04.5	−2.7	7.29	4=7 58.3	−1.3	1.69	4=8 06.	− .6	.36		
5=8 08.5	+1.3	1.69	5=7 59.0	− .6	.36	5=8 07.	+.4	.16	mean	42.574
mean 8′07.2″ E $=\pm 1.65$ $E_0=\pm .50$			mean 7′59.6″ E $=\pm 1.24$ $E_0=\pm .37$			mean 8 06.6″ E $=\pm 61$ $E_0=\pm .19$				

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 twenty-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 ten-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 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 toward us, and at long distances it becomes invisible altogether. To overcome this glaring defect I used discs of translucent material: painted glass, ground and 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 background, of course, will affect 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 pre-arranged 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 sometimes 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 in 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 long)*, 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 on a bad day and we may look for an error of fifty or sixty links, or even more, and that, too, though we use our 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 one-sixth 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 atmospheric density at different altitudes, the conditions due to different temperatures and degrees of moisture, the intensity of light and shade, I consider it impossible to ever 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 distance 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 approximately 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 refractions due to the altitudes of the points sighted on. But in practice we find that 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 range 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 downward, 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 affected 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 determinations 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 hindrances of improper light and shade and bad background can, as I have already said, be remedied by the base-man with proper appliances.

I will now give a list of distances as chained in 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 focus 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

Fahrenheit, and using all my available distances, but I found this would entail a lot of work more than I had time for, and decided to arrange them under four atmospheric conditions, and in grades of distances differing by five chains, beginning with 12—15 chains, then 15—20 chains, 20—25, and so on, and give, as far as my records would permit, ten distances in each grade, under such conditions.

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 errors in many cases, especially the longer distances, where they were sometimes difficult to see (particularly so on gloomy days).

(See Tables pages 66–73.)

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 twenty-link base used, except under the conditions hot and moist, nearly all the errors reduced proportionately to forty chains come well within the five or six-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 to read the parts of divisions. Whatever part of the error 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 2,438 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 twenty-link base been used, we get a total error of – 19.35 chains, or a correction under this condition of about one part in 125 to be added. Taking the same quantities under the condition "hot and dry," we find a total distance of 2,447.43, with a total error of – 12.71 chains, or an error of about one part in 192 short. This reduced to a twenty-link base would give an error of – 5.08 chains, or an error of about one part in 480 short. Under the condition "cool and moist," the total distance is 1,679.01 chains, with a total error of + 1.56, or an error of about one part in 1,076 long; this reduced to a twenty-link base gives sixty-two

links of an error long, or a correction of one part in about 2,690 to be subtracted. Under the condition "cool and dry," the sum of the distances is 1,765.4 chains, and the algebraic sum of the errors thirty links, which is practically nothing, being only one part in 5,885. 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 8,329.84 chains, or 104 miles, with a total 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 twenty-link base would give us an error of 23.69 chains in the total distance, or about one part in 400 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 as large a ratio to the distance as this. Taking the columns forty to forty-five 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 twenty-link base would be 4.41 chains, or about forty-one 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 twenty-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 twenty-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 twenty-link base this would be 8 links, or about 4 links per half mile.

All those measurements were made along the line of the Canadian Pacific Railway, where 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 that a few feet above. It will be noticed in the long courses that three of the errors have the + sign. Those were from the summit of one ridge to another across a valley, where the line of sight was from fifteen to thirty-five feet above ground most of the way. Long distances measured on the same day, but 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.

CONDITIONS.—Hot and Moist. TEMPERATURE.—70° to 100° in the Shade.

12–15			15–20			20–25			25–30		
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 ch. - .11 ch.			Per 40 ch. - .116 ch.			Per 40 ch. - .51 ch.			Per 40 ch. - .90 ch.		
Reduced to 20 link base.					.046 ch.			.20 ch.			.36 ch.

30–35			35–40			40–45			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	– .70
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 ch. .25 ch.			Per 40 ch. – 1.22 ch. .49 ch.			Per 40 ch – 1.02 ch. .41 ch.			Per 40 ch. – .88 ch. .35 ch.		

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

CONDITIONS.—Hot and Dry. TEMPERATURE.—65° to 100° in the Shade.

12–15			15–20			20–25			25–30		
Chain.	Mic.	Error.	Chain.	Mic.	Error.	Chain.	Mic.	Error.	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 ch.			Per 40 ch. – .045 ch.			Per 40 ch. – .031 ch.			Per 40 ch. – .056 ch.		
Reduced to 20 link base.			– .018			– .012 ch.			– .022 ch.		

30–35			35–40			40–45			45–		
Chain.	Mic.	Error.	Chain.	Mic.	Error.	Chain.	Mic.	Error.	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	425.45		−2.52	530.85		−9.61
Per 40 ch. −.01 ch.			Per 40 ch. −.048 ch.			Per 40 ch. −.24 ch.			Per 40 ch. −.72 ch.		
−.004 ch.			−.019 ch.			−.096 ch.			−.29 ch.		

The condition, "Hot and Moist" was when the sun was shining strongly after a heavy rainfall; "Hot and Dry" was during a continuance of dry, hot weather.

CONDITIONS.—Cool and Moist. TEMPERATURE.—From 30° to 65°.

12–15			15–20			20–25			25–30		
Chain.	Mic.	Error.	Chain.	Mic.	Error.	Chain.	Mic.	Error.	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 ch.			Per 40 ch. .16 ch.			Per 40 ch. .04 ch.			Per 40 ch. .11 ch.		
Reduced to 20 link base.			.06 ch.			.016 ch.			.044 ch.		

30–35			35–40			40–45			45–		
Chain.	Mic.	Error.	Chain.	Mic.	Error.	Chain.	Mic.	Error.	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	−.127
30.52	30.56	+.04									
226.11		+.18	110.46		+.03	127.50		−.17	404.00		−.93
Per 40 ch. .04 ch. .016 ch.			Per 40 ch. .01 ch. .004 ch.			Per 40 ch. .05 ch. .02 ch.			Per 40 ch. .09 ch. .036 ch.		

* Those 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.

CONDITIONS.—Cool and Dry. TEMPERATURE.—From 30° to 65°.

12–15			15–20			20–25			25–30		
Chain.	Mic.	Error.	Chain.	Mic.	Error.	Chain.	Mic.	Error.	Chain.	Mic.	Error.
14.32	14.43	+.11	16.68	16.79	+.11	21.58	21.62	+.04	22.53	22.51	−.02
12.54	12.60	+.06	17.51	17.60	+.09	24.98	25.02	+.04	29.41	29.48	+.07
13.20	13.25	+.05	19.14	19.17	+.03	24.16	24.23	+.07	28.52	28.49	−.03
12.87	12.96	+.09	16.17	16.20	+.03	24.21	24.29	+.08	25.64	25.59	−.05
14.60	14.65	+.05	16.01	15.97	−.04	22.75	22.81	+.06	28.88	28.75	−.13
13.89	13.94	+.05	15.98	16.06	+.08				25.51	25.67	+.16
14.22	14.29	+.07	18.45	18.53	+.08				25.96	26.00	+.04
			19.73	19.76	+.03				28.32	28.10	−.22
			17.76	17.81	+.05				25.30	25.36	+.06
			16.55	16.50	−.05				23.27	23.22	−.05
95.64		+.48	173.98		+.41	117.68		+.29	263.34		−.17
Per 40 ch. .20 ch.			Per 40 ch. .095 ch.			Per 40 ch. .10 ch.			Per 40 ch. .026 ch.		
Reduced to 20 link base.			.04 ch.			.04 ch.			.01 ch.		

30–35			35–40			40–45			45–		
Chain.	Mic.	Error.	Chain.	Mic.	Error.	Chain.	Mic.	Error.	Chain.	Mic.	Error.
33.90	33.84	–.06	38.44	38.76	+32	42.12	42.24	+.12	60.95	60.30	–.65
33.75	33.75	.00	39.69	39.67	–02	40.88	40.96	+.08	58.31	57.61	–.70
35.56	35.68	+12	38.75	38.65	–10				46.79	46.39	–.40
34.49	34.38	–11							46.60	46.20	–.40
33.50	33.64	+14							53.54	53.36	–.18
34.24	34.25	+04							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
205.44		+.17	116.88		+20	83.00		+.20	625.24		–1.28
Per 40 ch. .032 ch. .013 ch.			Per 40 ch. .07 ch. .028 ch.			Per 40 ch. .10 ch. .04 ch.			Per 40 ch. .09 ch. .036 ch.		

* 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 sundown on a cool evening with the sun shining full on the discs. Two readings, 2′ 13″.5 and 2′ 13″.75.

DISCUSSION.

Mr. Klotz moved a resolution, tendering him the thanks of the Association, at the same time remarking as follows:

"I am very much pleased with the paper, and I think it will be the means of bringing the micrometer more prominently before the notice of surveyors and of extending its use among them. It is an instrument that deserves a good deal of attention, and will undoubtedly be largely used in the exploratory surveys of the future, and I recommend it most heartily to any surveyors going out. I would strongly impress upon surveyors that, in using any instrument whatever, they should use it in both positions; that is, in *circle right* and *circle left*, and, in using the micrometer, to use the right hand motion of screw and the left hand motion of screw. In the use of the instrument formerly used for this purpose many errors would be avoided by so doing, and in the use of the micrometer the lost motion of the thread would be avoided. Another thing I would point out is that, in taking a reading, the instrument should not be turned far forward past the picket, because every instrument has more or less of torsion, which I found by experience in a long traverse survey over the C. P. R., in which I used this instrument. I found that if I turned my instrument twice I got a difference of reading amounting to a maximum of .014 of a degree, by three complete revolutions of the instrument. This amount of difference I could obtain by unwinding and turning in the opposite direction. I would recommend always taking two readings circle right and two readings circle left, giving twelve readings for the angle. Each of the three verniers would be read completely, not only the decimal of a degree, but the whole degree, to avoid any error. From a comparison of a series of measurements by the chain and measurements by the micrometer, under ordinary circumstances, equally favourable to both systems, I have determined that the probable error of a reading of chain measurement is about six links per half mile. An assistant of mine measured a piece of land in a tangent of the C. P. R. in the Rocky Mountains by the chain system, and made it 34 chains 65 links. I took several readings right hand and left hand with my micrometer, and made it 34 chains 45 links. My chain assistant chained it over again, and found that his measurement was wrong, while mine was correct."

Prof. Galbraith asked what means there was of insuring the base being at right angles to the line of sight in holding the machine horizontally.

Mr. Ogilvie said he had never used the instrument horizontally, but merely suggested it. His opinion was that the angles would be more constant, and that refraction would affect it far less than would be the case in a vertical position.

Prof. Galbraith—But do you think it would be practicable in ordinary surveys with the time at your disposal to assume that the mean line of sight is at right angles to the base?

Mr. Ogilvie—Well, suppose that it were a degree out of the vertical, the difference in the result would be so slight as to be scarcely appreciable.

In connection with the micrometer which Mr. Ogilvie exhibited, he also drew attention to a new tripod, manufactured by Messrs. Troughton & Sims, with a traversing bead. It was preferable to the ordinary American instruments, he said; could be brought down to a circle of two or three inches, and could be set up in a minute or two.

[*This Association is not responsible as a body for any opinions expressed in its Papers by Members.*]

ASSESSMENT OF BENEFITS IN DRAINAGE SURVEYS.

By WILLIS CHIPMAN
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WHILE we find the literature on "ditch making" quite voluminous, there is very little published on assessment of benefits. In the sixth and seventh annual reports of the Ohio Society of Surveyors and Civil Engineers are papers on "The Problem of Just Apportionment of the Cost of Ditch Improvements," by E. B. Opdycke, C.E., which are the most exhaustive I have seen on this subject. Another paper in the sixth annual report of the same society, by J. L. Geyer, C.E., on "The Principles Involved in making Ditch Estimates and Assessments," is also very interesting.

The elements which determine the area benefited or taxed, and the proportion of such tax, may be conveniently considered under two heads, *legal* and *physical*.

The determination of the topography of the area enclosed by the water-shed, nature of soil, rainfall, etc., and the laying down of the results upon a proper plan, may be considered as the physical elements that enter this question, and must vary with every case.

The *legal elements* may be considered as a constant, the *physical elements* as a variable.

The statutes concerning ditch making and ditch assessment in the United States appear more advanced, more concise and clearer than our Ontario Statutes. The law there, as defined by statute and court decisions, appears to be:

(1) That the lower lands owe a servitude to the upper lands, the owner of a dominant or superior heritage has an easement in the servient or inferior tenement, for the discharge of all waters which by nature rise in, or flow, or fall upon the superior.

(2) While an upper owner cannot construct new water channels across his land and discharge water on the lower land, he can improve his lands by drainage into a natural watercourse that flows through the lower land, increasing the flow in such watercourse, even though the increased flow damages the lower lands.

(3) Surface depressions where water naturally runs in times of excess, are to be construed as watercourses.

Some of the general principles Mr. Opdycke arrives at in his first paper regarding the assessment of benefits are as follows:

(*a*) Benefits increase as the elevation of the land decreases.

(*b*) Lands near the outlet should be assessed less than the lands more remote.

Three of Mr. Geyer's general principles are :

(1) "The lands at or near the source of improvement are usually more benefited than those near the outlet, because in a state of nature these lands, everything else being equal, are worth less than land near the outlet, for the very reason of this distance from sufficient opportunity for drainage ; now if this improvement accomplishes the bringing of the outlet to said lands, it renders them as valuable as the lands below, therefore the benefits are greater here.

(2) "Lands on a tributary, and not having a direct drainage, should be assessed only to assist in the construction of the portion *below* the confluence.

(3) "No land should be assessed sufficient to bring this improvement to the upper line of said land assessed, unless this upper side is the limit of water-basin ; because that otherwise the lands above would have the outlet brought up to them without an assessment for the same. The lands above should not only be assessed to build their due proportion through length of same, but also a proper amount for the outlet below."

Here in this Province the law appears to differ slightly from the law across the border. "The Ditches and Watercourses Act," sec. 3, sub-sec. 2, provides as follows :

"Every such ditch, or drain, shall be continued to a proper outlet, so that no lands, unless with the consent of the owner thereof, will be overflowed or flooded through, or by the construction of any such ditch, or drain, and it shall be lawful to construct such ditch, or drain, through one or any number of lots, until the proper outlet is reached." Section 9 of the same Act provides that the engineer may order the opening of a ditch across the lands of persons not interested, at the expense of the upper owners, without being trespassers.

Section 590 of the "Municipal Act, 1883," provides that "if any municipality, company or individual, by any means, cause waters to flow upon and injure the lands of another municipality, company, or individual, the municipality, company, or individual, causing waters to flow upon or injure such lands, may be assessed by the engineer for the construction of such drain or drains as may be necessary for conveying from such lands the waters so caused to flow upon and injure the same."

The first point to consider, assuming the physical elements determined, is the limits of the area benefited, after which, the proportion of benefit to each parcel benefited.

I have concluded to present my views as to the method of determining the area benefited, and the proportion of cost to be assessed on each parcel of land, in the form of a series of propositions based upon definitions and axioms.

DEFINITIONS.

"Benefit" means the increased market value of the land after the work is done.

"Improvement" means the increased value of the land, not taking into account the cost of the works.

"Cost of works" includes all expenses of surveys, plans, estimates, ditching, removing obstructions, pumping machinery, purchase of mill sites, etc., etc., as fully defined by statute.

"Assessment" is the proportion of the cost of works paid by any parcel of land.

AXIOM I.

The assessment for benefit cannot exceed the benefit derived, or the improvement of the land.

AXIOM II.

The assessment for benefit must be in exact proportion to the benefit derived.

NOTES ON THE AXIOMS.

Axiom I. is self evident. Axiom II. becomes evident from reading Sec. 570, Chap. 18, Stat. of Ontario, 1883, part of which reads as follows:

"Stating as nearly as may be, in the opinion of such Engineer or Surveyor, the proportion of benefit to be derived therefrom by every road and lot, etc., etc." Again in Sub-Sec. 3 of same Sec. 570: "For assessing and levying in the same manner as taxes are levied, upon the real property to be benefited by the work, a special rate sufficient for the payment of the principal and interest of the debentures, and for so assessing and levying the same, as other taxes are levied, by an assessment and rate on the real property so benefited (including roads held by joint stock companies, or private individuals), in proportion as nearly as may be to the benefit derived by each lot or portion of lot and road in the locality."

Again in Sub-Sec. 7 of same Sec. 570, we find: "The proportion of benefit to be derived from any works by different parcels of land or roads may be shown, etc."

The words and terms "improvement," "benefit," "assessment," "cost of works," as they appear in Chap. 18, Stat. Ontario, 1883, are very vague and confusing.

In the following propositions we will assume that the principles of *ditchmaking* have been fully mastered and understood by the engineer or surveyor.

PROPOSITION I.—THEOREM.

The benefit to a parcel of land must always equal the fraction of the cost of the works assessed on such parcel of land.

This is evident from the following consideration :—

If a parcel of land benefited by the construction of certain works be worth a certain sum after the completion of such works, then the value of such parcel before the commencement of the work must be the same amount, minus the fraction of cost of works borne by said parcel.

Therefore the benefit, etc.

PROPOSITION II.—THEOREM.

The area benefited need not be the whole area enclosed by the water-shed.

Let *A*, *B*, *C*, . . etc. . . *Y*, *Z* be several owners in the area of the water-shed, *Z*, being at the outlet, *A* at the source.

If any person's land, as *M's*, is situated above the watercourse or ditch so that it is not benefited in any way than by Axiom I., the assessment must be nothing.

His land may have been fully ditched before, or it may be so perfectly drained by nature as to require no ditching or underdraining, or it may be rocky or of such nature that draining cannot improve it.

Therefore it is unjust to tax the whole water-shed in every case.

PROPOSITION III.—THEOREM.

The area benefited cannot be bounded by any one contour line.

The surface of the water in an efficient ditch or watercourse must have a fall towards the outlet and cannot, therefore, be parallel to any contour.

Let *B* and *Y* be two owners having same area of land, *B's* land being near the source, *Y's* near the outlet, each parcel of land being similarly situated, the same distance from the watercourse, and at the same height above the surface of the water in the watercourse ; then the improvement derived by each is the same, but the contour line passing through *Y's* land will be below *B's* land ; also the contour line that includes all the benefited areas near the outlet will generally not include all the areas benefited near the source.

Therefore the area benefited cannot be bounded by any one contour line.

PROPOSITION IV.—THEOREM.

A parcel of land near the source should pay more than a parcel nearer the outlet, the improvement in land being the same.

Let *A*, *B*, *C*, . . *Y*, *Z* be different parcels along a watercourse or ditch. *A* being at the source, *Z* being the first above the outlet, each parcel being equally improved by the construction of the ditch or improvement of the watercourse, then *Y* should be assessed higher than *Z*, *X* than *Y*, etc., etc.

If Z were the only parcel, then this land should be assessed for all works to drain it, and no more.

Suppose parcel Z worthless or eliminated, then Y should be assessed for all work on parcels Y and Z to drain Y. If Y and Z are both eliminated, then X should be assessed for total cost of all of works on parcels X, Y and Z to drain X, etc., etc., from which it will be seen that if each parcel is assessed, independent of every other parcel, that the nearer the source the parcel is situated the higher the assessment should be.

Therefore a parcel of land near the source, etc.

COROLLARY 1, PROPOSITION IV.—When the assessment equals the benefit derived, the works must stop at that point.

COROLLARY 2.—If there is but one obstruction to be removed, and that situated at the outlet, then lands near the source should be assessed the same as those near the outlet.

PROPOSITION V.—PROBLEM.

To determine the limits of the area benefited.

Let the area enclosed by the water-shed be accurately shown on a map, with contour lines at different elevations.

Locate thereon the main watercourses or ditches, and tributaries, and all other ditches and underground drains for subsoil drainage that are necessary to drain the whole area.

Deduct or mark off from this total area those lands not benefited, as more particularly mentioned in Proposition I.

Deduct or mark off also any area in which the assessment of fraction of cost exceeds benefit or is greater than the improvement of the land. (Corollary 1, Proposition IV.)

