"metric measurement K/17/5
J. C. McLennan

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THE CENTRAL RAILWAY AND ENGINEERING CLUB

OF CANADA

OFFICIAL PROCEEDINGS FOR MAY, 1907

W. KENNEDY,
President.

C. L. WORTH,
Sec-Treas.

. . THE CENTRAL . . Railway and Engineering . . . . Club . . . . OF CANADA

OFFICIAL PROCEEDINGS

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PROCEEDINGS OF THE CENTRAL RAILWAY AND ENGINEERING CLUB OF CANADA MEETING.

ROSSIN HOUSE, TORONTO, May 21st, 1907.

The Vice-President, Mr. McRae, occupied the chair.

Chairman,—

It is now 8.30 p.m. and will call meeting to order. Unfortunately our President is out of the city to-night, and it falls upon me as Vice-President to open the meeting.

I am sorry we could not open meeting at the regular time, 8 o'clock, as it makes it late in getting away. However, we have something to be given to-night of unusual interest to all of us.

The first order of business is the reading of minutes of previous meeting. I believe all members have been supplied with a copy of minutes of last meeting, and therefore propose that some member move that they be adopted as read.

Moved by Mr. Baldwin and seconded by Mr. Mooney that minutes be adopted as read. Carried.

Chairman,—

Next order of business is remarks of President. As Chairman, I do not know that there is any special thing to be said to-night on matter of remarks from chair. We have some work to do, however, as to filling vacancy on our executive, also some other few matters which came up before executive meeting.

I may say here, that we have with us to-night one of the ablest educational men in the country, and he is going to speak to us on the subject of Metric System and its uses. Perhaps there is no person who can speak better on this matter. To give Dr. J. C. McLennan all the time required, I will not say anything further.

Chairman,—

Next order of business is announcement of new members. I will call upon the Secretary to read same.

NEW MEMBERS.

Wm. Sharp, Engineer, G.T.R., Sarnia Tunnel.
A. E. Hawker, Mechanical Engineer, Toronto.
Jno. Lyon, Engineer, G.T.R., Sarnia Tunnel.
Frank Wright, Engineer, G.T.R., Brantford.
Geo. A. Lockhart, Engineer, G.T.R., Sarnia Tunnel.
Hy. Bertram, Secretary Bertram Mfg. Co., Dundas, Ont.
E. G. Yates, London Machine Tool Co., Hamilton, Ont.
Chas. A. Jackson, Leading Machinist, G.T.R., Fort Erie.
J. J. Fisher, Engineer, G.T.R., Sarnia Tunnel.
W. H. Chidley, Locomotive Inspector, G.T.R., Stratford.
Charles Geldart, Chargeman Tool Dept., G.T.R., Stratford.
George Teskey, Engineer, G.T.R., Sarnia Tunnel.
F. G. Morris, Engineer, G.T.R., Sarnia Tunnel.
A. D. Howard, Travelling Engineer, Detroit Lubricator Co.

MEMBERS PRESENT.

Jno. W. Griffin.	W. J. Jones.	R. N. Perrin.
R. G. Gilbride.	J. Hay.	L. Salter.
W. R. McRae.	J. McWater.	J. W. McLintock.
W. H. Nix.	E. Logan.	D. C. Hollowell.
Geo. Baldwin.	H. G. Fletcher.	Harry Hague.
J. Mooney.	W. Gell.	J. F. Campbell.
F. R. Wickson.	J. C. Blanchflower.	C. W. Steel.
Harry Ellis.	W. H. Jackson.	J. H. Stortz.
M. W. Barker.	W. H. Wensley.	J. R. Armer.
A. G. McLellan.	C. A. Jefferis.	Geo. Black.
Geo. Williams.	F. W. Brent.	Geo. Shand.
R. N. Card.	J. W. Perry.	J. E. Houghton.
Robt. Pearson.	Jno. Dodds.	W. Evans.
I. Jefferis.	J. Markey.	N. MacNicol.
G. McIntosh.	G. Cooper.	R. Preston.
J. Duguid.	W. H. Farrell.	C. L. Worth.

"Unfinished Business."—The Secretary advises that he has received the following letters from the Secretary of the Department of Labor at Ottawa, and from the Secretary of the Department of Education at Toronto, in reference to Resolution passed by this Club re question of technical education of apprentices:—

"TORONTO, May 2nd, 1907.

"Sir,—I am directed by the Minister of Education to acknowledge receipt of your letter of the 29th ult., enclosing a copy of the Resolution passed by your Club, re question of Technical Education in this country.