NOTE ON PROPOSITION V.—We can assume a case in practice in which the surface of ground is such in the water-shed that it gradually increases in elevation as we approach the source, and also that the surface of the ground is parallel with the grade line of the constructed ditch. In this case, if the water-shed is unlimited in the direction of the source, then the amounts assessed on the different parcels increase as we approach the source and are therefore unlimited, but we cannot assess where the tax is greater than value of land; this, therefore, will limit the length of the work constructed.

It may be said that the next parcel above should pay something towards the works, and thus destroy the whole proposition, but it is evident that if the next owner above discharges any water into the works that the size, and therefore the cost, must be increased for the whole length to the outlet, and all at the expense of this upper owner. This amount being greater than the benefit to land, we must conclude that this land cannot be benefited.

PROPOSITION VI.—PROBLEM.

To determine the proportion of benefit to each area.

Let the area enclosed by the water-shed be carefully shown as in Proposition V.; also show the area benefited.

$A, B, C, \ldots X, Y, Z$ be different parcels of equal area, A being near the source, Z at the outlet.

Eliminate all parcels but A, then, as in Proposition IV., this parcel should pay for cost of works from parcel A to outlet, which we will call a—being a sum to efficiently drain parcel A.

$\therefore$ by eliminating all but A this parcel should pay a
" " " B " " b
" " " C " " c
" " " etc. " " etc.
" " " Y " " y
" " " Z " " z

Thus the proportion to be assessed on each parcel is the ratio that each of the sums a, b, c, etc., bears to the sum $a+b+c+\text{etc.}\ +y+z$.

It will be seen that the total cost cannot be determined until the area to be assessed is determined—that is, Proposition VI. cannot be done until we have determined where the work is to end.

In practice this will be found by trial calculation.

The conclusions arrived at in these propositions are at first sight paradoxical, and I must say that in applying them to practice I was at first somewhat puzzled, but upon closer study the mists partially cleared away. I confess the problem is a difficult one.

It can be demonstrated mathematically, however, that although when a work is completed from source to outlet that the land near the source should bear a higher assessment than one near the outlet; yet, if only the part of work near outlet is now constructed, the assessment for this much of the work decreases as we approach the source, from the point where construction ends to the source.

In practice make the parcels A, B, C, etc., as large as possible, taking for the unit land fully saturated, in which soil water is lowered at least three feet after the completion of the work. Land not fully saturated before the commencement of the work, and land in which the soil water is lowered to a less depth than three feet below the surface, should be assessed in a lower proportion.

[This paper is quite incomplete, the difficult problems of apportioning the assessment on lands situated at different distances from the watercourse, on lands timbered and cleared, and on lands with different soils, has been left for some future paper. I will not say that I had not time to complete the paper, but admit that I considered I had advanced enough of what many members might think "heretical doctrine" for one session of this Association. Next year we have been promised papers on Drainage by some of our members who have had great experience in drainage works. I regret exceedingly that none of these members could prepare a paper this year, although urged strongly to do so by the Executive and the Drainage Committees.]

DISCUSSION.

Mr. Coad—Mr. Chipman's ideas are very good. I would like to ask if he has any scale of the difference he would make in assessing the lots? The ditch would be made larger as you go down stream; would you leave the lot above free of the extra cost of the extra size of the ditch or not?

Mr. Chipman—Mathematically the higher parcel of land should pay sufficient proportion to drain the water off it altogether.

Mr. Coad—Then, what would you assess the next lot above? Suppose the bottom lot was two feet six inches, and the next up was two feet, would you make the next lot pay for the extra six inches?

Mr. Chipman—I would make an approximate estimate of the cost of draining each lot. Then put them in proportion. Each would pay its proportion of the total cost.

Mr. Coad—In the first place you were speaking of the man up stream draining into a natural course, and according to the American law the water would be allowed to run down over the next man, and the first man would not be liable. Do you think that right?

Mr. Chipman—I think in the long run it would be. I think it would be better to let the man below take care of it. Then every man would be obliged to drain his own farm.

Mr. Coad—Another question—suppose the lot to be perfectly free of water. Are we to understand that you would assess lands back half a mile from the drain as much as you would lands quarter of a mile from it?

Mr. Chipman—No; that does not follow.

Mr. Coad.—Another question that comes up in districts where we are constructing large drains is this: Suppose we go to work and construct a large drain that carries water from branch drains. We enlarge the drain and make an assessment upon the lots on the branch drains. Would you assess the lots equally, or would you assess the man up stream higher than the man below?

Mr. Chipman—Theoretically the man up stream would be assessed higher than the man further down.

Mr. Coad—The main drain is already constructed, and the branch drain is made. Then you find that the main drain is not large enough to carry off all the water, and you enlarge it, and you have to make an assessment all over the branch drains that go into the main drain. The first lot on the branch we will call "A," the next "B," and so on. Would you assess all the lots equally?

Mr. Chipman—Of course the work is not yet completed. I would make an assessment as if it were completed, take the difference, and charge them with it. On the original assessment, if the ditches were rightly assessed, "A" should pay more; and then, when the work is finally completed, I should take the difference between the total assessment and the first assessment, and assess him for it.

Mr. Coad—The principle of making the one pay more than the other is the proper one. Suppose the drain through the first lot is constructed, and you are assessing for outlet. There has been a great deal of discussion as to whether that lot should be assessed.

Mr. Chipman—The man above pays more on the first assessment. If you reverse them you must reverse the order of assessment.

Mr. Coad—Mr. McGeorge and Mr. Jones of Sarnia assess this land all the way up the stream equally.

Mr. Chipman—I do not think that it will hold mathematically or theoretically.

Mr. Coad—They say that the branch drain takes as much off one lot as it does off the other, and that consequently all should pay equally.

Mr. Chipman—I do not believe that is the right principle. I also do not believe that it should be done by guess-work, though a guess could be better made by an engineer than by a layman.

Mr. Coad—We have a great many arbitrations in the West about drains. They spend about two-thirds of their money in the West in digging drains, and the other third goes to the lawyers. (Laughter.)

Prof. Galbraith—There is one point which is not quite clear to me. Suppose you take lot "Z" for the outlet. As I understand it, the amount to be paid by that lot would be regulated as follows: finally, when the whole drainage has been completed and the whole cost settled, then the amount it cost to enlarge it should be partially borne by that first lot. Suppose the first lot never needed any drainage, would it be fair to assess it?

Mr. Chipman—No, but the area benefited need not be the whole area enclosed by the watershed.

Prof. Galbraith—That removes my difficulty.

Mr. Coad—The lot would not be benefited, but if the water should ascend into this drain there would be a certain amount of liability.

Mr. Chipman—Yes, but people do not pay any attention to it.

Mr. Coad—A case arose in which the water was drained three miles into the head of the ditch by nature. In such a case we would have no right to assess him for that.

Mr. Chipman—If it gave him the benefit of the outlet he should be assessed for it whether he took advantage of it or not.

Mr. T. H. Jones—The case comes up where a large number are not benefited. The main drain has to be made larger on account of the water that comes down from the lots above them. Should these persons be assessed for the extra ditch needed to carry off the water that comes down from those above them?

Mr. Chipman—If it can be shown that the people below have dug enough to drain their own land, then the people above should be assessed for the total cost of enlarging. You cannot assess them under the Ditches and Watercourses Act, of course, but under the Municipal Act.

Mr. Davis—That very point would raise any amount of trouble.

Mr. Chipman—I would like to get the opinion of this Association in regard to the difference in the assessment of timbered and cultivated lands.

Mr. Coad—I make very little myself, but I know that it is a question that is often brought up.

Mr. Chipman—Down East I assess timbered lands about half, as very few farmers clear all their land.

Mr. Davis—I assess them just about the same.

Mr. Jones—I always assess timber lands about three-quarters the amount of the cultivated. I consider that land that is not cleared is not benefited to the same extent as land that is cleared.

Mr. Burke—Farmers say that if you dig a drain through a swamp you will ruin the timber. I would like to have the opinion of the Convention on that point. I have had them come to me, and ask me to allow them for it in the assessment.

Mr. Chipman—The raising or lowering of water will affect the growth of timber.

Mr. Coad—It will injure spruce, tamarack, and swamp elm.

Mr. Davis—A certain amount of water is necessary to the growth of timber, but very wet land is not favourable to its growth.

Mr. Bolton—It is true that if you dig a drain down through a black ash swamp it will kill the timber, but I have known cases where the timber has been improved by the draining of the land.

Mr. Chipman—In our part of the country I have assessed the cultivated land higher than the other, because the probability that a man will clear his land is about one in two.

Mr. Stephens—I would like to ask you how you assess roads in municipalities. I would like to have the experience of the Convention on this.

Mr. Chipman—I find out how much money has been expended on the road. I capitalize that and assess the roads for that amount. I do not know whether it will hold out or not. There is even a greater difficulty than that, and that is in the case of railroads.

Mr. Miller—The Grand Trunk has a special provision in its charter, which provides that it cannot be assessed for a ditch on the main line.

Mr. Chipman—Under the Ditches and Watercourses Act?

Mr. Miller—Under any Act.

Mr. Chipman—I have a case now under way. I assessed the C. P. R. for five hundred dollars, and I do not know whether they will pay it or not.

Mr. Butler—There is the difficulty of applying Provincial laws to Dominion railways.

Mr. W. R. Aylsworth—The Grand Trunk has a special provision, and my impression is that it applies only to the main line. I do not think that it would apply to those branches acquired since the provision was made.

Mr. Coad—A case arose on the Mooretown branch of the Michigan Central. The railway was not assessed at all. The land that we wanted to drain was so situated that we had to dig about four feet into theirs to reach a large canal, and the judge decided against us merely on account of these few feet.

[*This Association is not responsible as a body for any opinions expressed in its Papers by Members.*]

TRUSSED BEAMS.

By J. GALBRAITH,

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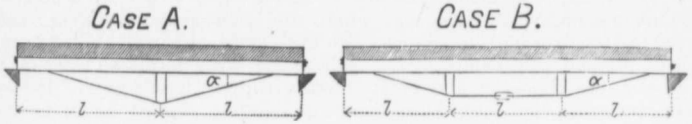
When the weight to be supported by a wooden beam is so great as to render necessary a cross section unduly large, it is the custom, in many instances, to use a beam of convenient cross section, and to make it of sufficient strength by placing a short strut under its centre, which is supported by a tie-rod inclining upwards both ways from the foot of the strut and fastened to the ends of the beam. In longer spans two struts are used, the space between them being one-third the length of the beam; the centre portion of the tie-rod is horizontal, the other two portions being inclined and fastened to the ends of the beam. In this case it is usual to make the tie-rod in two equal lengths, connected at the centre point by a turnbuckle.

The tie-rods and struts constitute the trussing. It is sometimes convenient to make the beam in two parts, lying side by side, and pass the ends of the tie-rod up between them; when this is done the two halves are separated by wooden keys, and are strongly bolted together. It is in most cases desirable that, when the beam is supporting its full load, the points where the struts are placed should be on the same level as the ends. The surest way of securing this is to put a small amount of camber in the beam, before the load is applied, by screwing up the rods, and to test the levels after the load is on; if the points at the struts are then not at the proper level the load may be removed, in some cases, and the rods again adjusted. If it is not possible to remove the loads, as, for instance, where the beam supports a floor in process of construction, jack-screws may be used to support the weight while the rods are being adjusted. I doubt that there is any formula which will enable the necessary amount of preliminary camber to be determined beforehand. The object of the present paper is to give formulas by which the cross sections of trussed pine beams and of the tie-rods and struts may be determined. The cross section of the beam is to be rectangular and uniform from end to end, and the load uniformly distributed. The conditions to be fulfilled are the following: (1) The beam must be stiff enough to resist injurious bending, either vertically or horizontally, under the compression produced by the tie-rods. (2) The stresses due to this compression, combined with those due to the weight carried by the beam, must not exceed the safe limit. (3) The beam at the struts must be at the same level as at the points of support. (4) The stresses in the trussing must not exceed the safe limits.

For convenience the letter *A* will be used to denote the case where the beam has a single strut in the centre, and *B* where the beam has two struts equally distant from the ends and from each other.



Let l denote the length in inches of the beam between the end and the first strut; thus, the whole length of the beam in case *A* is $2l$, and in case *B* is $3l$.

b, the breadth of the beam in inches.

h, the depth of the beam in inches.

α, the angle of inclination of the inclined portion of the tie-rod to the horizontal.

g, the greatest compression in pounds per square inch produced in the beam from the combined effect of the load and the strain on the tie-rod. This compression (g) exists at the lowest point of the cross section at the strut in both cases *A* and *B*.

q, the load on the beam in pounds per lineal inch; thus, $2ql$ is the total load in case *A* and $3ql$ in case *B*.

m and n are numerical co-efficients.

In case *A*, $m = 15$ $\quad n = 12.5$. In case *B*, $m = 12$ $\quad n = 22$.

Then we have in both cases

$$b = \frac{ql}{20g}\left\{m\frac{l}{h^2} + n\frac{\text{cotan } \alpha}{h}\right\} \quad \text{(I.)}$$

Having first decided upon a safe value for g the above equation will give a value of b corresponding to any assumed value of h. We may thus have any number of pairs of corresponding values of b and h. In order to select the pair suitable for our purpose, we must introduce the condition that the beam shall have sufficient stiffness to resist unsafe bending under the strain of the tie-rods, which condition is not included in the above equation. This condition is expressed by the inequality:

$$\frac{S}{bh} < \frac{1}{K}\,\frac{5000}{1 + .008\left(\frac{L}{d}\right)^2} \quad \text{(II.)}$$

where S is the total compression in pounds produced by the action of the tie-rods on the ends of the beam. K is a numerical factor of safety against flexure; d is in some cases $= b$, and in others $= h$; and

L in some cases $= l$ (cases A and B), and in others $2l$ (case A) or $3l$ (case B), or some value intermediate between l and $2l$ or $3l$.

We shall now describe how the values of d and L are to be decided. If the beam is so well supported against side bending as to be liable to bend only in a vertical plane, $d = h$ and $L = l$ in both cases A and B. This is generally the case, *e.g.*, where the beam supports a floor; the joists, if partly butting against it on both sides, or if well spiked to it, will prevent side bending; also, where the beam forms a girder of a bridge, the cross-ties and cross bracing support it sideways. If the beam has no such support against side bending, d must be made $= b$, and $L = 2l$ in case A, and $L = 3l$ in case B, to provide against side bending; d must also be made $= h$ and $L = l$ to provide against undue vertical bending. If the beam has side support, but only at such intervals as to render it doubtful whether it will yield or not, d must be taken $= b$ and $L =$ the unsupported interval. In all cases d must be made $= h$ and $L = l$ to provide against undue vertical bending.

The formulas which give the total stresses in pounds in the trussing are the following:

Let R = pressure exerted by strut against beam.
S = end pressure exerted by tie-rod against beam.
= also tension in horizontal part of tie-rod in case B.
T = tension in inclined part of tie-rod.

Then $R = \frac{5}{4}\ ql$ case A.
$R = \frac{11}{10}\ ql$ case B.
$S = \frac{5}{8}\ ql \cot \alpha$ case A.
$S = \frac{11}{10}\ ql \cot \alpha$ case B.
$T = \frac{5}{8}\ ql \sqrt{1 + \cot^2 \alpha}$ case A.
$T = \frac{11}{10}\ ql \sqrt{1 + \cot^2 \alpha}$ case B.

By dividing the above values of R, S and T by the admissible stresses per square inch for the materials, the cross sections of the trussing will be determined.

It must be observed, however, that if this division gives too small a cross section for the strut, to resist bending, the cross section must be increased. This may be done in most cases without calculation, since an overplus of strength in the strut is of little consequence. In long struts, however, Gordon's formula should be applied.

As it is generally convenient to make the tie-rod of uniform cross section, both in horizontal and inclined portions (case B), the cross section determined for the inclined portion should be adopted for the whole.

The area of the tie-rod obtained as above is its smallest area, viz., that given by the bottom of the thread in the screwed ends—thus, in order to economise material, it may be advisable to upset the screw ends. If the strain of the tie-rod is applied to the end of the beam through a cast-iron plate, this plate must be of sufficient area not to crush into the wood.

We shall now illustrate the application of the above formulas by some examples:

First example, case *A*.

A railroad girder, 16 feet in length, to support a load of 2,400 lbs. per lineal foot, including half the weight of bridge, cot $\alpha = 4$, $g = 600$.

$$\text{We have } l = 8 \times 12$$
$$q = \frac{2400}{12}$$
$$\cot \alpha = 4$$
$$g = 600$$
$$m = 15$$
$$n = 12{\cdot}5$$

Then
$$b = \frac{\frac{2400}{12} \times 8 \times 12}{20 \times 600} \left\{ 15 \frac{8 \times 12}{h^2} + 12{\cdot}5 \frac{4}{h} \right\} = \frac{2304}{h^2} + \frac{80}{h}$$

Assume $h = 14$; then we shall have $b = 17{\cdot}46$, say $18''$.

Thus this girder may be built up of three pieces, each $6'' \times 14''$, side by side, separated by wooden keys, and bolted together.

Before finally accepting these dimensions we must test them for bending under the end compression due to the tie-rod. From the construction of the bridge there will be no danger of side bending. We have thus only to see if the above dimensions give security against vertical bending:

$$S = \frac{5}{8} ql \cot \alpha = \frac{5}{8} \times \frac{2400}{12} \times 8 \times 12 \times 4 = 48000 \text{ lbs.}$$
$$\frac{S}{bh} = \frac{48000}{18 \times 14} = 190 \text{ lbs. per square inch.}$$

$$\frac{1}{n} \frac{5000}{1 + {\cdot}008 \left\{ \frac{L}{d} \right\}^2} = \frac{1}{3} \frac{5000}{1 + {\cdot}008 \left\{ \frac{8 \times 12}{14} \right\}^2} = 421 \text{ lbs. per square inch.}$$

And $190 < 421$.

Thus the dimensions $\begin{matrix} b = 18'' \\ h = 14'' \end{matrix}$ will do.

To determine the cross section of the tie-rod we have area of tie-rod cross section $= \frac{T}{f}$ where f is the admissible stress per square inch. Take $f = 10000$ lbs.

$$\text{Then } \frac{T}{f} = \frac{\frac{5}{8} \times \frac{2400}{12} \times 8 \times 12 \sqrt{1 + 16}}{10000} = 4{\cdot}95 \text{ square inches.}$$

It would be advisable in this case to use two tie-rods passing through the spaces between the three portions of the beam; rods of $1\frac{3}{4}''$ diame-

ter at bottom of screw-thread will give nearly the above cross section. The compression on the strut:

$$R = \frac{5}{4}\,ql = \frac{5}{4} \times \frac{2400}{12} \times 8 \times 12 = 24000 \text{ lbs.}$$

If the strut be of wood, $7'' \times 7''$ would be amply sufficient for strength, but in order to make neat connections it would be better to make it larger. If made of cast iron the strut will be amply strong if sufficiently large at the lower end to receive the rods with a good bearing, and gradually enlarging towards the upper end, so as to fit the beam properly.

Second example, case *B*.

A floor girder, 24 feet long; load, 600 lbs. per running foot—$\cot \alpha = 5$.

$$\text{here } q = \frac{600}{12}$$
$$l = 8 \times 12$$
$$\cot \alpha = 5$$
$$g = 800$$
$$m = 12$$
$$n = 22$$

$$b = \frac{\frac{600}{12} \times 8 \times 12}{20 \times 800} \left\{ 12 \frac{8 \times 12}{h^2} + 22 \frac{5}{h} \right\} = \frac{345{\cdot}6}{h^2} + \frac{33}{h}$$

Assume $n = 9''$, then $b = 7''{\cdot}94$, say $8''$.

We must now, before accepting these dimensions, apply the test for stiffness under the compression due to the tie-rod:

If the girder is well supported sideways by the joists we shall only require the condition of vertical stiffness:

$$\frac{S}{bh} = \frac{11}{10} \frac{ql \cot \alpha}{bh} = \frac{11}{10} \frac{600}{12} \times \frac{8 \times 12 \times 5}{8 \times 9} = 367 \text{ lbs. per square inch.}$$

$$\frac{1}{k} \frac{5000}{1 + {\cdot}008 \left\{ \frac{L}{d} \right\}^2} = \frac{1}{k} \frac{5000}{1 + {\cdot}008 \left\{ \frac{l}{h} \right\}^2} \text{ in this case}$$

$$= \frac{1}{3} \frac{5000}{1 + {\cdot}008 \left\{ \frac{8 \times 12}{9} \right\}^2} = 872 \text{ lbs. per square inch, and } 367 < 872.$$

The dimensions $8'' \times 9''$ therefore fulfil the necessary conditions. If this beam were not supported sideways at all we should have

$$\frac{1}{k} \frac{5000}{1 + {\cdot}008 \left\{ \frac{L}{d} \right\}^2} \quad \frac{1}{k} \frac{5000}{1 + {\cdot}008 \left\{ \frac{3l}{b} \right\}^2} = \frac{1}{3} \frac{5000}{1 + {\cdot}008 \left\{ \frac{3 \times 8 \times 12}{8} \right\}^2} = 146.$$

And 367 is not < 146.

This beam is thus not of sufficient breadth under this condition. If we assume $h = 6\frac{1}{2}''$ we shall find b about $13\frac{1}{2}''$, which dimensions will be found to satisfy the conditions of stiffness, both vertically and horizontally, under the longitudinal compression due to the tie-rods.

To determine the cross section of the tie-rod we have

$$\text{Area} = \frac{T}{f} = \frac{11}{10}\,\frac{ql\sqrt{1+\cot^2\alpha}}{f} = \frac{11}{10} \times \frac{600}{12} \times 8 \times 12\,\frac{\sqrt{1+25}}{10000}$$

$$= \frac{26928}{10000} = 2{\cdot}69 \text{ square inches.}$$

which corresponds with a diameter of nearly $1\frac{7}{8}''$. The compression in the strut is given by

$$R = \frac{11}{10}\,ql = \frac{11}{10} \times \frac{600}{12} \times 8 \times 12 = 5280 \text{ lbs.}$$

Similar remarks apply to the dimensions of the struts as in the previous example.

The values to be given to g depend upon the judgment of the engineer. Where the beam is subject to loads suddenly applied and removed, g should be taken smaller than in cases where the greater portion of the load is stationary. It should also be taken smaller with poor material than with good.

The factor of safety, k, should be made greater with poor material than with good.

Values of g from 600 to 800 and $k = 3$ will suit good, fairly-seasoned pine.

The value $L = l$ in the condition for stiffness in a vertical plane should more properly be $L = \frac{3}{4}l$ case A, and $L = \frac{1}{2}l$ case B, but practically the value given is near enough, and errs on the side of safety.

When an assumed value of g gives dimensions which may not please the eye, such as in example 2, where we had $b = 13\frac{1}{2}$ $h = 6\frac{1}{2}$ with $g = 800$, dimensions more nearly equal to each other may be obtained by assuming a smaller value of g. Thus if we had in this case assumed $g = 600$, we should have found $b = 11''.6$ $h = 9$ satisfy all the conditions.

The condition, as given above, to ensure sufficient stiffness against the end pressures is simply the condition that the average pressure per square inch on any cross section shall be $\frac{1}{K}$ part of the breaking pressure given by C. Shaler Smith's adaptation of Gordon's Formula to pine posts. It may be considered by some that $K = 3$ gives too small a margin for safety. A little consideration will show that this probably is not the case.

When a post breaks under the average pressure per square inch $\frac{5000}{1 + {\cdot}008\left\{\frac{L}{d}\right\}^2}$ fracture takes place only on account of the end pressures continuing after bending takes place, and causing stresses in the

material, which increase very rapidly with the bending up to the breaking point. This will happen when the stresses are due to external loads on the post which are free to follow up the bending, so to speak. The case is entirely different when the compression is produced by truss-rods. In this case the bending of the beam tends to relieve it of pressure, and the only way in which the pressures can follow up the bending is by the truss rods being shortened by being screwed up, an operation which evidently cannot be performed by the trussed beam itself. I am inclined to think that the chances are that the value $K = 3$ would, in many instances, be unnecessarily large.

It would be impossible, in a short paper, to give the investigation of the above formula. The object of the paper is to place in the hands of builders and architects, rational formulas of easy application, which will secure trussed beams with properly proportioned parts, and to relieve them from the necessity of simply copying what has been done before, or of trusting to mere guess work.

DISCUSSION.

Mr. Butler asked if the beam hinged over the strut, in the design shown by Mr. Galbraith, or if the beam were continuous?

Prof. Galbraith—The formula is based on the supposition that the beam is continuous. The other method is that generally used, and is much simpler, but this is complicated.

In reply to another question, Mr. Galbraith said he practically considered the rods in his design at the foot of the strut. He thought that was quite sufficient. In testing the rods it would be advisable to give the foot of the strut a slight tap to keep it in position.

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HIGHWAY BRIDGES.

By M. J. BUTLER,

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In reading the various papers published in the proceedings of the different Societies of Engineers throughout the United States, on the subject of Highway Bridges, the trouble with our cousins seems to be that their Bridge Commissioners are either corrupt or incompetent. In two treatises on this subject published in the United States the same wail is to be found, so there must be something in it. Where there is so much smoke, it is probable there is some fire. In this Province matters are somewhat differently arranged; and while it is a rare thing to find lettings made by competent men, there is no reason to doubt the honesty of purpose which generally actuates our municipal officers in such matters. Still, with us, as in all other communities enjoying perfect liberty of action in the choice of municipal officers, it frequently happens that some honest farmer or storekeeper is pitch-forked into a position requiring the education and judgment of an engineer, and from motives of false economy it is rare that such professional advice is taken as the importance of the subject warrants.

As this paper is not intended to be a history of highway bridge building, no particular description of present practice will be given, except incidentally, as prevailing practice happens to coincide with portions of the work here presented. In the following pages it is the writer's intention to attempt a practical treatment of the subject, and to endeavour to make plain for beginners some of the principles of design. As yet our counties have built but few iron bridges; but where they have, the work has been done by reliable bridge companies, and the results have been good. The time is rapidly approaching when all bridge renewals will be of iron, and as bridge builders and bridge companies are springing into existence to meet the increased demand, it behooves our County Engineers to post themselves on the subject as far as they can. The safest plan will always be to have plans and specifications prepared by an expert bridge engineer, and to have the completed structure accepted by him, so as to make sure the work has been properly done. Unfortunately many men of good average intelligence can see no difference between one iron bridge and another (it requires an expert to do so), the difference in cost being, in their minds, only a measure of the greed of the bridge company. A poor iron bridge is about the worst investment any county can make, and as a commercial axiom it may be written

that the supply will always suit the demand; and when our county officers begin to buy the cheapest offered, because it is the least in first cost, then we will get poor defective traps like our cousins across the line.

In answer to the question, What constitutes a really good bridge? it may be said that in a first-class bridge all parts are of equal strength, that the design is of such character as to admit of exact and rigid analysis, that the material is so distributed that it will resist the strains to which it is subjected, that all parts will be accessible to the paint brush, and rendered easy for inspection.

It was formerly, and is still to some extent, the custom to specify a certain factor of safety for all bridges; and while it sounds well in the ears of inexperts, to say the bridge is strong enough to bear five, six (or whatever factor was adopted) times the greatest load that can ever come upon it, still as a matter of fact such bridges do fail. It is doubtful as to what is intended by a factor of safety of six, say. Does it mean $\frac{1}{6}$ of the breaking load? If so, the true factor is only three or thereabout. It has been demonstrated by Wöhler and other experimenters that material should not be strained up to or beyond the limit of elasticity; that repeated renewals of loads, unless very much below the elastic limit, will cause rupture quite as surely as the single application of the breaking load. Now, the elastic limit is only about one-half of the ultimate strength, and when we take into account the effects of shocks, blows, corrosion, secondary and incalculable strains, it will not seem at all wonderful that failures in bridge constructions have occurred. Modern practice specifies certain unit stresses to which members may be subjected, well within the limits of the elasticity of the material, and when that practice is followed in conjunction with a carefully prepared strain sheet, good results are obtained.

In the writer's opinion no more foolish practice could be indulged in than that of adopting light loads for bridges, and as there is good authority for such practice, he thinks it advisable to devote a few minutes to this branch of the subject. In the standard specifications prepared by Mr. Theodore Cooper, M. Am. Soc. C.E., there are three different types of loading designated as "A," "B" and "C." Bridges in Class A are intended for cities and large towns where road rollers and other heavy loads frequently pass. The loads recommended are 100 pounds to each square foot of floor for all spans up to 100 feet, eighty pounds for all spans over 200 feet, and proportionately for intermediate spans, or a concentrated load of fifteen tons, no span to be for a less load than 2,000 pounds per foot. Class B is intended for towns, villages, etc., where excessively heavy loads only occasionally pass. The loads recommended are eighty pounds to the square foot for spans up to 100 feet, sixty pounds for spans 200 feet, and proportionately for intermediate spans, or a concentrated load of eight tons on two pair of wheels eight feet centres. Class C is for rural districts, and the loads recommended are the same loads as for Class B, or a load of five tons on two pair of wheels eight feet centres.

Prof. J. A. L. Waddell, in his excellent work on "Iron Highway Bridges," also advises a similar classification for live load. In the writer's opinion no highway bridge should be designed for a less live

load than 100 pounds to the square foot of roadway, for the following reasons. All bridges are liable to the passage of heavy traction engines, concentrating from four to eight tons on two pair of wheels seven feet centre to centre, or to the passage of road rollers which weigh from ten to twelve tons, to large crowds of men, or to specially heavy loads of iron, stone, grain, etc. To the writer's knowledge a bridge designed to carry eighty pounds to the square foot failed under loads of large stone used in the construction of a bridge necessitated by a new line of railway in the back country. In another case an old bridge was broken down by a crowd of men dancing on it at the time. Of course these two examples were wooden bridges, and it is altogether likely that the deterioration of the material was a factor in their failure. In wooden bridges calculate on excessive loads, and use low unit stresses.

Of course it will be said that the cost of providing for such large loads will be excessive; from numerous designs made by the writer, he is satisfied that the increased cost of a first-class bridge, *i.e.*, for the heavy load specified over one of the lower class of loads will not exceed from five per cent. to eight per cent. The items which go to make up the cost of a bridge are as follows:

1. Raw material, rolled and plate iron ..... 55 per cent.
2. Work on same in shop ..... 15 "
3. Transportation by rail, etc ..... 3 "
4. False work and erection ..... 12 "
5. Profit and administration ..... 15 "

Of the above, (1) would be affected by providing for the greater loading; (2) scarcely at all; (3) to a certain percentage only; (4) not at all; (5) probably not at all, depending on circumstances. With properly prepared loads, properly designed bridges of iron or steel should last for ever.

The writer believes that all bridges should be designed to carry the following loads: 1st, the dead weight of the structure; 2nd, a wind pressure of 30 pounds to the square foot, the exposed area to be taken at $1\frac{8}{10}$ times the area of one side of the bridge; 3rd, a live load of 100 pounds to the square foot of roadway, and 80 pounds square foot of sidewalks, if any. Account to be taken in special cases of extraordinary concentrations, in the case of joisting and floor beams. Under the above loadings no members in tension to be strained beyond the following limits or unit stresses: for wrought iron—

On lateral bracing	15,000 lbs.	per sq. inch.
On solid rolled beams, used as cross floor beams and stringers	12,000 "	"
On bottom chords and main diagonals (forged eye bars, etc.)	12,000 "	"
" " " " (plate and shape, net section)	10,000 "	"
On counters and long verticals, forged eye bars	10,000 "	"
" " plates or shapes, net section	8,000 "	"
On bottom flange of riveted cross girders, net section	12,000 "	"
On floor beams, hangers, and similar members, liable to sudden loading (bar iron, with forged ends)	9,000 "	"
On floor beams, hangers, and other members, liable to sudden loading, plates or shapes (net section)	7,000 "	"

Wrought iron in compression should be so proportioned that the maximum load will cause no greater strains than that given by the following formulæ, $P = \frac{10000}{1 + \frac{L^2}{30000 R^2}}$ In no case must the length of a compression member exceed 45 times the least width. Steel compression members to be proportioned by the same formula, with 50 per cent. added. $P =$ the allowed compression per square inch of cross section.

$L =$ the length of compression member in inches.

$R =$ the least radius of gyration of the section in inches.

Timber compression members to be proportioned as follows:

$$P = \frac{933}{1 + \frac{L^2}{275 d^2}}$$

When $P =$ the allowed compression per square inch of cross section.

$L =$ the length of member in inches.

$d =$ the least diameter or side in inches.

The iron and steel used shall be capable of undergoing the cold bend tests. (The writer thinks it useless to specify the limits of elasticity and ultimate strength in a paper before a Society like this, inasmuch as the probable bridges would not justify the expense incident to the necessary testing, nor in this country is it easy to get the use of a machine, it being premised that if material will stand the simple cold bend test it is suitable for bridge construction.) The cold bend test is as follows: Specimens must stand bending cold for about 180° to a curve, the diameter of which is not more than twice the thickness of the piece. Or, when nicked with a cold chisel and broken over an anvil or vice with a sledge, the fracture shall be mostly fibrous, with but few granular specks. Steel may in addition be heated to a low cherry red, and cooled in water of about 80° F., after which it should stand bending cold in the same manner as above mentioned. The timber used should be sound, well-seasoned body timber cut from moderately large trees, free from sapwood, windshakes, large black or loose knots, worm holes or other defects. (Above all avoid the use of the word "merchantable" which is so common in specifications.)

Pine timber should not weigh more than 30 pounds to the cubic foot, nor white oak more than 53 pounds to the cubic foot, and this is the proper measure of the seasoning.

It was the writer's intention to have prepared a form of general specification for highway bridges, before he saw the admirable one issued by Mr. Theodore Cooper, M. Am. Soc. C. E., and from which he has taken the liberty to make some extracts in this paper. As they cost but 25 cents each, parties in want of such a guide cannot do better than to secure copies. They are published by the Engineering News Publishing Co., Tribune Building, New York City.

It has been thought advisable to add a list of books treating on the subject of this paper, as many beginners are at a loss to know what books to buy and where they can be obtained. The writer submits the following list, to be taken in the order given :

1st. "An Elementary Treatise on Iron Highway Bridges," by A. P. Boller. This little book is excellent in character, and is a good introduction to the subject ; the author is an acknowledged expert.

2nd. "The Designing of Ordinary Iron Highway Bridges," by J. A. L. Waddell, of the Phœnixville Bridge Company. This work is the most complete manual of designing ever published, and it is to be regretted that there are not more works of this character published ; it leaves nothing to be desired, as it is both practical and theoretical. Works of this kind would soon remove such classifications as "theoretical" and "practical" men, if applied to every branch of engineering.

3rd. "The Elasticity and Resistance of the Materials of Engineering," and "The Strains in Structures." Two excellent manuals by Professor Burr, late of Renssaelar Polytechnic Institute, Troy, now with the Phœnixville Bridge Co. These works are of a more advanced type, and probe the problems of material and design to the bottom.

4th. "The Strains in Framed Structure," by Prof. A. J. Dubois. A large quarto volume on bridge building. The work is a good one, but the author is an expert mathematician, and prefers to use the calculus in many investigations where a much more simple algebraical analysis would give quite as satisfactory and accurate results ; however, in the analysis of the ordinary types of bridge he is very plain and satisfactory. This work was the first, known to the writer, wherein the principles of design were laid down in a practical manner, by the designing of a complete bridge, *i.e.*, by taking out the strain sheet, apportioning the material to the strains, order bills, shipping bills, etc., detail plans, and everything necessary to the construction of the bridge.

5th. For the graphical treatment of strains, consult "Green's Graphic Statics, Bridges, Roofs and Arches, etc.," or "Dubois' Graphical Statics." There is also a work by Edmund Olander, published by Spon, of London, England, wherein the graphical method is used.

6th. Of course "Trautwine's Engineer's Pocket-Book" should be in the hands of every engineer. Some well-arranged data on bridge work, as on nearly everything else pertaining to civil engineering, will be found in "The Civil Engineer's Pocket Book."

7th. Engineers intending to design bridges will find that one or more of the Iron Companies' Pocket Books is well-nigh indispensable —Carnegie's is the best.

As an appendix to this paper several designs have been prepared.

No. 1 is a bowstring girder, and is probably the cheapest iron bridge of equal strength that can be built. It has in its favour less dead weight, and a more graceful and pleasing appearance. Against it is its lack of rigidity, from inability to put in overhead sway bracing, and some ambiguity in determining the stresses in the web system, and

the alternating stresses under moving loads to which the web members are subjected.

Design No. 2 is a single intersection pin connected Pratt truss bridge, and is an example of the best type of bridge construction.

Design No. 3 is for a combination bridge, and is a type of construction that has not yet made its appearance in this Province, and in the writer's opinion this is due, not to lack of merit in the bridge, but to lack of knowledge of its merits on the part of those who buy bridges. When a county does not feel able to buy *first-class iron* bridges, the combination bridge is much the superior of a *poor* iron bridge; the latter, when partially worn out, has only its scrap value, whereas, by the addition of iron struts, the combination (if properly designed) can be turned into a first-class wholly iron bridge. Combination bridges, when properly designed and built, will last from twenty to forty years.

Design No. 4 is the ordinary Queen truss wooden bridge, in use in this Province. The only point wherein the design varies from those usually built is in the lower chord; two scarfs or splices are given instead of one. As ordinarily built, one scarf is made in the centre panel, the point of maximum strain, thus necessitating two rather long sticks and less strength. The mere lengthening of a stick of timber from 13 feet to 25 or 30 feet will add from $2 to $4 per foot.

Cast iron blocks are placed at the foot of the braces and bolted to the chord, instead of oak, as is sometimes the custom. Oak and pine, when placed in contact, have a mutual rotting effect on each other.

Owing to the great fluctuation in the price of materials, estimates of cost would be of little or no value, and have not therefore been given.

DISCUSSION.

At the conclusion of Mr. Butler's paper, Prof. Galbraith moved a vote of thanks in the following terms:

"I think Mr. Butler's paper will be a most valuable contribution to the information we possess on the subject of Highway Bridges. The paper shows signs of close and correct theoretical knowledge, and practical experience. I don't think I have ever seen or heard a paper on the subject that combines those qualities so admirably and completely as this seems to do."

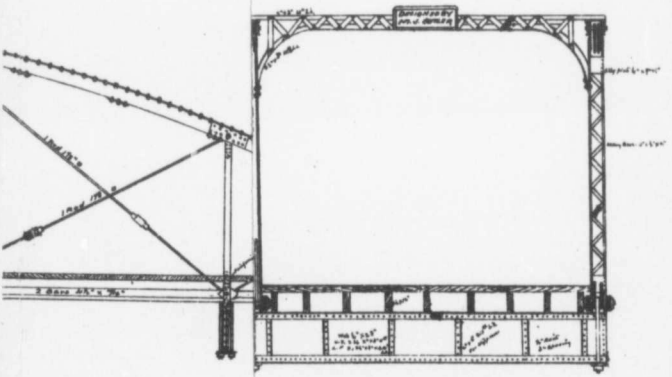
Mr. Niven seconded the vote of thanks, which was carried unanimously.

Prof. Galbraith said he was often asked by correspondents to name some reliable work that would give county engineers and surveyors simple specifications and descriptions for designs of bridges such as were to be yet found, and would have to be used for a good many years yet in back country districts, viz.: wooden bridges.

Mr. Butler said he supposed the subject was so elementary that no one had ever cared to write a book on it, but any of the standard works above mentioned would give the principles of design for a man who had a fair knowledge of mathematics.