"The Minister desires me to thank you for your courtesy in this matter, and to say, that the suggestion contained in your letter shall receive his most careful consideration.

"Sincerely yours,

"C. W. JAMES,

"Secretary Department of Education.'

"OTTAWA, May 2nd, 1907.

"Sir,—I have the honor, by direction, to acknowledge your communication of April 29th, addressed to the Honorable the Minister of Labor and enclosing a report of the meeting held on March 19th, 1907, of the Central Railway and Engineering Club of Canada in Toronto.

"I am instructed to thank you for the report in question and to state that the Minister notes with interest that at the

meeting a resolution was passed, urging that the Government should give a thorough consideration of the question of Technical Education in Canada. A report of the meeting will be printed in the May number of the Labor Gazette.

"I have the honor to be, sir, yours obediently,

"F. A. ACLAND,

"Secretary to Minister of Labor."

Chairman,—

Under head of new business I might mention that the Executive Committee met and discussed the matter of the Club holding a social evening in June or thereabouts. There was a motion made to that effect by Mr. McRae and seconded by Mr. Garden, that a social evening be held some time in June, but same to be brought before Club to-night for discussion.

This question is now open to discussion, and shall be pleased to have some of the members give us their opinions and advice on this matter.

Mr. Baldwin,—

Mr. Chairman,—I think it is a very good idea to have a social evening, and to bring the matter to a head, I would move that we hold a social evening in the form of a supper, music, singing, etc.

Chairman,—

What about date of holding this?

Mr. Baldwin,—

That is for the meeting to decide, but I think it best to hold it soon, as the weather will be getting warm shortly, in which case we may not be able to get many to attend.

Chairman,—

When this question of a social evening was taken up by the Executive Committee, the idea prevailing this motion was to keep up the interest in the Club during the holidays (June, July and August), when we are not holding meetings regularly.

We were figuring in the Executive Committee whether it would be better to use the funds of the Society for that purpose for the first social entertainment, or whether it would be best to ask each member to pay a small amount. We have made rapid advances considering our age. I think it would be advisable to hold a social evening, and I believe the majority are in favor of holding such a gathering.

These are matters of vital interest from a financial standpoint, and also for the success of the Club.

Mr. Baldwin,—

Considering these points, I will withdraw my motion and suggest that committee be appointed to go into matter and discuss same at the next meeting.

Secretary,—

Perhaps it would be well to consider holding a dinner at the end of the year.

Chairman,—

We did not think of having two social evenings during the first year. This is another question to be considered. Shall we hold a social evening in the summer time and one at the end of the year, or only have one? However, all the members I have spoken to on the subject are unanimous in thinking that we should have a gathering of this kind. It seems to me that we should have a gathering at the end of the year. A dinner in the summer time in close rooms, and naturally having smoking, would not be altogether as pleasant as it might be. I think the fall would be better. Of course, I am only giving my personal opinion. We must decide, however, to-night, if we are to hold this social evening in June, and in that case will appoint a committee to-night.

Mr. G. Black,—

Mr. Chairman, I think June would be a good month to hold meeting, and keep up the interest of the Club, and I am in favor of members bearing expense of same themselves. I think the members will be glad to do this.

Secretary,—

I think a social evening would be a good idea. We have had five or six meetings now, and after each meeting is over, a large number of the members present walk out and do not attempt to get acquainted with each other, whereas the idea of holding a social evening is to get acquainted with one another.

Mr. G. D. Bly,—

Mr. Chairman,—Would it not be better to hold this social evening at the first meeting in the fall, in order to start new interest in the fall sessions?

Mr. Gilbride,—

Mr. Chairman,—I suggest that we hold a smoker and not a dinner. Most members are smokers and would not have to

eat. We could have in connection with the smoker, an entertainment of music, singing, etc.

Mr. Fletcher,—

In the event of motion of Mr. Gilbride being adopted, I shall be very pleased to get some talent.

Chairman,—

It is moved by Mr. Gilbride and seconded by Mr. Fletcher that smoker be held in month of June. Has any person anything further to say before voting on same?

Mr. Black,—

Mr. Chairman, I move that we hold a social evening in June, and expense be met by members, and each member bring a friend with him.

Chairman,—

Moved by Mr Black, seconded by Mr. McLellan, that we hold a social evening with refreshments in the month of June, each member to pay his own expenses and to bring a friend with him if possible.

Chairman,—

It is moved and amended by Mr. Black, and seconded by Mr. McLellan that we hold a social evening at which there will be entertaining talent, and each member attending shall pay $1.00, which will cover expenses of friends. Motion put to vote and carried.