SHEET A.

ors of Ontario,



SECTION THROUGH CENTRE OF BRIDGE

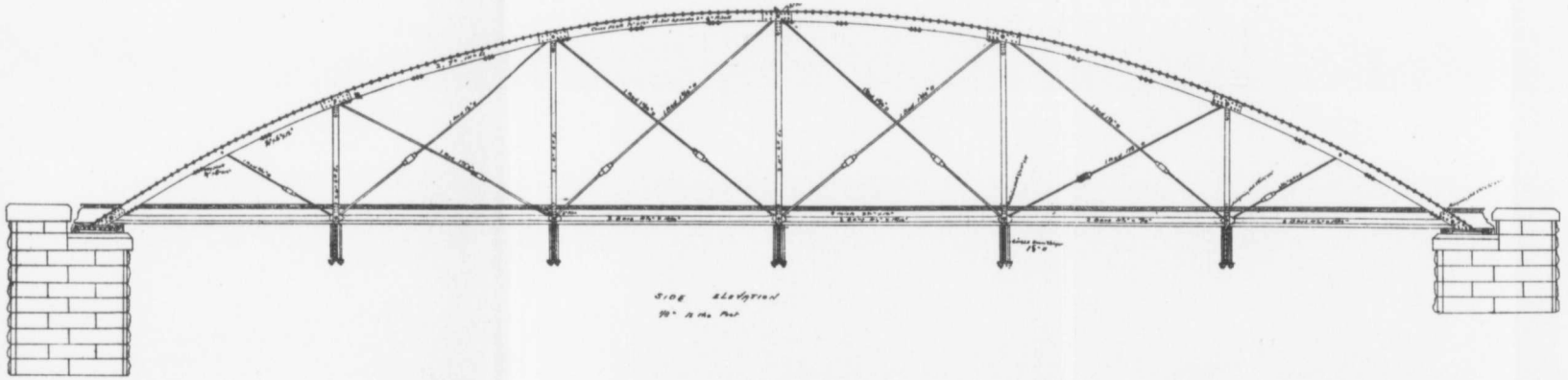
SHEET A.

Proceedings of the Association of Provincial Land Surveyors of Ontario,

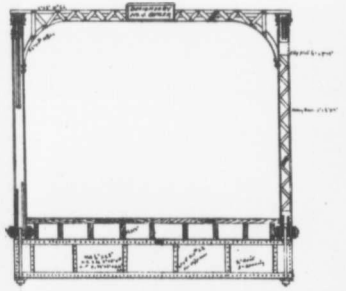
TO ACCOMPANY PAPER ON HIGHWAY BRIDGES, BY M. J. BUTLER.

1887.

PLATE No I
BOWSTRING GIRDER
HIGHWAY BRIDGE

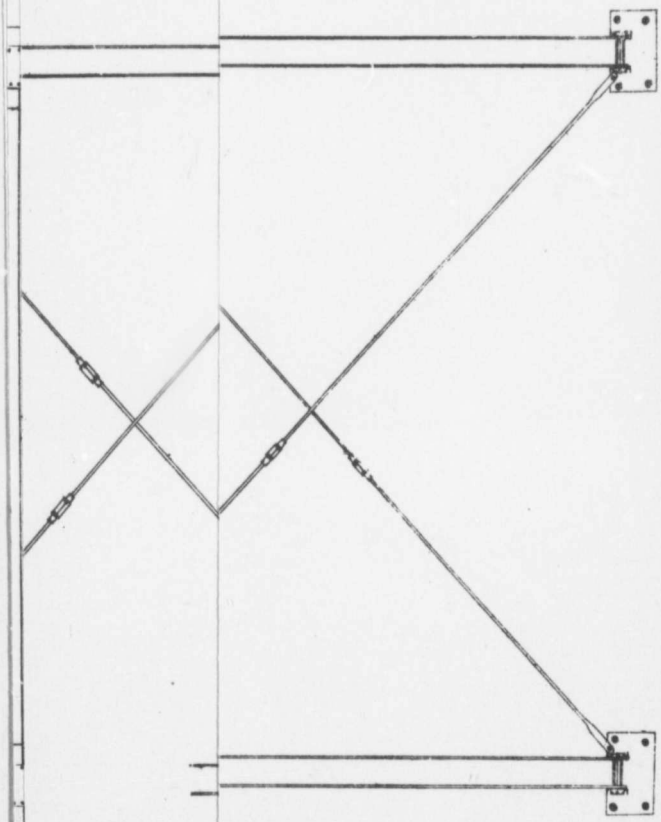


SIDE ELEVATION



SECTION THROUGH CENTRE OF BRIDGE

SHEET B.



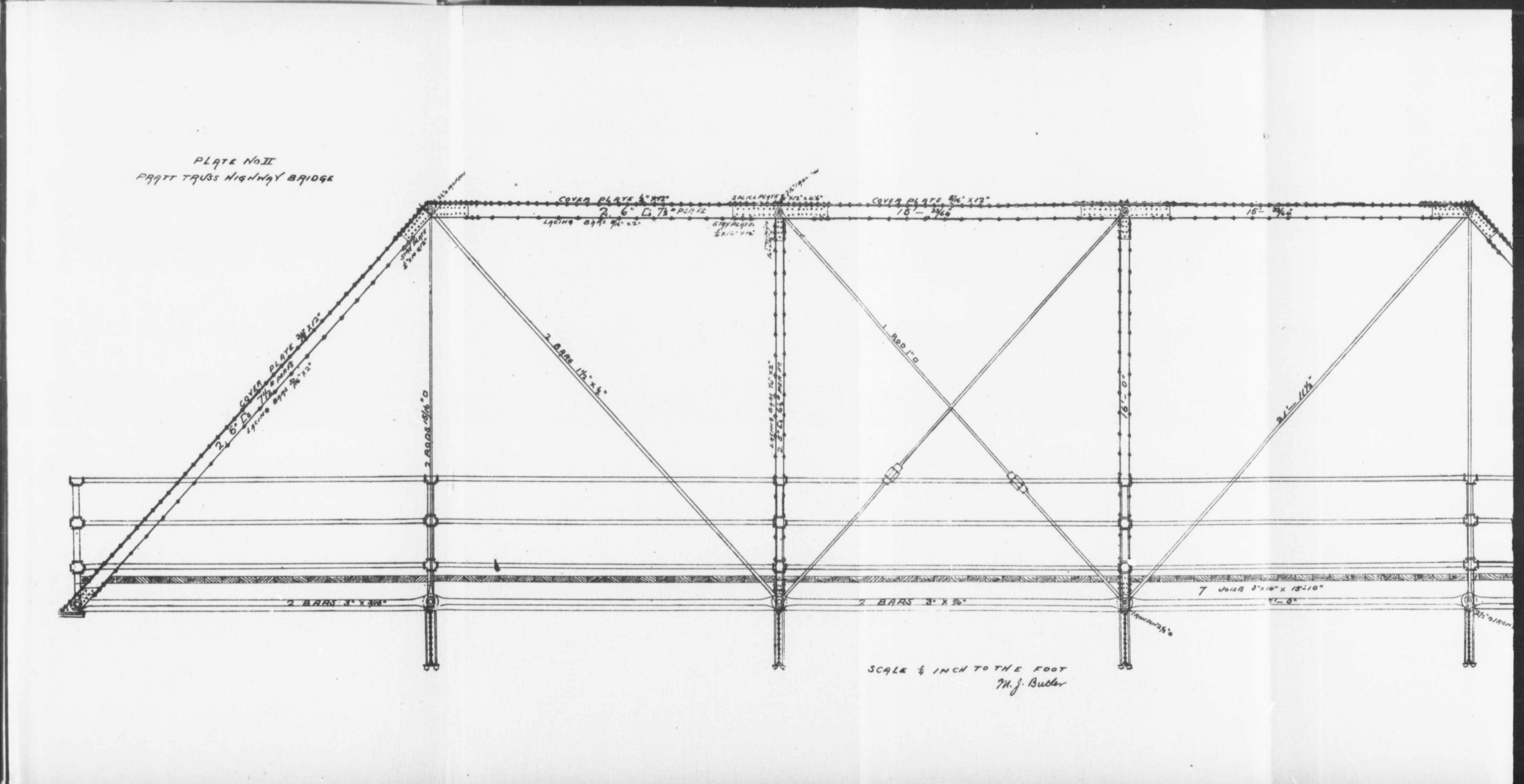


PLATE No. II
PRATT TRUSS HIGHWAY BRIDGE
SCALE ¼ INCH TO THE FOOT
M. J. Butler

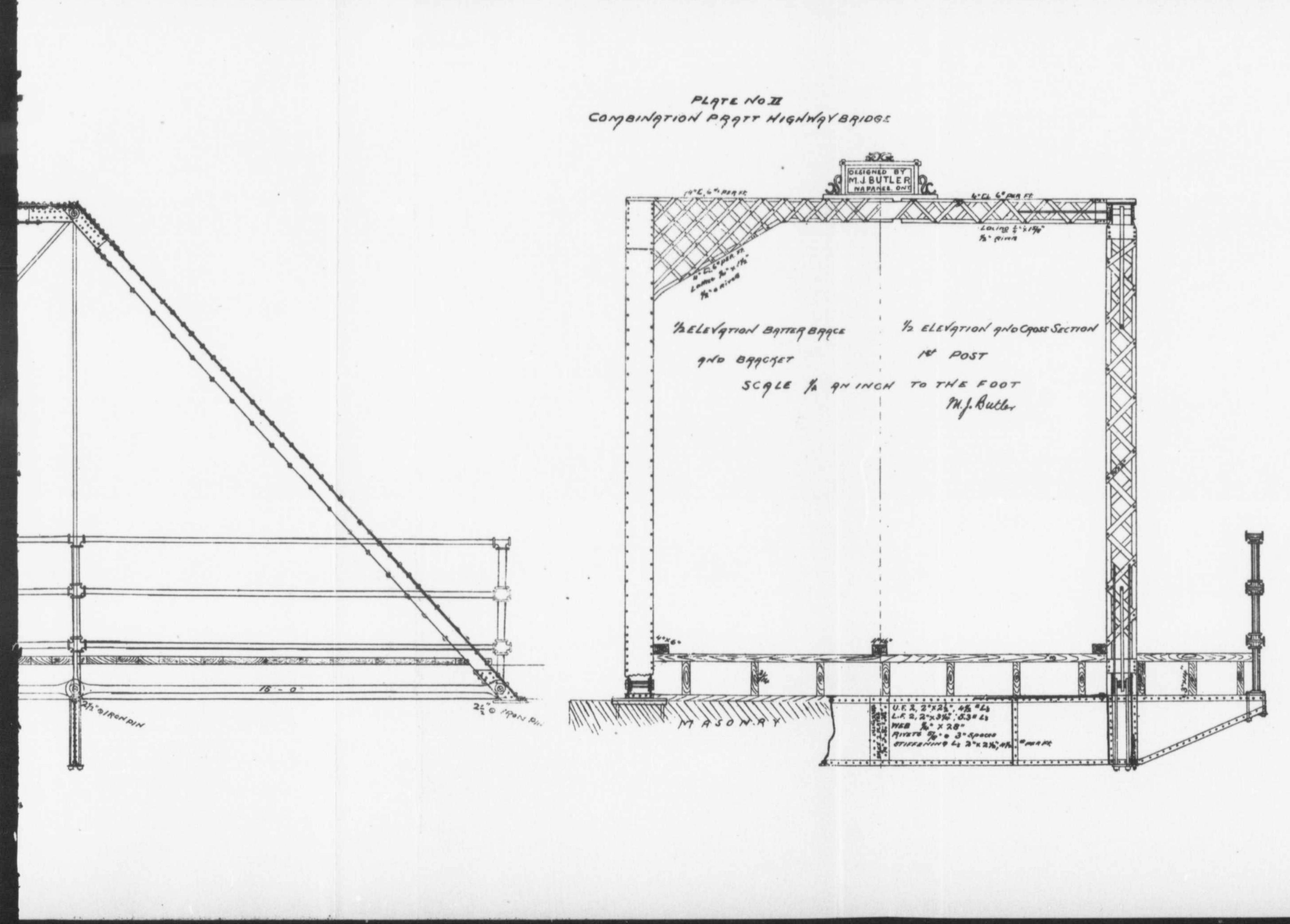


PLATE No. II
COMBINATION PRATT HIGHWAY BRIDGE
DESIGNED BY M.J. BUTLER NAPANEE, ONT.
½ ELEVATION BATTER BRACE AND BRACKET
½ ELEVATION AND CROSS SECTION 1st POST
SCALE ½ AN INCH TO THE FOOT
M. J. Butler

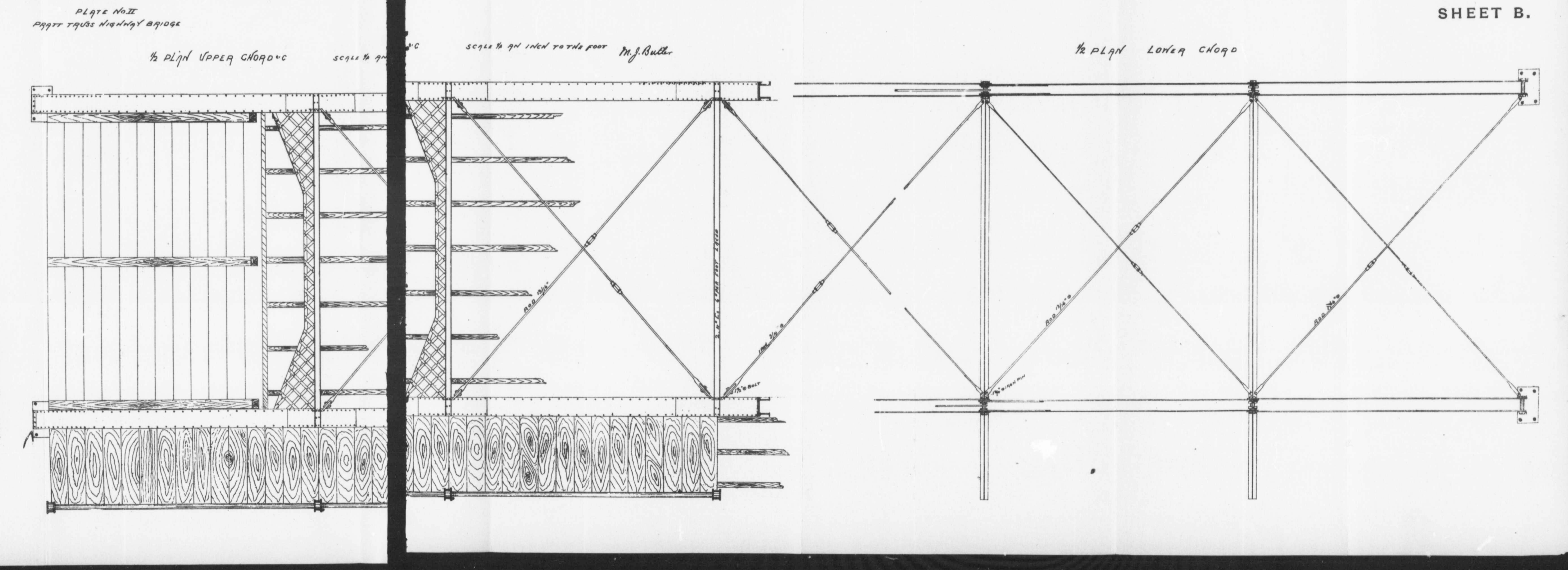


PLATE No. II
PRATT TRUSS HIGHWAY BRIDGE
½ PLAN UPPER CHORD &c
SCALE ½ AN INCH TO THE FOOT
M. J. Butler
½ PLAN LOWER CHORD

SHEET C.

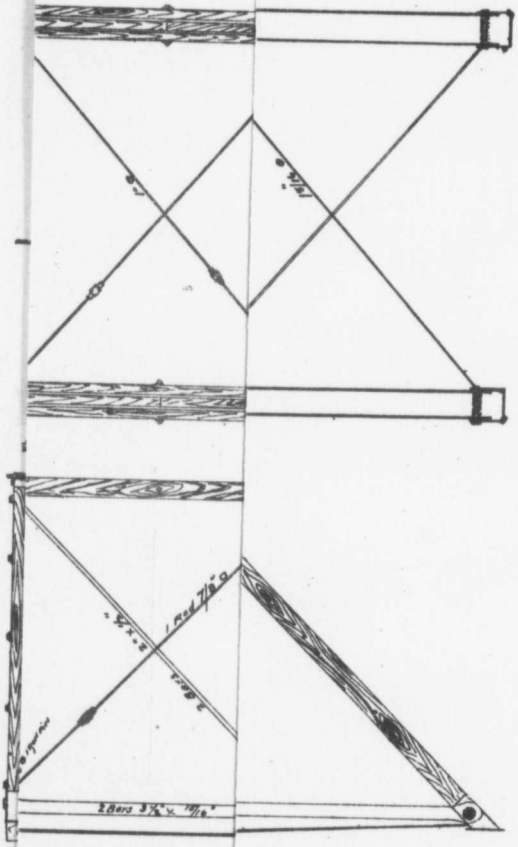
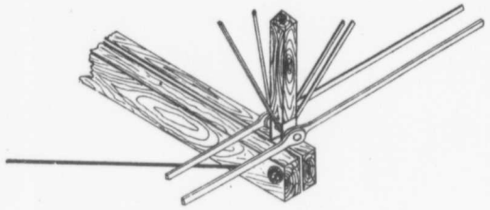


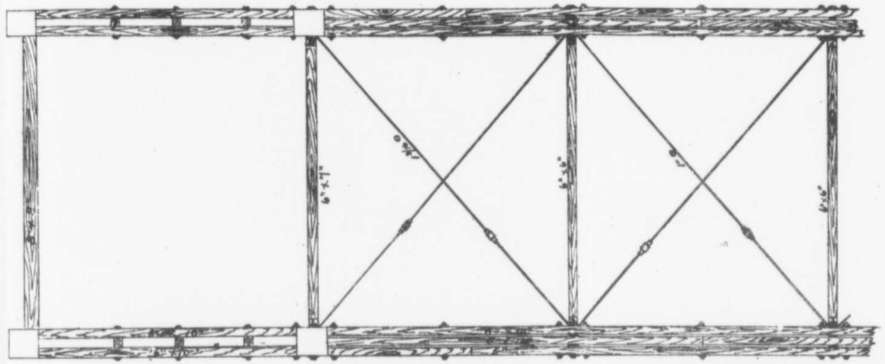
PLATE No III
COMBINATION PRATT HIGHWAY BRIDGE

SHEET C.