Chairman,—

Social Evening Committee nominated as follows:—Messrs. Baldwin, McLintock, Fletcher, Worth, McLellan, Bannon, Jackson and Hollowell.

Chairman,—

Moved by Mr. Black, and seconded by Mr. Mooney, that nomination for entertaining Committee be closed. Motion carried.

Chairman,—

The Social Evening Committee are asked to meet after this meeting to-night to take up matter.

Chairman,—

Next order of business, election of one of our members

to fill vacancy caused by withdrawal of Mr. H. H. Brewer. The Executive Committee have recommended Mr. Spaidal, Superintendent, Canadian Northern Railway. Has any other member of the Club a member he wishes to propose for this vacancy.

Mr. Fletcher,—

Mr. Chairman, I understand that the stationary men have been invited and are coming into the Club to a great extent, but I am inclined to think they think they are being shunned somewhat. I do not mean shunned exactly, perhaps side-tracked may be a better way to express it.

I suggest that some stationary man be nominated to fill this vacancy. I have in mind Mr. Smith, Chief Engineer of the T. Eaton Co. plant, whom I would like to see on this committee, and shall be pleased to move the nomination of that gentleman for the office vacant.

Chairman,—

We have tried to spread the honors and think we have done so fairly well. Yet Mr. Fletcher is right when he says there should be a representative of the Stationary Engineers on our Board. We have divided the honors very fairly among all our steam railways, electric railways, and manufacturing industries. Naturally the largest number of offices are filled by railway men, they being in the majority. However, not being a steam engineer myself, I do not wish to see all these honors go to the steam railway men, and think the stationary engineers, if out in force to-night, might put in a man against the steam engineers. I shall be glad to have it done.

Personally, I would rather see four or five names put to vote for nomination.

Mr. Jones,—

I second nomination of Mr. Smith.

Chairman,—

I declare nominations closed. It has been moved by Mr. H. G. Fletcher and seconded by Mr. W. J. Jones that Mr. Smith, Engineer of the T. Eaton Co., be elected to our Executive Board. We shall put the election of Mr. Spaidal and Mr. Smith to vote.

Chairman,—

Mr. Smith is elected to fill vacancy on Executive Board.

Chairman,—

Gentlemen, we are going to call upon Dr. J. C. McLennan to address you to-night on the Metric System. As I said before there is probably no other man more able to present this system to you than Dr. McLennan. I am sure you will very much appreciate having come here to-night to hear what the Doctor has to say to you.

I now take pleasure in asking Dr. J. C. McLennan to come before us and give his address.

THE METRIC SYSTEM OF WEIGHTS AND MEASURES.

The lecturer, Professor McLennan, on being introduced, addressed the Club as follows:

Mr. Chairman and gentlemen,—In the short time at my disposal this evening, it will be my aim to give you a brief account of the origin and development of the metric system of weights and measures; to present some of its chief characteristics, to point out some of its advantages, and to outline its introduction into and adoption by a number of the countries of the world.

1.—HISTORICAL DEVELOPMENT.

The moment that primeval man emerged from a state of almost animal barbarism, the natural tendency to acquire property made itself manifest. All possessions of value must necessarily bear some relation to each other, and such relation, the base of any system of barter, can only be established by some means of measurement. The simplest form of measurement, of course, is mere enumeration; but the ability to count alone could not long satisfy the needs of the dawning intelligence of men. In consequence our earliest ancestors found it necessary to adopt some standard and naturally turned to objects more or less constant either in size, weight or some other physical property. The lack of intimate association between the early communities necessarily gave rise to diverse standards of measurement, resulting in a confusion which was further increased by a natural tendency to adopt as standards personal measurement, such as the length of the foot and the arm, the first joint of the thumb, etc. Owing to the different stature of men in different localities these standards were very inexact and their elasticity greatly favored fraud on the part of unscrupulous dealers. As an example of the origin of these diverse measurements, which were in no way related to each other, and which were in every case excessively local in their application, may be cited the origin of the inch from the length of the first joint of the thumb and that of the yard from the length of the king's arm. More indefinite still were

such terms as "furlong," meaning a furrow long, and "perch," derived from the Latin *pertingo*, to stretch. Standards of weight were fully as indefinite as those of linear measurements, as may be seen from the fact that our familiar "pound" owes its origin to nothing more definite than the Latin *pondus*, a weight.