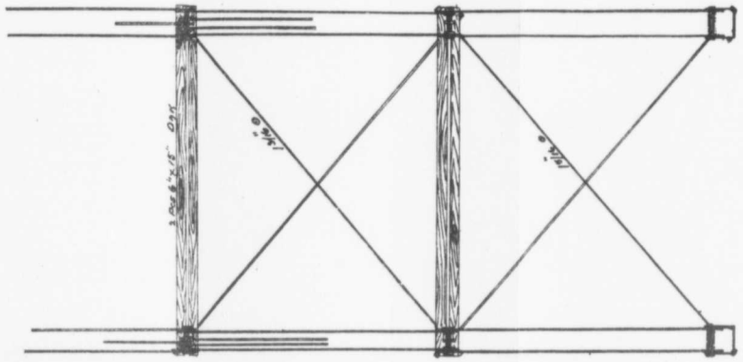


FOOT OF POST No 0
ISOMETRIC SCALE 3 INCH TO THE FOOT

½ PLAN UPPER CHORD

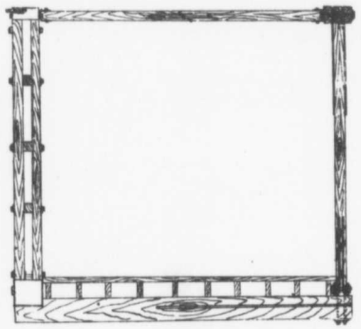


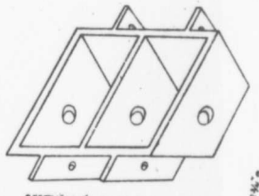
½ PLAN LOWER CHORD



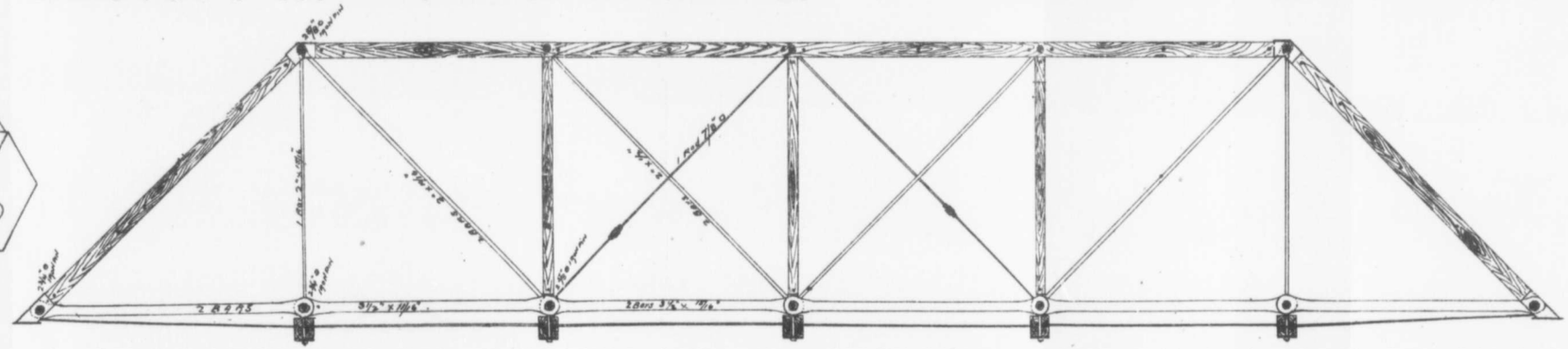
½ SECTION BATTER POST

½ SECTION 1ST POST





SKETCH OF MOULDING BOX
NOT TO SCALE

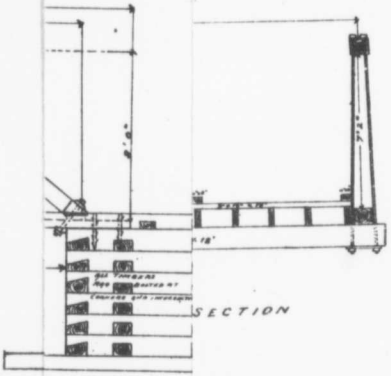


SIDE ELEVATION

Scale 3/4" to the Foot

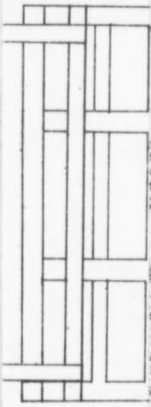
Wo

SHEET D.

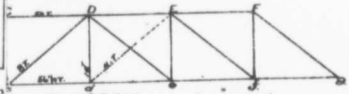


SECTION

ALL PLANS
are inch to the foot



N TRUSS
0 Ft. C. to C. Bottom Brackets
" " " Chords
" " "
120 500 Lbs. PER 12 Panel
90 1500 " " "



IN DIAGRAM

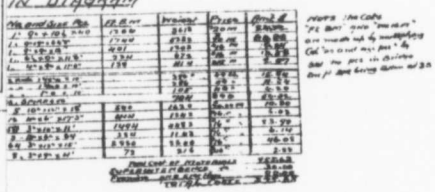
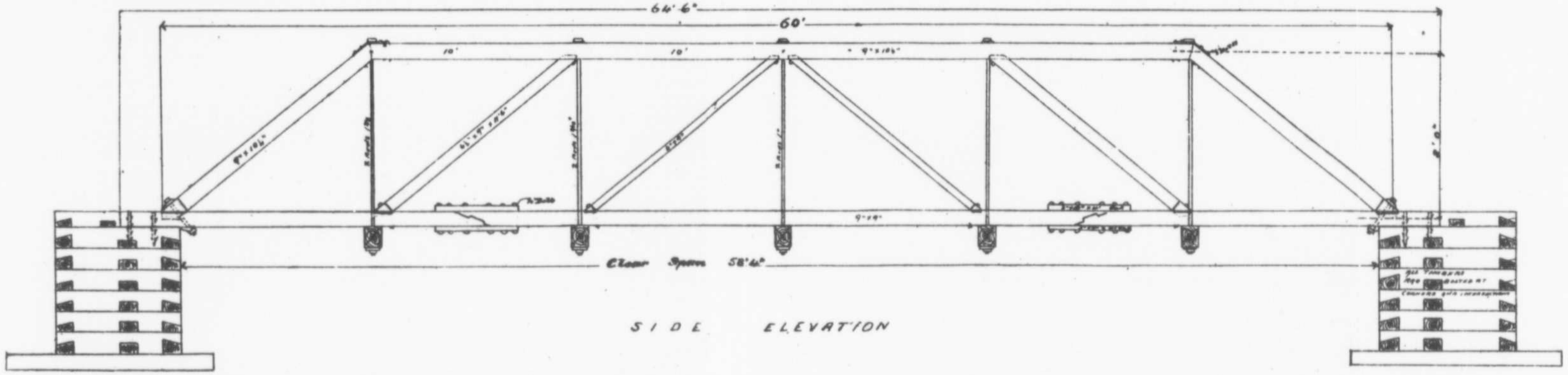
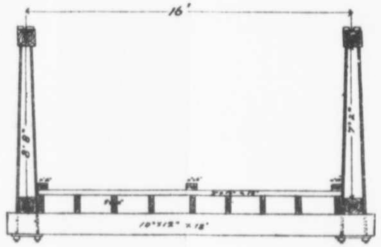


PLATE No IV
WOOD QUEEN HIGHWAY BRIDGE

SHEET D.

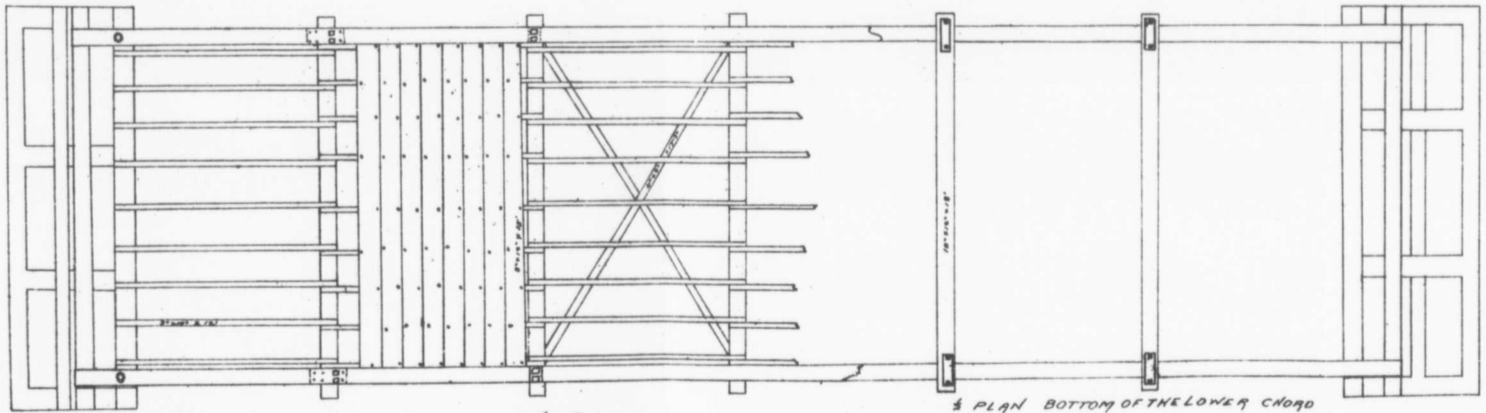


SIDE ELEVATION



CROSS SECTION

FOR ALL PLANS
Scale ⅜ of an inch to the foot



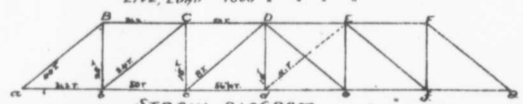
½ Plan
TOP CHORD &C

½ PLAN BOTTOM OF THE LOWER CHORD

QUEEN TRUSS

SPAN 60 Ft. C. to C. Bolter Braces
WIDTH 16 " " " Chords
DEPTH 8 " " " "

DEAD LOAD 500 Lbs PER Ft. Run
LIVE LOAD 1500 " " " "



STRAIN DIAGRAM

Members	Strain	Stress	Area	No. and Size Pcs.	Ft. B.M.	Weight	Price	Amt. $
B.F. Top Chd	28 Tons	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	28 Tons	[illegible]	[illegible]	[illegible]	1744	[illegible]	[illegible]	[illegible]
[illegible]	28 Tons	[illegible]	[illegible]	[illegible]	401	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
Washers, Nuts, Bolts, Bearing Castings, Spikes etc.						[illegible]	[illegible]	[illegible]
Floor Beams				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Lateral Braces				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				[illegible]	1494	[illegible]	[illegible]	[illegible]
[illegible]				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Floor Plank				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] (app.)				[illegible]	72	[illegible]	[illegible]	[illegible]

[illegible] COST OF MATERIALS [illegible]
[illegible] [illegible]
[illegible] [illegible]
TOTAL COST [illegible]

Note: the Cols "Ft. B.M." and "Weight" are made up by multiplying Col. [illegible]

[*This Association is not responsible as a body for any opinions expressed in its Papers by Members.*]

MINING IN THE PORT ARTHUR DISTRICT.

By HENRY DEQ. SEWELL,
P.L.S., Assoc. M. Inst. C.E., Port Arthur.

THE mining industry in Western Algoma has gradually been for years drawing more and more the attention of Land Surveyors, and although this industry is not likely to afford employment to many Provincial Land Surveyors, other than those who have made a special study of Mining Engineering; still, as the mining industry in Canada is fast leaving the field of speculation and uncertainty, especially in Western Algoma, where it is fast developing into a rich and undoubted field of legitimate commercial enterprise, far surpassing in richness, both in silver and gold, the hitherto unrivalled mines of Colorado, Nevada, California and Mexico, the author has thought that a short digest of these industries, and also a few comments on the working of "The General Mining Act," by which the profession has to be guided in the subdivision of Crown Lands for mineral purposes, would be interesting to the members of our Association.

THE GENERAL MINING ACT.

Sec. 9 provides that "every regular mining location shall be rectangular in shape, and the bearings of the outlines thereof shall be due north and south and due east and west astronomically; and such location shall be one of the following dimensions, namely: eighty chains in length by forty chains in width, containing three hundred and twenty acres, or forty chains square, containing one hundred and sixty acres; or forty chains in length by twenty chains in width, containing eighty acres."

It also lays down rules for the laying out of irregular or broken mining locations, along the margin of a lake or river where the narrow width must front on the road allowance of one chain, which is reserved along the margin of the lake or river.

This provision, so far as regards the road allowance of one chain in width along the margin of a lake or river, the author has generally found mining men consider to be a great defect, and one that is liable to inflict great injustice on the miner, more especially as mineral veins often only show up close to the water's edge, and if not traced through the road allowance might never be found further on in the location. It is also argued with a great show of reason that in most cases the rocks along the shores are so steep and precipitous that it would be impossible to utilize them as roads, and the author has always considered that the reservation of five per centum of the acreage is ample security for the provision of suitable roads; and it would be a grace-

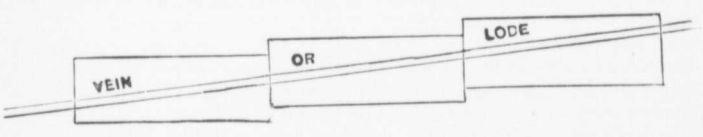
ful act on the part of the Government were they to rescind this objectionable provision.

Sec. 10 provides that in unsurveyed territory all mining locations shall be surveyed by a Provincial Land Surveyor, and connected with some known point, while Sec. 9 provides that in surveyed territory every mining location shall consist of a half section, a quarter section, or an eighth of a section.

This latter provision the author has found uniformly prevents the taking up, in a majority of cases, of land for mining purposes, owing to the large amount of useless land that would in many instances have to be taken to cover a vein, as the locations must follow arbitrary lines that have previously been laid down. This system also affords no protection to the explorer, unless he is rich enough to pay for the land himself. And now that the price of mineral land is $2.00 an acre, against $1.00 per acre for agricultural land, the author believes it would pay the Government to encourage the exploration of surveyed territory by permitting mining locations, when so desired, to be laid out by a Provincial Land Surveyor in the same manner as in unsurveyed territory, with such restrictions as would ensure the accurate position of the locations being located on the township map. As it is, a good deal of valuable mineral lands, that are perfectly useless for agriculture, remain unexplored and unapplied for, solely because explorers prefer to go where they can have their locations laid out to suit themselves. The author has in his mind a case in point in the recently surveyed Township of Strange, where an explorer dropped a promising vein after having spent money to find it, solely because, as he said, he could not properly locate the vein without taking up at least double the land he actually required.

LAYING OUT MINING LOCATIONS.

The practical method of laying out mining locations generally consist of a number of eighty acre lots (there being usually too much waste of land necessitated by using three hundred and twenty acre or one hundred and sixty acre lots), as the mineral veins or lodes usually occur, with some few exceptions, parallel to the formation of the country rock, which generally lies north sixty-four degrees east, astronomically. It thus will be readily understood that if the vein is located about the centre of one of the north and south boundaries, say ten chains north and ten chains south of the lode or vein, the next location will require to be jogged from four to five chains, thus :



Of course if the veins or lodes always followed a straight line, and descended vertically, any intelligent surveyor could easily make these surveys; but it so happens that in many cases the veins get diverted by rocks or hills, and also the dip or angle of descent has to be taken

into consideration, especially when the surface of the ground varies considerably in elevation. The dip is generally to the southward, but even this cannot always be depended on. There is also a class of veins, technically called "North Veins," which cut across the formation, and lie about twenty to thirty degrees to the north of east; while last but not least is the nature and probable richness of the ore, which often has to be decided on the ground. All these points commonly have to be decided to a large extent by the surveyor, on whom most of the work in locating locations generally falls.

MINERAL BELTS.

Gold and silver-bearing veins are usually to be found within certain mineral belts, or lines of ancient volcanic disturbance, and carry a number of mineral-bearing veins. These *belts* usually extend from one to six miles in width, and, although veins are often found outside them, these are generally barren, or contain so little of the precious metals as to render them comparatively valueless. A casual glance at any map of the country, showing the mining locations that have already been surveyed, will indicate this very clearly. Take, for instance, the so-called silver "district" extending westward from the Township of Oliver. The bulk of the surveys will be seen to be contained within a well-defined mineral belt, barely three miles in width, and extending from Arrow Lake through Whitefish Lake, Silver, Rabbit and Beaver Mountains, and still eastward up to the old Shuniah Mine. Further south there is undoubtedly another strong silver belt running through Silver Islet, and very probably there may be other equally rich silver belts lying between the latter and Whitefish Lake, as well as to the north of it. The first strong gold belt that has so far been discovered appears to pass in the neighbourhood of the Huronian Mine, in the Township of Moss, and appears to be about two miles in width, but still running in the same direction. The next prominent mineral belt contains gold and a grayish mineral, probably platinum, and appears to run from near Otter Lake to Sturgeon Lake. Still further westward there is a strong gold belt running through Lake Manitou (on the road to Fort Francis); while, on the Lake of the Woods, the principal discoveries have been made within a six-mile belt, extending from Pipe Stone Point, about north sixty-four degrees east, and burying itself in the granitoid gneisses north of the Pine Portage gold mine, and which, presumably from their very close resemblance to granite, have been erroneously classified as such by the Geological Survey of Canada.

GEOLOGICAL FORMATION.

The question as to the geological formations, in which gold and silver are to be found, in Western Algoma, and the relative age of those formations is, unfortunately, at present a matter of considerable doubt and uncertainty. The fiat of the Geological Survey Department of Canada is, however, very clear and decided on this point. They say that gold is to be found in the Huronian, and silver

in both the Huronian and Laurentian formations. They say, also, that the Huronian is the later formation. The author's observations, which have been considerable, and which have extended over a period of upward of four years, have led him to the conclusion that there are several distinct geological formations in the territory, extending from Port Arthur to the western boundary of Ontario. The so-called Huronian slates in the neighbourhood of Whitefish Lake are of an entirely different colour and appearance from those which have also been classified as Huronian, situated above the height of land; and, while the former are to be found underlying the Laurentian gneiss, in the Township of Strange, and in the neighbourhood of Sand River, from Savanne westward above the height of land, the similarly classified Huronian slates invariably overlie the Laurentian. From this it would appear that there is probably some mistake in the classification of these so-called Huronian rocks.

HISTORY OF THE MINES.

Until ten years ago the means of reaching the mining district of Western Algoma with supplies was only during the summer of about six months in the year, by boats up the great lakes; and the great distance from the seat of government, together with its spare settlement, hindered the construction of proper roads, bridges, etc., necessary for cheap connection between the mines and the lake shore. These drawbacks, and the difficulty of inducing capital to make investments in a country then but little known, and which was reputed to be wild and barren, tended much to retard its development. The date of the first discovery is somewhat uncertain, but in 1845 Colonel Prince, in searching for copper at Spar Island and Prince's Bay, found, in the vein, gray copper ore carrying a high percentage of silver. In 1841 to 1842 a strong organization, the Montreal Mining Company, sent up Prof. Sheppard and a large, well-equipped party to explore the north shore of Lake Superior. This resulted in the taking up of large tracts of land, but they did no mining work. In May, 1865, the McKellar Brothers, associated with Mr. J. McIntyre, the Hudson's Bay Factor, found the Enterprise Mine, and the next year Peter McKellar found the Thunder Bay mine, with native silver and argentite, and from that date commenced the great silver mining boom of Port Arthur. From this time out discoveries were frequent and rich, until 1868, when a man named Morgan, in the employ of the Montreal Mining Company, sent up to examine and report upon their land, found the Silver Islet vein on a small rock included in the Company's land. In 1866 the Shuniah Mine was discovered by Peter McKellar. In 1868 a large deposit of baryta was found on McKellar's Island, but nothing was done to develop it until last year, when a considerable force was put on it, and a large quantity of baryta ore was taken out and shipped. The vein is about forty feet wide, and the ore is of a very good quality. In 1870 Silver Harbour, or Beek Mine, was discovered; and in 1870-71 3A, Pie Island and Cloud Bay were brought to light. Native gold was first discovered at the Huronian Mine in 1871, and at Partridge Lake in 1872. The Huronian Mine

has been worked sufficiently to prove its capability of being made into a valuable paying mine. A ten-stamp mill has been erected, and, together with the Highland and Neebish gold mines, they have been formed into a mining company, with a capital of £360,000 sterling. With regard to the success of the older mines, it may be said that at the time they were originally operated but little was known of the geological characteristics of Western Algoma, and the more modern principle of following the veins—which has since been reduced almost to a science in the United States and in Mexico—was then almost entirely unknown, so that it is hardly a matter for surprise that the Silver Islet Mine alone proved a success; and there can be but little doubt that many of these more ancient discoveries are capable of being developed into paying concerns under more skilful and able management. Indeed, in the case of the Shuniah Mine, Dr. Lehnen, the Captain of the Rabbit Mountain Mine, has stated his belief that when the Shuniah Mine was shut down they were fully four hundred feet off the vein. To turn to more modern and recent discoveries and developments, the Jarvis Island Silver Mine, situated in the same locality as the famous Silver Islet Mine (in a report dated on the 15th of September last), they had run two drifts, one eighty feet from the surface, and the other one hundred and forty-five feet. The vein in these drifts is composed chiefly of baryta, or heavy spar, and the Captain is confident that they will strike something rich when they come in contact, at the junction between the diorite and slate, where the principal bonanzas were always found at Silver Islet. The mine is owned and operated by a wealthy English company, who are working it systematically on the most approved modern principles. The other mines in operation near Port Arthur are situated in what is known as the Whitefish Valley. There are numerous fair prospects, such as Crown Point, Silver Hill, Silver Falls, Peerless Mine, Big Bear, Porcupine, and The Palisades, that have all been more or less developed, and some of them will, in all probability, if properly managed, be enumerated amongst the paying mines of the future; but so far they have not been sufficiently developed to warrant a description in this paper. There are, however, three mines in this locality that have fairly passed through the preliminary and doubtful period of their existence, and now bid fair to prove valuable and remunerative properties. These are the Beaver, Rabbit Mountain and Silver Mountain. And when it is borne in mind that all these developments result from one single year's operations, namely, 1886, some slight conception can be arrived at of the magnitude and importance of this entirely new and valuable Canadian industry. The following accounts of these three mines have been taken from the Port Arthur local papers, as the author has not had a recent opportunity of visiting them:

THE RABBIT MOUNTAIN MINE

has undergone the greatest amount of development. This mine was first opened in 1883, when some very rich ore was extracted. Among that taken out near the surface it was not uncommon to see pieces of silver glance the size of half a brick. Owing to disagreement among

the owners nothing was done in 1884, but mining was actively carried on during 1885 and 1886. The operations are chiefly confined to the main lode, but a smaller parallel vein, about fifty feet to the north-west of it, has been opened, and upward of $20,000 worth of silver taken from a stope near the surface. The outcrop of the veins occurs in a valley, on the sides of which the edges of the horizontal black slates may be seen. A mass of trap is brought by a fault into contact with the slates along part of the smaller vein. The main lode averages about four feet in width, although it varies from two to twenty feet, and consists of white calc spar with quartz, often in crystals, which are sometimes amethystine, lining vugs, together with a little purple and green fluor spar.