Unsatisfactory as were these crude attempts at measurements, they nevertheless answered the purpose of isolated communities, but soon the exigencies of trade between the different centres of civilization brought a new factor into the field and emphasized the confusion already existing. Furthermore, when national growth manifested itself and organized government appeared, the collection of revenue forced the adoption of something approaching a fixed standard and necessitated a definite relation between the different units of the systems of weights and measures. It is quite natural that buyer and seller should have different ideas of the length of a thumb joint, and we find that this difference of opinion was fully shared by the revenue officers and the importers of foreign goods. It is, however, to the government control of revenue that we owe the nationalizing and eventually the legalization of a system of standards.

Taking Great Britain as an example, we find that the attempts to reduce measurement to a standard proved an undertaking of great difficulty and that five centuries elapsed after the Norman conquest before anything like uniformity was attained. Even to-day many of the early units are clung to with a remarkable persistency. For example, the term "stone" is still largely used in Great Britain and the expression "baker's dozen" is frequently heard even in Canada.

It is worthy of note that no attempt has ever been made in the British empire to establish a relationship between the units of mass, length and volume. A possible exception to this statement may be found in the fact that a gallon of cold water is officially recognized to weigh ten pounds.

It is at once manifest that the legalization of the standards in each country tended only to the lessening of the confusion in that particular realm. The standards adopted by the different states were in no way related to each other, and consequently as international commerce and scientific investigation increased the need of a universal system of weights and measures became more and more apparent.

About the beginning of the eighteenth century the creation of a universal system began to be mooted by the leading scientists in Europe. Among the most active of these was James Watt, the inventor of the steam engine, who suggested the universal adoption of the Paris pound as the standard of mass and the length of the seconds pendulum at Paris as the standard of length.

He also proposed that all subdivisions and multiples of these standards should be decimally connected. Watt's proposal for a decimal system of weights and measures was not new, having been made by Sir James Stuart nearly a hundred years earlier, while the suggestion to derive the standard of length from the pendulum had been made by the French scientist, Picard, many years before.

In France especially the want of uniformity in the weights and measures of the different provinces had for a long period been exceedingly embarrassing and troublesome in the transaction of affairs. Various attempts had been made during the 16th and 17th centuries to establish a uniform system of weights and measures for that country, but it was not until near the close of the 18th century that the question assumed such importance as to warrant legislative action on the part of the National Assembly. In 1789 the assemblage of the States-General in Paris brought to a focus the long-felt discontent at the numberless variations in use in various parts of France and in the following year the Academy of Sciences was instructed to devise a system of weights and measures which would be suitable to all nations. This the Academy undertook to do, and the Royal Society of London was asked to take part in the movement, but declined the invitation, and England accordingly lost any share of the credit for formulating the new system.

The scheme of the Academy of Sciences, known as the Metric System of Weights and Measures, was laid before the National Convention in 1793, and received its endorsation. In this scheme all previous units were abandoned, and, in order to give it an extremely international character, the standard of length was based upon the length of a quadrant of the earth's meridian. The ten millionth part of this length was called the *metre*, and on this unit, together with the maximum density of water, the whole system of weights and measures was built up, all subdivisions and multiples of the standard unit, according to Watt's proposal, being decimally connected.

In order to carry out the scheme of the Academy, Delambre and Mechain, two able mathematicians and distinguished scientists, undertook to measure an arc on the earth's surface, from which the total length of the quadrant of a meridian could be calculated. The arc selected extended from Dunkirk in the north of France to Barcelona on the east coast of Spain. Their task occupied about seven years, and at its conclusion their measurements and calculations were submitted to a "Commission of Weights and Measures," composed of twenty-two members chosen from the various countries of Europe, who, after carefully revising all the computations, arrived at a determination of the length of the metre,

and proceeded at once to the practical realization of this standard of length. A bar of platinum one metre in length at the temperature of melting ice was constructed with the greatest care by Lenoir under the direction of Borda, and this bar, known as the Metre des Archives, is still preserved in the Palais des Archives, and served as the first practical standard of length in the metric system.

In the scheme presented by the Academy of Sciences, the theoretical unit of mass, or weight as it is popularly spoken of, was called the gramme, and was defined to be the mass of distilled water, which, at its maximum density, would exactly fill a cube with an edge one hundredth of a metre in length. This theoretical unit was small, and a larger one, the kilogramme, was adopted for practical purposes. The kilogramme is equal to 1,000 grammes, and is the mass of distilled water which, at the temperature of 4°C, under an atmospheric pressure equal to that represented by a column of mercury 760 millimetres high at 0°C, at sea level, and at latitude 45 degrees, would exactly fill a cube with an edge equal to one-tenth of a metre.