In addition to the solid gangue, much of which is considered vein matter, consists of the slate traversed in all directions with reticulating strings of the spar and quartz. The silver glance is associated with more or less of the sulphides of copper, iron, lead and zinc. This character belongs to all the veins in the Whitefish region, and, indeed, to all those cutting the black slates of the Thunder Bay district generally, so that it will not be necessary to repeat the description.

On the main vein at the Rabbit Mountain Mine the principal shaft is down 170 feet. At 80 feet a drift is run north-east about 300 feet and south-west about 120 feet, and from this level cross-cuts have been driven to intersect the smaller vein to the north-west. There are two other shafts, and some stoping has been done.

The stamp-mill is built on a hillside, so that, in treating the ore, it is carried by gravitation from one process to another, and the tailings are washed away by a brook at the bottom. It is built for two batteries of five stamps each, but only one is in operation, crushing ten tons a day. In flowing from the battery the stamped rock is equally divided to two Frue vanners. The concentrates are barrelled for export to Omaha, while the tailings pass to one or another of four tanks, from which, after settling, they are shovelled into two amalgamators. After treatment in these for five hours, at a temperature of 150° Fahr., the quicksilver is strained and the amalgam distilled and smelted into bricks from twenty to upward of fifty pounds weight. A laboratory for assaying, etc., is attached to the works. The mill had been running for only two months, but there was ore enough on the surface for six months ahead, and the stock is increasing. Twelve tons of concentrates, worth about $1,000 a ton, had been shipped up to the time of my visit. Sixty-five men are employed, of whom twenty-two are miners, the rest being mechanics, labourers, etc.

THE BEAVER MINE

is on a vein of a character similar to that of the Rabbit Mountain Mine, but running at right angles to it or in a northerly direction. It cuts through a flat-topped ridge 110 feet high, consisting of the horizontal black slates. In the face of the hill the vein shows a width of from two to three feet, but it is not so thick in the lowest level now worked. Three drifts have been driven into the hill along the course of the vein. The lowest one just referred to is 650 feet. At about

600 feet from the entrance a small lead crosses the vein, and this has been followed for forty feet to the north-east, and a winze is sinking upon it at this distance, which shows rich ore, and it increases in going down. The ore is mostly in the form of leaf argentite, associated with blende. The two upper drifts are not in so far as the third, but a good show of vein-stuff has been thrown out of them. An air-shaft is sinking on the south side of the ridge to intersect the lowest level. The mill, which is at work, is built on the bank of Silver Creek, a quarter of a mile south of the mine, from which the ore will be brought by a tramway. The ore is reduced without stamping, by means of pulverizers, one of which is Frisbee & Lucop's patent. The reduced ore will be separated by means of two of Frue's vanners and one "Golden Gate" vanner.

Seventy men are employed in connection with the mill and the mining operations, of whom eighteen are miners. Compressed air drills, worked by a sixty horse-power engine, are used.

AT SILVER MOUNTAIN MINE

they have run two drifts horizontally into the side of the mountain, the lower one being in about 275 feet, and the upper 200 feet. The upper drift is immediately above the lower about 80 feet, and runs parallel with it. Miners are working in each drift. They are also sinking a shaft to connect the two drifts; and similar shafts are to be sunk at intervals of 150 or 200 feet. There are three shafts sunk from the top of the mountain, immediately above the upper drift, it being about 80 feet from the surface down to this drift. Two of these shafts are now working. They are about 800 feet apart. One is down about 25 feet and the other 10 feet. They are both upon the vein, the object being to continue the drifts and shafts until they intersect, at which points rich ore may naturally be expected. There is also a third drift into the mountain of about 40 feet, following a stringer in this drift, which they expect to follow about 150 feet further, to intersect the upper drift. They are getting silver in the various shafts and drifts, but not in large quantities. They do not expect any large finds at this early stage of development; but the great aim and object of the manager seems, not so much the accomplishment of immediate brilliant results as the conservation of far-sighted schemes all tending to ensure the future success and permanency of the great work over which he has control. The amount of work in and around the mine is something wonderful, considering the short time this mine has been at work, namely—two and a half months ago. There are 52 men at work in and around the mines, 31 of whom are engaged in actual mining. They work three shifts of eight hours each, working day and night. There are a number of buildings. The office of the company is well built. They have an assay office, and an assayer; a blacksmith shop, engine-house and several boarding-houses.

During the past year a valuable discovery of (magnetic) iron ore has been discovered in a large deposit by the McKellar Brothers, on the Atic Okan River, in the Rainy River District. It contains seventy per cent. of iron, and is almost entirely free from sulphur

and other injurious substances. The deposit, which lies in a wide bed, contains an almost inexhaustible supply of suitable ore for the manufacture of Bessemer steel, which is now so largely in demand in the United States. The Chicago and Vert Island Stone Quarry is in operation at Nepigon Bay, about seventy-five miles from Port Arthur. About 40,000 cubic feet of this stone has been shipped during the past year, principally to Chicago. It is a red-brown sandstone, and is very popular for building purposes in Chicago, where they have been unable to supply the demand for it.

LAKE OF THE WOODS.

To the west of Port Arthur but little has so far been done in this Province, but an account of the mining operations on the Lake of the Woods forms a natural adjunct to the account of those in the neighbourhood of Port Arthur. The principal minerals found there are, gold, silver, iron, nickel, lead, antimony, cobalt, arsenic, asbestos, mica and moulding sand. Foremost amongst these ranks gold, the most precious and the most abundant It is found in veins traversing the Huronian formations, but the richest leads are immediately adjoining the Laurentian rocks, having Huronian slates, or diorites, on one side, and Laurentian gneiss, or granitic gneiss, on the other. The gold exists in almost minute particles, which are often undiscernable in the quartz until pounded and reduced to a fine sand, when, on being washed in a pan, the fine gold shows up in surprising quantities. The principal gold discoveries, enumerated in their order of merit, are: The Pine Portage, the Winnipeg Consolidated, the Partridge Nest (or Keewatin), the Yellow Girl, the Minerva, the Woodchuck, the Sultana and Gold Hill.

THE PINE PORTAGE

is the only discovery which, so far, has been sufficiently developed to warrant its being called a mine. It was discovered in the spring of 1880. It lies at the head of Pine Portage Bay, about eight miles from Rat Portage. A shaft over one hundred feet in depth has been sunk, together with several drifts and cross-cuts. The vein, which is about six feet in width at the top, is said to be at least twenty feet wide at the bottom of the shaft, which fairly glistens in every direction with free gold and silvanite. A ten-stamp mill with two Frue vanners, to concentrate the ore, has been erected, but it has been temporarily shut down. Some idea of the richness of this mine may be judged from the fact that the Geological Survey Department of the Dominion Government give, in their published reports, the enormous assay of 22 ounces of gold to the Canadian ton of 2,000 pounds. It is a matter to be greatly regretted that so promising a mine should not be worked, especially as the vein appears to be a true fissure vein, and the amount of rich ore in it is practically almost inexhaustible.

THE WINNIPEG CONSOLIDATED

was discovered in 1881. A shaft has been sunk on this property to a depth of 135 feet, at 95 feet two drifts of 75 and 50 feet respectively,

were made, and also two drifts at 40 feet. On an average the ore contains $90 worth of gold to the Canadian ton. The only drawback to this mine is the extreme narrowness of the vein, which is about one foot in width, but with careful and judicious management it might be made to pay handsome dividends.

THE PARTRIDGE NEST (OR KEEWATIN)

consists of two very good-looking veins from three to four feet in width. It is situated on Hay Island, and is in near proximity to the Winnipeg Consolidated, and Pine Portage, both of which latter are on the main land. A small amount of work has been done on the Partridge Nest, close to the surface. When panned out it yields a good show of gold, and if worked might possibly prove a good mine.

THE YELLOW GIRL.

is situated on an island about two miles north of a point of land called the Yellow Girl, and from which it derives its name. The vein is five to six feet in width, and is full of mineral. It is an exceedingly well-defined vein, and has probably a great future before it. Professor Chapman, of Toronto, assayed it at $33 to the Canadian ton of 2,000 pounds.

THE MINERVA

is a promising looking vein on an island almost opposite the village of Keewatin, and a little over six miles to the south of it. It was discovered in 1881. There are reported to be no less than six veins on this property carrying gold. At a point where two of these veins converge, a shaft has been sunk for 20 feet, increasing the width of the vein from ten inches at the surface to three feet six inches, with well defined walls. Assays averaged $47 per Canadian ton.

THE WOODCHUCK

is situated on Clear Water Bay, and is the only location in that neighbourhood that has not practically been abandoned. Some good shows of free gold have been found, but so little work has been done that it cannot be classified as anything beyond a good prospect.

THE SULTANA

is situated on an island near Pine Portage Mine. Some prospecting has been done on it last summer. The vein is large and well defined, and is said to carry a fair proportion of gold.

GOLD HILL

consists of a series of rich stringers, varying from 1½ inches to six or seven inches in width. They are said to be very pockety, some places showing free gold, whilst other parts are entirely destitute of the precious metal. It was discovered in 1885.

SILVER AND LEAD,

in the form of galena, has been found, principally in the neighbourhood of Ptarmigan Bay and Shoal Lake, and some apparently very rich specimens have been taken from this locality; but unfortunately in the rush for gold nearer home, the search for silver and lead ores has been much overlooked. There is, however, a strong probability that some rich silver finds might be discovered were qualified explorers to seek for it.

MAGNETIC IRON ORE

of a very superior quality has been found on the Winnipeg River, and good iron ore is reported to have been found on Rainy Lake, which is probably a continuation of the Vermilion iron ore deposits.

NICKEL.

A few discoveries of this metal have been made, but so far no mining locations have been taken up for this valuable mineral. Antimony, cobalt and arsenic have been found, but so far not in sufficient quantities to work; but what has been found has been the result of accident, and no proper search has been so far made for these valuable non-metals. About three years ago several carloads of antimony ore were shipped to Chicago. Common asbestos has been found in several places in small stringers, but so far it has not been found in sufficient quantities to pay to mine. Sheet mica has been found of superior quality and size on Big Island, but the inhabitants are so indifferent to the great mineral wealth in their midst that no attempt has been made so far to mine even this mineral, which Nature has so profusely provided, and that could be so easily manipulated. Moulding sand of good quality exists in abundance in several places on the Lake of the Woods, and some good castings have been made with it. With this, also, nothing has been done. That there is also abundance of really good brick clay has been conclusively proved by the manufacture of very superior bricks; but freight charges are so high that nothing beyond local trade has so far been provided for.

In conclusion, it should always be borne in mind that a successful mine means a successful business venture, managed with judgment, skill and capital; and when properly conducted with the same care, skill and judgment that is bestowed on every other business, mining becomes more profitable than any other commercial enterprise. Mineral deposits are discoveries, but mines are made. A full knowledge and appreciation of these facts will almost invariably insure success, if the agents employed are trustworthy and efficient; otherwise, no matter how rich the deposit may be, certain failure will be sure to ensue.

[*This Association is not responsible as a body for any opinions expressed in its Papers by Members.*]

ELECTRIC LIGHTING OF SMALL TOWNS.

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Before proceeding to the subject the following definitions may be observed:

The unit of resistance is called the Ohm, which is the resistance offered by 48 meters of copper wire, one millimeter in diameter, to the passage of an electric current through the wire.

The unit of electromotive force, or that force which tends to produce a transfer of electricity from one point to another in a conductor, is called a Volt.

The unit of strength or intensity is called an Ampere or Weber, and is defined by the fact that a Volt produces an Ampere in an Ohm in a second.

The unit of quantity is called a Colomb, and is defined by the fact that an Ampere gives a Colomb in a second.

The unit of capacity is called a Farad, and is defined by the fact that a Colomb in Farad gives a Volt.

In investigating the theory of mechanical electric generators there are three principles to bear in mind:

1. The energy of the electrical current and of magnetic attractions does not lie in the wire that carries the current or in the magnet, but in the space surrounding the wire or bar (magnet).

2. The current passing in a wire is a magnetic fact, as well as an electrical one.

3. Energy must be expended in order to produce magnetic or electrical work.

The space surrounding a magnet, in which the magnetic force acts, is called the field. If we hold a glass plate over a magnet, and place iron filings on the plate, and tap it, the iron arranges itself in certain positions; *i.e.*, in the form of lines upon the glass—these lines are the lines of force. It is generally assumed that these actions are carried through space by motion in the ether, which is assumed to pervade all space. A wire, carrying a current of electricity, acts similarly to a magnet in regard to the lines of force surrounding the wire, but with the difference that the lines do not emanate from the wire, but circle around it. If a magnet is passed in a coil of wire (or solenoid), a current of electricity is set up in the wire; and conversely,

if a bar of iron is placed within a solenoid having a current of electricity passing through it, the bar becomes magnetized. This current produced in the wire is called an induced current, and there are certain principles governing it; *i.e.*, there must be motion in the relation of the coil to the magnet, and the approach or recession produces currents in the opposite direction, and the strength of the current depends upon the strength of the magnet, the number of coils of wire in the solenoid, and the speed of the relative motion of the magnet to the wire.

The first generators made were called Magnetic Electrical Generators (now generally used in telephone bells), and the current was generated by revolving permanent steel magnets in front of coils of copper wire, or *vice versa*. The machines, or Dynamo Electrical machines of the present day, make use of the fact that the iron in a coil of wire is magnetized, and the current of the machine itself is used to make magnets, called field magnets, in front of which the coil (Armature) is revolved. These machines may be divided into three classes (according to the winding of the Armatures, and types of all three are in use in Canada), namely:

1. The Cylindrical, or Gramme Armature, illustrated by the Ball, Fuller, Wood, Van Depoele and Hochhausen.

2. The Drum Armature, illustrated by the Thomson-Houston and Wright.

3. The Disk Armature, illustrated by the Brush.

From the fact, in the generation of currents, that the stronger the magnet the more lines of force, the stronger is the current generated, the theory of an effective current is that the coils of wire should cut as many lines of force as possible in the shortest time. In order to thus get an effective machine there are four conditions, namely:

1. The Armature should have a high circumferential velocity, within certain limits, of course.

2. It should be placed in a very strong magnetic field.

3. It should have many turns of wire, each enclosing as great a space as possible.

4. The resistance of the Armature should be small.

A short history of electric lighting may now be noticed.

About 1810 Davy produced the first arc light by means of two soft pieces of carbon and a battery. In 1844 Foucault improved this by using hard carbon and a battery. In 1831 Faraday discovered the relation of magnets to electric currents. This remained a laboratory experiment until 1856, when Prof. Holmes called the attention of Trinity House to the use of an alliance machine for lighthouses, and, after repeated trial, the Elder Brethren adopted the light on Dungeness in 1862. Continuous improvements have been made to late dates, and the probability is that the arc light is as near perfect now as it ever will be.

With the improvements of the generators the lamps have also been improved from the two simple holders, fed by the hand of Davy, to the examples now before you. The electric light may be divided into two kinds, the arc and the incandescent. The arc light is made by using lamps similar to the above-mentioned ones, which feed together carbon rods as they are consumed by the current. The incandescent light is made by heating a film of carbon or other substance to a high temperature in vacuum, by passing an electric current through it, the current being produced by an ordinary generator, wound for the purpose, or from a battery, or from accumulators, and, as the two latter are expensive methods, the former is generally used.

The difference in the current of arc and incandescent lights is that the arc requires a high electro-motive force and small quantity, and the incandescent the opposite. The reason is that the arc lamps can be placed along a wire, the wire running from lamp to lamp and back to the machine; and, as the lamp requires a current of say 9 amperes and 45 volts each, the current would be, for a 50-light plant, 9 amperes and 2,500 volts, which would be a fair arc circuit. Whereas, to replace the above, 500 incandescent lamps would be required of say 1 ampere and 50 volts each, or a total of 25,000 volts—a current which is impracticable—so, instead of placing the lamps in that position they are placed as follows, each lamp forming a connection between the positive and negative poles of the generators. To carry this current a very large wire is necessary, which adds to the cost. A system has been patented in the States, by Geo. Westinghouse, to do away with this expensive wiring in this way. A current similar in strength say to the arc current is generated, but it is an alternative current; and it is used to generate a current in each house for the use of that house only.

In regard to the cost of a plant, from a number of examples, the following is a very good rule, providing the length of conducting wire is not excessive: Consider the price of machine and lamps at $100 per lamp, then add $1,000 for the first 20 lamps and $500 for each subsequent group of 20 lamps; *i.e.*, $3,000 for a 20-light plant, $5,500 for a 40-light plant, etc. The above cost simply covers the machine, lamps, wiring and connection to the motive power. The building and power must be added to the above, and they vary in different places and according to the capital and taste of the company.

In regard to the working expenses we might assume the power as one horse-power per light, or 50 horse-power for 50 lights. This is excessive, as it really takes from $\frac{3}{4}$ to $\frac{9}{10}$ of a horse-power per light. The cost of engine can be arrived at by taking the coal consumption per hour. As an example, take a 50-light plant, and suppose the engine to consume four pounds of coal per hour per horse-power, which is a fair consumption. Coal consumption would be 200 pounds of coal per hour, or, an average of five hours per night would be half a ton of coal per night, or 180 tons per year; in round numbers, $1,000 per year for coal. One man can attend a 50-light plant and engine, and can be obtained at $500 per year; carbons, 75 per night, or 27,000 per year, in round numbers, at $16.50 per 1,000, $450; oil, brushes,

segments, etc., at $100; collection of income and breakage, $200; total, $2,250 per year. The income, at 25 cents per night per light, is $12.50 per night, or $4,500 per year, in round numbers. Suppose plant to cost, set up, $9,000, and take 10 per cent. off the above revenue for the depreciation in the value of the plant, we have $1,350 left, or a 15 per cent. dividend. As to the use in mills the following example applies: The machinery for two mills (each using a machine and four lamps) cost $1,400, set up. They run all night, and therefore consume 24 carbons per night, or about 8,000 carbons per year, at $16 per 1,000, $128 per year. Suppose the breakage and wear and tear to amount to $72 per year, the total yearly expenses amounts to $200, considering the power and attendance after. The coal oil for these mills cost $400 per year; saving in insurance, $80 per year. Total saving is $480 per year. This, then, leaves $280 to pay for power, interest and attendance. The power costs nothing, as they use water and have an abundance; and the attendance is less than it was for coal oil, as the machine-man attends to the electric lamps at no extra cost.

NOTE.—The author showed examples of the various lamps, and showed illustrations and explained the working of the various machines.

EXHIBIT OF INSTRUMENTS.

Mr. Ogilvie, of Ottawa, exhibited and described:

1. A Lugeol Micrometer Telescope, such as is now being used in the Traverse Surveys in the North-West Territories (see his paper on this telescope in this volume of Proceedings, also page 54 of Proceedings of 1886), which is simply a portable Heliometer.

2. A small German "universal" instrument of good design and very finely finished. Its telescope is in the position of the telescope axis of ordinary instruments, and at right angles to the line sighted. The line of sight is reflected at right angles by a mirror placed in front of the object glass. Focal length $4\frac{3}{4}$ inches. Notwithstanding short focal length, this instrument defined sharply and clearly, and is credited with reading to 15″. "A complete epitome of an observatory."

Mr. Burke, of Ingersoll, exhibited a "Gurley Mountain Transit," with extension tripod. This allows legs of tripod to be shortened to nearly half the usual length, convenient for "portaging." This instrument is compact, light, convenient to use, and substantial.

Mr. Speight, of Toronto, exhibited an Anster Polar Planimeter. An instrument for measuring areas of plats. This instrument is of German make. The area is integrated and added up by the machine, the result being read off the measuring wheels.

Mr. Butler, of Napanee, exhibited a Polar Planimeter, of which he and Mr. Fessenden are joint inventors. The tracer is constructed to follow the curve of a parabola of special dimensions. Some theoretical advantages are claimed for their instruments by the inventors, the revolving wheel being much larger than the wheel in Anster's (see page 54, Proceedings 1886).

Mr. Sankey, of Toronto, exhibited a "Mechanical Traverse Table," recently patented. This instrument may be set to any required course, when the latitude and departure of that course may be at once read off. The instrument shown has the circle divided to quarter degrees and the distance, latitude and departure scales divided to 20 to the inch. This instrument was manufactured for Mr. Sankey by Mr. Foster.

Mr. Chipman, of Brockville, exhibited a Compass of "ye olden tyme," the one used by R. Sherwood, D.P.S., on the Crown Surveys in the Counties of Leeds, Grenville, Carleton, Lanark and Frontenac, between 1790 and 1820, and had, no doubt, seen many "squibby" days.

Mr. Cook, of Brockville, exhibited :

1. A peculiar instrument, what American makers might call a Mining Surveyor's Transit. This instrument, said to be 200 years old, attracted considerable attention from its peculiar construction. The standard is in the form of a segment of a circle, greater than a semi-circle, with centre above the compass box, and the plane of this circle being about $1\frac{1}{4}$ inches on one side of vertical centre of instrument. The telescope is rigidly attached by an arm which is centred at the centre of the circular segment, and telescope is then depressed or elevated by a cogged pinion working into cogs, the circumference of above described standard. The telescope could only look one way without reversing 180° in azimuth ; but could be directed vertically, and was furnished at each end by sight vanes which were probably more used than the telescope. The horizontal plates were also moved by rack and pinion motions. This instrument was manufactured by Heath and Wing, but no date.

2. Small nautical sextant.

3. Clinometer.

Professor Galbraith exhibited :

1. Mountain Transit, manufactured by Gurley, with solar attachment, and shifting tripod head.

2. Lugeol Micrometer, mounted on a tripod, with ball and socket joint, and vertical and horizontal axes.

3. Nautical Sextant, 8″ arc.

Mr. Abrey, P.L.S., of this city, exhibited a number of instruments, and described those of exceptional or novel construction ; the following may be mentioned :

1. A 6-inch Reiterating Transit, made by Troughton and Sims, designed for and imported by the Dominion Government, for use in the standard line surveys in the North-West Territories. The instrument stands on three levelling screws covering a broad base, and attached to a framed tripod stand. The circle is read by three equidistant verniers to 0°·004 (decimally divided). The telescope has $1\frac{1}{2}$ inch clear aperture, and is sufficient for observations of *Polaris* while the sun is several hours high. Several eye-pieces, ranging from 12 to 60 diameter, are provided. Striding and plate levels are divided and read to about 10″. The vertical finding circle is attached to the axis of telescope, and does not connect with the standards. The instrument is found to meet all of its requirements in an efficient manner.

2. A Goniometer for horizontal angles, made by Young & Sons. This instrument has two telescopes which may be set to any angle with each other, they have each of them their axis vertically over the spindle of the instrument. It is a strong, handy instrument for most kinds of work.

3. A Goniometer for horizontal angles only, made by Troughton and Sims for the Trigonometrical Survey of Great Britain ; the limb

is 12 inches, read by three verniers to 10″, the telescope is of 20 inches focal length, the centre is of steel. The lower limb has an endless screw motion for setting to zero, the standards are short and telescope does not transit but may be reversed in the Y standards.

4. A Burt Solar Compass of the ordinary pattern, made by Gurley.

5. A Theodolite Solar Compass. This was originally an English Cradle Theodolite 5″ limb. Mr. Charles Potter, of this city, under directions from its owner, changed it to as now shown. It has compass sights attached to the lower plate made adjustable to the zero line of the solar. Besides the ordinary four levelling screws it has a ball and socket quick levelling motion, and is mounted on a tripod having its legs adjustable for length. The solar is attached to the cross axis in a manner somewhat similar to that known as Pearson's patent, and consists of a bar having a lens of about 6 inches focal length at one end, and a mirror at the focal distance. This bar moves on its declination axis over an arc both sides of zero, with clamp and tangent attachment. The latitude is laid off on the vertical arc of the theodolite, most of its parts are adjustable with striding levels, and when used as a solar the theodolite telescope, with its Y bar holder, may be removed. A 5-inch needle and variation plate is added. The instrument complete weighs about half as much as the Burt solar above.

6. A German Alt-Azimuth, or universal instrument, made by Extel & Sons, of Munich. This instrument has a 10-inch horizontal circle, divided by four verniers to 10″, an altitude finding circle reading to single minutes. The instrument has a vernier on each of the standards to read the circle when reversed in its Y bearings. The telescope is of the prismatic form, viz., the object end half is at right angles to the cross axis at its centre, while the other half coincides with the cross axis itself, the incident rays being bent by a prismatic reflector placed in the centre of the cross axis. The axes, all of them, are of steel. The weight of the upper portion being partly borne by a spring attachment at the spindle to prevent wearing of the centres, and give smooth motion in use. The instrument is adjusted by a very sensitive striding cross axis level. The telescope transits and may be reversed in its Y bearings. It is precisely balanced by adjustable counterpoises. The standards being very low the instrument has a very solid and rigid appearance. The instrument stands on three levelling screws with micrometer heads, is of very broad base, and is not intended to attach to a tripod stand, but merely to rest on the same. The workmanship is of the very highest class.

7. A transit made principally of aluminium, having a horizontal circle of about 6¾ inches, read to 10″ by two double opposite verniers. The instrument is attached to a framed tripod, and shifts for position over a point. The vertical circle of 5 inches is read by two double opposite verniers to 20″, and it, with all its attachments, are connected with the cross-axis and entirely disconnected from the standards. The telescope reverses on its Y standards;

micrometer or gradientor attachment to axis of telescope for measuring distances. Alidade level, divided to read 10″, is attached to vernier of vertical circle. Striding level to cross-axis, and striding level instead of attached level to tube of telescope, both reading to 10″. This arrangement of tube-level gives great convenience in adjustment of horizontal wire of telescope; telescope of about 11 inches focal length, and $1\frac{3}{8}$ inch clear aperture, the whole instrument weighing about eight pounds. There is attachable to this instrument a Lyman Patent Solar, but which the owner has not, for various reasons, found satisfactory. The instrument was made by Young & Sons for the owner. The owner has recently had constructed for him by James Foster a second telescope of similar dimensions to the above for use instead of it, and may be placed in the same Y bearings, and the same vertical circle, gradientor, striding levels may be attached. It consists of the telescope proper, adjustable for focus at the eye end. In front of the object-glass is placed a small mirror, which may be revolved on its axis, placed at right angles to the collimation. To this axis is attached an arm, carrying a vernier moving on an arc attached to the tube of the telescope, and reading to 20″. At the eye end behind the eye-piece, and attached to it, is an excentric disc, having three openings in it; one of these holes is left open, the second one has a dark glass inserted, and the third has a $\frac{1}{4}$-inch prism attached for right-angled sighting. By revolving this disc either of the three openings may be brought before the eye lens. The telescope has two cylindrical rings on the tube similar to a Y level. A cross-axis was made to fit the standards of the instrument, and this telescope, having a large ring cast in its centre, with bar and Y's like the level attached, the cross-axis with ring and Y bar being cast in one piece, the Y's for the telescope tube being adjustable laterally, so that the telescope may be placed at right angles to the cross-axis and in the centre over the spindle. The telescope, when in place, occupies the centre of the cross-axis, so as to be symmetrical, and eliminate parallax in vertical angles, as well as horizontal angles. The faces of the ring in the cross-axis are graduated for hour angles, and time is read by an index attached to the telescope. This telescope transits at its eye end. It is provided with a long, diagonal eye-piece, and with the aid of this, in connection with the reflector, the telescope may be placed in a vertical position, and most of its adjustments, both ordinary and equatorial, may be effected with the telescope in a vertical position. The number of the solar adjustments is fewer by this arrangement than by any other solar arrangement yet adopted, owing to its being neither an attachment nor a combination instrument. In use the full power of the instrument is obtained, as the sun, for solar observations, is viewed at the principal focus, the cross wires being arranged to observe the centre of the sun's disc always. Two distinct pairs of observations may be taken; the mean of either pair should be the true meridian. The weight of the instrument, when mounted with this equatorial telescope, is not so heavy as an ordinary Burt Solar Compass, and, of course, it may be used for ordinary transit or for solar work. A small guider,

weighing about $\frac{1}{2}$ of an ounce, is attached to the solar part for approximately placing in the meridian.

8. A small telescope of similar construction to that described above, which may be attached to the telescope of any transit, for solar use. It is as simple and light as any other attachment now in use.

9. A Nautical Sextant (8 inches), of best English make.

10. A Box Sextant, with supplementary arc for large angles.

11. A Clinometer, used in slope measurements in the Dominion surveys.

12. A Pocket Lever Chronometer, made by Frodsham, one of the two used by our department on the United States boundary survey, and is a very excellent instrument.

13. A Three-Arm Protractor, or station pointer, for office work.

14. A German silver 12-inch Micrometer scale of equal parts, graduated to 40 to the inch, and read by a vernier to 400 to the inch.

15. A Pocket Barometer for hypsometrical work.

16. A Spirit Pocket Thermometer.

17. A Rod Level.

18. A Lyman Trigonometer or Protractor, made by Heller & Brightly. This instrument is semi-circular, and reads by a vernier to single minutes. It has a steel arm 36 inches long; has clamp and trangent for setting, and an arrangement for setting to zero on any desired line. The instrument may be used as a parallel ruler, a T square or a protractor, and is first-class in each respect. It has a base-bar, square, 12-inch triangular scale of German silver, spring attachments and clamps in connection.

19. A Cleaver Protractor, made by Young & Sons. This is a circular protractor, with a square frame revolving about it. The instrument may be placed on the drawing in any convenient position, then, after adjusting its zero to the zero of the drawing, the centre or circular part is clamped to the drawing by loosening four spring pins. The circle reads by a vernier to single minutes, and courses may be drawn on any part of the plot by aid of a parallel ruler, by simply placing one edge of the ruler in contact with one of the sides of the square frame of the protractor, laying off the desired course on the circle, and transferring the same to its place on the drawing, and so on without removal of the instrument. It is equal to the best English protractor in all respects, and with the advantage of enabling the plotter to transfer each course when laid off at once to its place, instead of having to prick off all the courses first, then remove the protractor and draw in the courses afterwards.

20. An English Circular Protractor on silver, reading to single minutes.

21. And some other instruments.

MR. POTTER'S EXHIBIT.

Mr. Charles Potter, mathematical instrument maker, of this city, exhibited about $2,000 in value of instruments, consisting of the following:

Two complete Transit Theodolites (6 inches), both circles reading to 20″; striding, cross-axis levels, diagonals, etc.; heavy, strong, and very complete; English pattern.

One complete Transit Theodolite, 5″, reading to single minutes.

One Cradle Theodolite, 5 inches.

Y Levels, 14 inches to 20 inches.

Dumpy Levels, 10 inches to 16 inches.

Exploring Levels.

Drainage Levels.

Three Surveyors' Compasses, 4 inches, 5 inches, 6 inches.

Box Sextant, divided, on silver.

Prismatic Compass.

Aneroid Barometers for hypsometrical work.

Levelling Staves, painted divisions; English pattern.

Steel and iron chains, feet and links, of various lengths.

Chesterman's steel bands and tapes—a variety.

Rochon Micrometer Telescope.

Drawing instruments, separate and in cases.

Miner's Dip Compass.

Rolling parallel rulers of German silver, brass and ebony; straight-edges of steel, brass, nickel and wood.

T squares of wood.

Protractors of German silver, brass, rubber, horn, ivory and boxwood.

Mariner's Compass, with telescope.

French curves and set-squares of rubber and wood.

Arnsler Polar Planimeter, similar to the one described in this volume.

Field and marine glasses in variety.

Telescopes, astronomical and others, with other field and office outfit.

MR. FOSTER'S EXHIBIT.

Mr. James Foster, mathematical instrument maker, of this city, exhibited some $1,600 in value of instruments, consisting of the following:

One complete 5-inch Transit Theodolite, English pattern, with two verniers to horizontal and vertical limbs, reading to single minutes; level on telescope, etc.

One plain 5-inch Transit, American pattern.

One Y Level, 18 inches.

One Dumpy Level, 14 inches.

One " " 12 inches.

One Drainage Level.

One Planimeter of the Butler & Fessenden pattern, and described by Mr. Butler above.

Two Aneroid Barometers, arranged for hypsometrical work.

Four Surveyors' Compasses, with and without verniers, and of different sizes.

Several steel straight-edges, 24 inches, 36 inches, 48 inches, 60 inches, 72 inches.

Parallel rulers of brass, 18 inches and 24 inches, of superior construction.

Stanley's 12-inch divided scales.

Stanley's drawing instruments, separate and in cases.

Miners', or Dip-needle Compass.

Passometer.

Optical Square.

Reading Glasses.

Prismatic Compass.

Two very superior Binocular Field Glasses.

T squares, with steel blades.

Chesterman's steel bands, in links and feet of various lengths.

" tape-lines.

" steel chains, all usual lengths.

Levelling rods of English pattern.

A tripod constructed for the Dominion Government, for use with one of the large class of astronomical instruments now employed in the surveys in British Columbia.

A Mechanical Traverse Table Instrument, made for Mr. Sankey, and a quantity of other outfit for office and field use.

Mr. Timpson, of Toronto, one of the oldest mathematical instrument makers on this continent, and well known a generation ago, exhibited a 6" Ramsden Cradle Theodolite of ancient pattern.

THE MINTO PROVINCIAL DRAINAGE SCHEME.

The following are extracts from a circular issued by the promoters of this scheme to show its objects and the means of attaining them:

"The Local Government shall prepare a bill embodying the following clauses, viz.:

"1. All main leading outlets or discharges to be opened, improved and maintained by the municipalities with money borrowed from the Government at a rate of interest not exceeding 2½ per cent. per annum, principal and interest payable in annual instalments, the time of payment extending over a term of twenty years, the said municipality to have the privilege of paying the amount so borrowed at the expiration of five years.

"2. The Government shall appoint one engineer to each county, whose duty it shall be to report to the Government from time to time the nature and extent of the work required to be done in his municipality, the said engineer to be empowered to employ assistance whenever necessary, all expenses connected with the engineering staff to be paid out of the funds set apart for that purpose by the Government. It shall also be required of the engineer that a quarterly report be prepared by him and presented to the township council, specifying the concession, name of owner and number of lot, from whom applications have been received, and the amount of valuation of the said improvements.

"3. Any landowner being disposed to locate surface or underdrains shall notify the engineer of his intention, who will prepare plans and specification of the proposed improvements, the landowner shall then proceed to execute the work, and upon its completion a final inspection to be made by the engineer who shall then report to the township council the true value of the work.

"4. The landowner shall then make a demand upon the Provincial Treasurer for the amount required, upon a form of application signed by the engineer and countersigned by the Warden of the County, the said loan to extend over a term of twenty years. Interest at 2½ per cent. per annum, payable in annual instalments, with the privilege of liquidating the debt at the expiration of five years, payments to be made to the Township Treasurer each year, along with the other municipal taxes and subject to the same conditions.

"5. A Board of Arbitrators consisting of the engineer, Reeve of Township, and one appointed by the party interested in the improvements."

The following is a summary of Mr. Dobson's address, referred to in the Minutes:

Mr. Dobson expressed his thanks to the Association for the invitation to be present at the meeting. He stated that there are in Ontario 115,200,000 acres of land, of which only 7,000,000 acres are under cultivation. In Germany the population is 200 to the square mile, in Belgium 440, in Ontario only 9, yet we are obliged to erect poorhouses. The Surveyors should know better than any one else the amounts of land available, and amounts unavailable, for cultivation, and they know the farmers' wants.

In regard to the method of raising the funds to carry on the proposed scheme, he stated that the Ontario Government has a surplus of six millions, of which one and one-half millions will be spent on new Parliament buildings. This will leave four and one-half millions, and it is proposed that this amount be handed over to the Dominion Government, who will authorize them to issue capital to the amount of sixteen millions on the banking system. This amount to be used for drainage purposes only, because agriculture is the root of the trade and commercial prosperity of a country. He then compared the cost of raising wheat in Ontario, India and Manitoba. In India it cost twenty-four cents to raise one bushel of wheat, in Manitoba seventy-two cents, and in Ontario ninety-eight cents.

In the scheme proposed the outlets of mains are to be opened and maintained by the municipality, and shall be under the superintendence of an engineer appointed by the Government. The present Drainage Act is too complicated. Boiled down to the very lowest degree it occupies some eighteen pages. If you place it in the hands of the average farmer he gets muddled in the reading of it.

Our main object is to place the whole matter in the hands of the farmers and the engineers, and take it out of the hands of the lawyers and judges. We propose to ask each of the councils in the counties of Ontario to send delegates, or to send a representative, to a convention to be held. We do not want them to send gentlemen who are officials or members of the councils, because they are generally men in easy circumstances, and would not take the same interest in these matters. But we would ask each township council to appoint a delegate to attend a meeting in Toronto for the purpose of considering this scheme, and of eliminating all errors from it. After the scheme has been revised by the farmers and engineers in the way proposed, a bill will be drafted, and will be sent to the Ontario Government with a petition.

In the financial part of the question we want your assistance. The Government would receive 2½ per cent. for their money, whereas they are now receiving 5 per cent. We say that if you place the Government in the position of bankers, that is, if you regard them as holding the funds as a bank does, to make money out of them, then the 5 per cent. arrangement holds good; but if the Government is to be regarded as the trustees of the public, who hold the public funds for the good of the people, and for the good of the people only, then, we say, drainage will pay for itself in three years, and by adopting

the scheme the Government would be actually realizing 33⅓ per cent. on the investment. It will reduce the financial forces of Ontario, of course, for a few years, but after the system has been freely working for a few years, and the people begin to see the benefit of it, the funds of the Province will assume a firmer tone, and when the land has been thoroughly drained, we have an unlimited field to the north of us where our surplus capital can be invested in mining.

We don't say that this movement is perfect. We are perfectly sensible of its imperfections. Still we hope that you may be able to devise ways and means whereby we can bring into cultivation our waste lands, and bring Ontario up to the standard which she ought to occupy.

The past history of drainage in Ontario is calculated to frighten the farmer from going into it.

If my time permitted me to go more into detail I might make the scheme a little plainer to you. We propose that the borrowers shall have the privilege of paying back the entire loan at the end of five years. We would prevent speculation. If I can borrow money at the rate of 2½ per cent., I might be able to take it out and use it for other purposes, this would have to be prevented. The Township of Minto has, say, 500 lots, and say that there is an average of 10 acres on each lot requiring drainage. That would make 5,000 acres. Taking the average of $30 per acre, that will make $150,000 to drain it. That would keep 100 men, at a dollar a day, working for three years and four months. In this way the population can be retained in the country. The manufacturing industries are overstocked with labour, and something must be done to give our people employment in order to keep them in the country. I leave the matter in your hands.

DISCUSSION.

Mr. Aylesworth—You said it was your intention to ask the township councils to send delegates to a meeting to be held in Toronto, where a petition will be drafted. Have you any idea of getting that done for this session?

Mr. Dobson—This is a gigantic scheme. I have been engaged for three or four years in it. It will take time to bring it to completion. I hardly think it possible that we should have this convention in time for this session. We propose, in the coming summer, to invite a delegate from each division, along with as many of the engineers as possible, to draft the skeleton of a Bill, which can be circulated among the farmers, so as to let them see what we are asking the Legislature to do. This convention will be held at a time possibly to be determined by yourselves, because the Executive Committee have come to the conclusion that the only way to do is to place it in your hands. We look to you as taking the initiative in the matter. I have already explained the difficulty that we find from these men who hold positions in the township and county councils. We would suggest that the meeting should be held this summer.

Moved by M. J. Butler, seconded by A. Niven, "That this Association does not feel called on at present to express an opinion on

the Minto Provincial Drainage Scheme, as we have not had sufficient time to consider it; and we beg to return our best thanks to Mr. Dobson for the information furnished us."

Mr. Butler remarked, in speaking to the motion, that the subject was of such magnitude as to require years of consideration and thought. It would be premature to take any steps with regard to it now.

Mr. Chipman—I would suggest to the secretary of the scheme that it would be a good idea to have these circulars distributed among members of the Association.

Mr. Aylesworth—I think that the thanks of the meeting are due to the speaker for the ideas he has given us in the direction of placing the agricultural interests of the Province in the position they ought to occupy. There are the interests of the land surveyors also to be considered as well.

Mr. Stewart—I have endeavoured to understand, as far as possible, the ideas that he has presented. He speaks of the present Drainage Act being complicated. I do not know how anything can be made less complicated than the Drainage Act to contain all the necessary points. I cannot understand why the surplus of the Province should be placed in the hands of the Dominion in the way he proposes. It seems to me that the guarantee of the Provincial Government would be all that was necessary, without interfering with the surplus.

Mr. Stephens—I would like to know if we have any means of ascertaining what the surplus really is. (Laughter.)

The Chairman put Mr. Butler's motion, which was carried unanimously.

BOUNDARY COMMISSIONERS.

Moved by William Ogilvie, seconded by G. B. Abrey, "That the draft of the bill attached to this motion, respecting the appointment of Boundary Commissioners, be referred to the Legislative Committee, and a copy of this draft be embodied in the Annual Report for the consideration of the members of the Association, in order to a thorough discussion of the matter at the next annual meeting." —Carried.

March 3, 1887. G. BELL.

The Lieutenant-Governor shall appoint in each county in the Province a Provincial Land Surveyor, who shall be styled and known as "Boundary Commissioner," for the county to which he has been so appointed.

The duties of these Boundary Commissioners shall be as hereinafter set forth in this Act.

They shall retain office during life, unless they have been guilty of gross inattention to their duties, or of gross partiality in their decisions in cases submitted to them.

When any Boundary Commissioner shall have been guilty of gross inattention to the duties of his office, or of marked partiality in deciding any case submitted to him as hereinafter provided, the party or parties injured by such misconduct may, within three months of the time of the discovery of such misconduct, notify the County Judge of the county in which such misconduct has been committed, and petition him to investigate the charges formulated in such petition against said Boundary Commissioner.

The County Judge shall within three months of the time of receiving such notice, summon before him at a time and place to be plainly set forth in such summons, the Boundary Commissioner so accused, and his accusers, for the trial of such charges, and shall issue summonses for the appearance before him of witnesses to be heard in the trial.

If the County Judge finds that the charges have been sustained, he shall report the fact to the Lieutenant-Governor, who shall at once dismiss such Boundary Commissioner from his office, and appoint another Provincial Land Surveyor to the office thus made vacant.

When the office of Boundary Commissioner in any county becomes vacant by the death of the incumbent of said office, the judge of the county in which such vacancy occurs shall report the fact, duly attested by the certificate of a legally qualified medical practitioner, to the Lieutenant-Governor, who shall, upon the receipt of such

notice and certificate, appoint another Provincial Land Surveyor to the vacant office.

Whenever the parties to any disputed boundary case, where such question is purely a question of survey, shall so agree, they may refer the adjustment of such disputed boundary to a Court of Arbitrators composed of three Boundary Commissioners appointed as aforesaid.

Each of the parties to such dispute shall choose one such Boundary Commissioner, and the County Judge of the county in which the disputed boundary is situate, shall appoint the third.

The arbitrators so chosen and appointed, shall, within days after receiving notice of their appointment to the said duty of arbitration, give ample notice to the parties to such disputed boundary, of their intention to proceed, on the day set forth in such notice, to the place of the boundary in dispute, and to adjudicate upon the case; and the arbitrators shall, on the day appointed, proceed to the scene of the disputed boundary, and shall then examine all witnesses in the matter on the ground to which their evidence relates, and shall perform any operations, as surveyors which they may deem necessary to a proper understanding of the matter in hand.

Upon the completion of the examination of all evidence submitted to them in the case, and such measurements and operations as they may deem advisable, the arbitrators shall make their award in the case, and such award shall be final and binding on both parties to the dispute, except in the case of gross negligence or gross partiality, as hereinbefore provided for.

The Boundary Commissioners constituting the Court of Arbitration which has tried any case of disputed boundary, shall award the costs of such trial, and the proportion to be paid by each of the disputants, in a manner that shall be deemed just and equitable by the arbitrators.

Each Boundary Commissioner shall be entitled to the sum of dollars per day, together with travelling and living expenses, while engaged in the trial of any disputed boundary case submitted to them as hereinbefore set forth; such fees and expenses to be a part of the costs of the trial, and to be paid as hereinbefore set forth.

Before proceeding to the trial of any suit or question submitted to them, the Commissioners, as above chosen, shall make an affidavit before the County Judge or before some Justice of the Peace, or Commissioner for taking legal affidavits, that he has not any personal interest in the suit at issue, and that he has not in any way been engaged professionally as a surveyor on it. Such affidavits to be filed along with the rest of the documents connected with the case, with the Clerk of the County Court of the county in which the dispute is located.

(Signed) W. OGILVIE.

NOTES.

The students of the School of Practical Science, attending the meeting of the second day, and, either from the interest taken in the proceedings or from fear of one of their professors, who was present, desisted from "hazing" or other college pastimes. Many of these graduates are now leading members of our Association.

The discussions, Mr. Dobson's address, and much of the article on Exhibit of Instruments are prepared from the stenographer's notes. Mr. Frost, of the *Globe*, was engaged to act as "our reporter" at the last meeting—the same gentleman who accompanied Mr. Bolger on his Rainy River explorations in 1886, and whose popular account of the trip has appeared in the *Globe* this winter.

ATTENDANCE AT THE SCHOOLS OF ENGINEERING IN CANADA—SESSION 1886-1887.

McGill University, Montreal—Department of Practical and Applied Science:—1st year, 19 students; 2nd year, 13 students; 3rd year, 13 students; 4th year, 8 students; partial, 4 students; total, 57.

Royal Military College, Kingston:—1st year, 24 students; 2nd year, 24 students; 3rd year, 15 students; 4th year, 8 students; total, 71.

School of Practical Science, Toronto:—1st year, 20 students; 2nd year, 18 students; 3rd year, 8 students; special students, 10; total, 56.

REPORT OF COMMITTEE ON LEGISLATION: A POSTSCRIPT.

The Committee on Legislation beg to report that at the request of your Association the Honourable the Commissioner of Crown Lands introduced and carried through the House all the amendments asked for in the "Act Respecting Land Surveyors and the Survey of Lands." The thanks of the Association are due to the honourable gentleman for his assistance. With regard to the amendments to the "Ditches and Water Courses Act," asked for by your Association, the three delegates from the Association, Messrs. Burke, Coleman, and Proudfoot, appeared twice before the Municipal Committee of the Legislative Assembly, and explained the proposed amendments. Delegates from the following Counties, on behalf of the Municipal Councils, were also present, viz.: Perth, Kent, Essex, Elgin, Lambton, and Welland, and after hearing the explanation of the engineers, were practically of the

same opinion as to the desirability of the proposed amendments. To Mr. Waters, M.PP., the thanks of the Association are due for carrying through some of the proposed amendments in his Bill to amend the "Ditches and Water Courses Act, 1883." One important amendment failed to pass the Municipal Committee, viz.: that concerning a proposed Court of Appeal; the members of the Association interested in drainage are recommended to endeavour to devise some scheme which could be easily and inexpensively worked, as nearly all the delegates from municipal corporations were favourable to some such scheme. With regard to the proposed amendments to the Municipal Act, so far as relates to drainage, the arguments of the engineers must have failed to convince the Municipal Committee, as, with the exception of one almost unimportant amendment, none of the proposed changes were inserted in the "Act to Further Amend the Municipal Act," introduced and carried through by the Hon. A. Hardy.

Respectfully submitted,

GEORGE B. KIRKPATRICK,
Chairman of Committee on Legislation.

Toronto, May, 1887.

Samuel Ridout, Deputy Surveyor.

BIOGRAPHICAL SKETCH

OF

SAMUEL RIDOUT,

DEPUTY SURVEYOR.

By HIS SON, JOHN RIDOUT, Esq.,

TORONTO.

SAMUEL RIDOUT was born in the Town of Hancock, Maryland, on the 7th of September, 1778, and there received his education as land surveyor. In 1798 he came to Toronto, and held several appointments under Government. He was Deputy Clerk of the Crown in 1800, and chief clerk in the office of his father, Thomas Ridout, Surveyor-General from about 1802 until the year 1829. He was appointed Sheriff of the Home District in 1815, and held that office until the year 1827, when he was appointed Registrar of the County of York. He retained the office of Registrar until his death, which occurred in 1855.

He was appointed a Deputy Land Surveyor at an early date; was captain in the militia, and served in the War of 1812, at the close of which he was assigned the duty of conveying prisoners of war to Quebec. He was also appointed, in 1816, agent for the officers of the Land Granting Department, and in this connection received a pension from the year 1834. He owned and occupied for some time a farm on Yonge Street, now known as Summer Hill; also, park lot No. 4, now in the city, where he resided at the time of his death. He was twice married; two sons and one daughter survived him.

SAMUEL RIDOUT, DEPUTY SURVEYOR.

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LIST OF MEMBERS.

Active Members.

NAME.	OCCUPATION.	ADDRESS.
Abrey, George Brockitt		31 King Street East, Toronto.
Apsey, John Fletcher		35 Elgin Avenue, Toronto.
Aylsworth, Charles Fraser		Madoc.
	Engineer for Village of Madoc, and Townships of Madoc and Rawdon.	
Aylsworth, Wm. Robert		Deseronto.
Baird, Alexander		Leamington
	Chief Engineer Leamington and St. Clair Railway, Engineer for the Townships of Mersea, Tilbury West, South Colchester, and Malden and Village of Leamington.	
Bazett, Edward		Midland.
Beatty, David		Parry Sound.
Beatty, Walter		Delta.
Bell, James Anthony		St. Thomas.
	City Engineer, St. Thomas.	
Berryman, Edgar		7 Place d'Armes Hill, Montreal.
	Chief Engineer Montreal and Sorel Railway, Engineer South Eastern Railway.	
Biggs, Jas. Morley Mowatt		Orillia.
	Sub-Assistant Engineer Welland Canal.	
Blake, Frank Lever		Toronto.
	Astronomical Assistant at Observatory.	
Bolger, Thos. Oliver		Belleville.
Bolger, Francis		Penetanguishene.
Bolton, Jesse Murray		Albion.
Bolton, Lewis		Listowel.
	Engineer for Townships of Wallace, Elma, Grey, Morris, Town of Listowel and Village of Drayton.	
Booth, Chas. Edward Stuart		Kingston.
Bowman, Cleming Derstine, Grad. S.P.Sc. (Toronto)		West Montrose.
	Engineer for Townships of Woolwich, Peel and Nichol.	
Bowman, Herbert Joseph		Berlin.
Bowman, Isaac Lucius		Berlin.
	Engineer for Townships of Waterloo, Wilmot and Wellesley.	
Bray, Edgar		Oakville.
Browne, Harry John		17 Toronto Street, Toronto.
Browne, Wm. Albert		" " Toronto.
Burke, Wm. Robert		Ingersoll.
	Engineer for County of Oxford.	

NAME.	OCCUPATION.	ADDRESS.
Burt, Frederick Percy	Artist *Engineering News.*	New York City.
Butler, Matthew Jos., As. M. Inst. C.E.; M. Am. Soc. C.E.	Chief Engineer N. T. and Q. Railway.	Napanee.
Byrne, Thomas		Sarnia.
Cadenhead, John Arbuthnot		Morris, Man.
Campbell, Archibald Wm.		St. Thomas.
Campbell, David Suter	Engineer for six Townships.	Mitchell.
Casgrain, Jos. Philip Bakey		198 Spadina Avenue, Toronto.
Cavana, Allan George	Engineer for Townships of and Mara Rama.	Orillia.
Chipman, Willis, B.A.Sc. (McGill)		Brockville.
Coad, Richard		Glencoe.
Coleman, Richard Herbert	Drainage Engineer, Canada Company.	Toronto.
Cooke, Richard P.	Contractor Welland Canal Enlargement.	Brockville.
Cozens, Joseph		Sault Ste. Marie.
Cromwell, Jos. Miller Oliver	Engineer for the County of Lanark and one Township.	Perth.
Davidson, Walter Stanley		Arkona.
Davis, Wm. Mahlon, Grad. Royal Military College	Town Engineer, Woodstock.	Woodstock.
Davis, John	City Engineer Guelph, Chief Engineer Guelph Junction Railway.	Guelph.
DeGursé, Joseph		Windsor
Dickson, James		Fenelon Falls.
Doupe, Joseph, C.E. (McGill)		7 Princess Street, Winnipeg, Man.
Drewry, Wm. Stewart		Belleville.
Duchesnay, E. Juchereau, B.Sc. (Laval)	Division Engineer, Canadian Pacific Railway.	Chapleau via Biscotasing.
Ellis, Henry Disney	Northern and North-Western Railway.	74 St. Patrick Street, Toronto.
Esten, Henry Lionel		26 Adelaide Street, Toronto.
Evans, John Dunlop	Chief Engineer Central Ontario Railway.	Trenton.
Fawcett, Thomas, D.T.S.	Surveying Dominion Lands.	Gravenhurst.
Fitton, Chas. Edward		Orillia.
Foster, Frederick Lucas		176 Argyle Street, Toronto.
Fox, Edward	Chief Clerk of Patents, Crown Lands Department.	Toronto.
Furlonge, Wm. H.	Mining Engineer.	Port Arthur.

NAME. OCCUPATION. ADDRESS.

Galbraith, John, M.A.; Assoc. M. Inst. C.E., D.T.S. .....Toronto.
Professor of Civil Engineering, School of Practical Science.

Gardiner, Edward.....St. Catharines.
Engineer for the County of Lincoln.

Gaviller, Maurice, C.E. (McGill).....Collingwood.

Gibson, Peter Silas, B.Sc., C.E.; M. Sc. (Univ. of Mich.)..Willowdale.
Engineer for Townships of York, Scarboro' and Etobicoke.

Hanning, C. G., C.E. (T. C., Dublin, Ireland),..135 Bloor E., Toronto.

Henderson, Edward Eli.... .....Wardsville.

Johnston, Wm. Oswald.....Whitby.

Jones, John Henry .....Sarnia.
Engineer for the County of Lambton.

Jones, Thomas Harry, B.A.Sc. (McGill).....Brantford.
Engineer for the Townships of Brantford, Burford and South Dumfries.

Keefer, Tho. Coltrin, M. Inst. C.E.; Vice.-Pres. A. Soc. C.E...Ottawa.

Kirk, Joseph.....Stratford.
Ex-Engineer for the County of Perth, Engineer for the Township of Mornington.

Kirkpatrick, George Brownly.....Toronto.
Chief Clerk Survey Branch, Department of Crown Lands.

Klotz, Otto Julius, D.T.S.; C.E. (University of Michigan)..Preston.
In charge of Astronomical Work British Columbia.

Laird, James Stewart .....Essex Centre.
Engineer for County of Essex and Townships of Rochester, Maidstone, Sandwich East, Anderdon, North Colchester and Gosfield.

Lawe, Henry .....Dunnville.

Lendrum, Robt. Watt.....Vankleek Hill.
Engineer for Townships of Lochiel and Hawkesbury.

Lumsden, Hugh David, M. Inst. C.E.....Montreal.
Engineer in charge of construction, Ontario and Quebec Railway.

McAree, John, D.T.S., (Grad. S.P.Sc.)..245 Parliament St., Toronto.

McDonell, Augustine .....Chatham.

McGeorge, Wm. Graham .....Chatham.
Engineer for County of Kent.

McGrandle, Hugh .....Huntsville.

McKenna, John Joseph .....Dublin.
Engineer for Township of Hibbert.

McNabb, John Chisholm.....Chatham.
Chief Engineer Erie and Huron Railway.

Maddock, Junius Arthur.....Lindsay.

Manigault, Wm. Mazyck .....Strathroy.
Engineer for Townships of Adelaide, Caradoc, East Williams and Town of Strathroy.

Miles, Charles Falconer .....Walkerton.
Engineer for the Townships of Minto, Normandy, Carrick, Culross, Greenock, Brant, Arran and Bruce, and Town of Wingham.

NAME.	OCCUPATION.	ADDRESS
Miller, Fred. F., Assoc. M. Inst. C.E., B.A.Sc. (McGill)		Napanee.
Moore, John McKenzie		London.
Murphy, Chas. Joseph		26 Adelaide Street East, Toronto.
Niven, Alexander	Surveying base lines and meridians near Lake Temiscamingue.	Haliburton.
Ogilvie, William, D.T.S.	Astronomical work, British Columbia.	Ottawa.
Ord, Lewis Redmond	Assistant Engineer Algoma Branch C. P. R.	Thessalon.
Patten, Thadeus James		Little Current.
Proudfoot, Hume Blake, C.E. (University, Toronto)	Engineer for nine Townships.	Clinton.
Purvis, Frank	Engineer for Townships of Wilberforce, North Algoma and Bromley.	Eganville.
Reilly, William Robinson		Regina, N.-W.T.
Russell, Alexander Lord		Port Arthur.
Sanderson, Daniel Leavens		Courtice.
Sankey, Villiers		17 Toronto Street, Toronto.
Scane, Thomas		Ridgetown.
Selby, Henry Walter	Engineer for Townships of Nottawasaga and Sunnidale.	Stayner.
Sewell, Henry DeQuincey, Assoc. M. Inst. C.E.		Port Arthur.
Smith, George	Engineer for the Townships of Ops, Eldon, Georgina, Thorah and Bexley, and Villages of Woodville, Cannington and Beaverton.	Beaverton.
Smith, Henry	Superintendent of Colonization Roads in Ontario.	Toronto.
Speight, Thomas Bailey		Toronto.
Sproatt, Charles, C.E.	City Engineer.	Toronto.
Stewart, Elihu		Collingwood.
Stephens, Haldane Hincks		Owen Sound.
Traynor, Isaac	Engineer for Townships of Egremont and Preston, and Village of Dundalk.	Dundalk.
Tyrrell, James Williams, Grad. S.P.Sc. (Toronto)	Last year at Meteorological work, Hudson's Strait.	Weston.
Unwin, Charles		Toronto.
Van Nostrand, Arthur Jabez		Toronto.
Vicars, John	Engineer for Township of Brock.	Cannington.

NAME.	OCCUPATION.	ADDRESS.
Warren, James	Engineer for Townships of East Wawanosh, Bruce, Greenock and Huron.	Kincardine.
Weatherald, Thomas	Engineer for the County of Huron.	Goderich.
Webb, Major Adam C.		Brighton.
Wheelock, Charles Richard		Orangeville.
Wicksteed, Henry King, B.A.Sc. (McGill)	City Engineer, Port Arthur; Chief Engineer Port Arthur, Duluth and Western Railway.	Port Arthur.
Willson, Alfred	Chief Engineer Canada Company.	Toronto.
Wilson, Hugh		Mount Forest.
Yarnold, William Edward	Engineer for Townships of Reach, Mariposa, Scugog and Georgina.	Port Perry.

Associate Members.

Rathbun, Edward Walter, jun.	Articled student with M. J. Butler.	Deseronto.
Sherman, Ruyter	Articled student with T. H. Jones.	Brantford.