A cylinder of platinum was constructed by Borda, with the greatest possible precision, so as to have a mass equal to that of the kilogramme just defined, and was deposited along with the metre in the Palais des Archives, at Paris. This standard mass, which is known as the Kilogramme des Archives, and the standard metre referred to above, form the basis of the scheme elaborated by the Academy of Sciences, and they are the two practical units to which all the weights and measures of the metric system are referred.

Such is briefly the history of the origin of a system of weights and measures which, in spite of opposition, has now been adopted by a large majority of the nations of the world, who recognize its value and appreciate its extreme simplicity.

The metric system of weights and measures was made compulsory in France in 1802, but as many opposed its adoption, it was subsequently decreed by the National Convention in 1812 that the old measures, though metrically altered, should still be used. This system of compromise went on until 1837, when a law was passed which prescribed that from January 1, 1840, none but the weights and measures of the metric system should be employed, and that the use of unauthorized measures should be punishable. Since the passing of this law the metric system, and that alone, has been the legal system in force in France.

The agitation in favor of the metric system gradually extended throughout Europe, and soon after the constitution of the German empire it was adopted in that country. An Act passed in August, 1868, made it optional from January

1, 1872, and since then the metric system alone has been legalized in Germany. In 1873 its use was made obligatory in Austria, and somewhat later in Italy. The movement has extended to America, to Africa and to Asia, and at the present time the metric system is the one official and legal system of weights and measures in force in forty-three of the countries of the world. In the United States, in Great Britain and Ireland, and also in a number of the British dependencies, including Canada, this system has been legalized, but not as yet made compulsory.

In 1867 the International Geodetic Conference, which assembled in Berlin, expressed the view that in the interest of science in general and of geodesy in particular, a unique system of weights and measures, with decimal subdivisions, should be adopted in Europe, that the system selected should be the metric system, that a new metre of length equal to that of the Metre des Archives of France should be constructed as an international standard, that a number of additional copies for distribution as standards to different countries should be prepared, and that for this purpose an International Bureau of Weights and Measures should be established.

In 1875 an agreement, known as the International Metric Convention, was entered into by eighteen contracting states—since increased by successive adhesions to twenty-two—by which the proposals of the geodetic conference were adopted. In conformity with this agreement an international bureau of weights and measures was established at Sevres, on the banks of the Seine near Paris, and is now maintained at the common expense of the contracting states.

The first work undertaken by this bureau was the preparation of a new international standard metre and a new international standard kilogramme. In establishing these new international prototypes the old standards of the Archives of France were taken as a basis. Platinum-iridium alloy was used in their construction, and they were standardized by the most approved methods and by means of the most perfect instruments which science and the art of construction have placed at our disposal. They are now kept in a vault underground at Sevres under lock and key, and are inspected only once in ten years, and even then they are not handled more than is absolutely necessary.

Copies of the "International Metre" and the "International Kilogramme" have been distributed as standards to those governments which have signed the convention, and others are being constantly prepared by the bureau for distribution to public institutions, scientific societies, observatories and laboratories, as well as to scientists and to the manufacturers of instruments of precision. All these copies are constructed and verified with the greatest precision, and can replace the

international standards in case the latter by any mischance should be lost.

The probability of the loss or destruction of all the standards is very remote, but the possibility of alteration through molecular changes in the prototypes is not to be disregarded. Consequently it was thought advisable to measure the international metre in terms of some physical constant of an absolutely unchangeable nature. The wave length of the light emitted from well defined lines in a spectrum is absolutely constant and depends on the vibrations of the ever-present and unalterable ether. The length of such waves was, therefore, regarded as particularly suitable for the purpose of recording the length of the international metre in terms of a factor entirely removed from the possibility of change with the lapse of time.

In 1892 Michelson was invited to carry out this work at the International Bureau and an extended series of the most careful measurements was conducted by this distinguished scientist with the red, green and blue lines of cadmium as the source of light, and the length of the metre was found to be 1,553,163.5 wave lengths of the red light, 1,966,249.7 wave lengths of the green light and 2,083,372.1 wave lengths of the blue light of the cadmium spectrum.

Advances in methods of measurement and refinement in the construction of instruments of precision have shown us that the international metre differs slightly from one ten-millionth part of a quadrant of the earth's meridian, and that the mass of the international kilogramme is not exactly equal to the mass of a cubic decimetre of water at its maximum density, but this fact, while it robs us of the sentiment connected with the origin of these prototypes, does not detract in the least from their value as the basis of the metric system.

At this juncture the lecturer exhibited a series of Inspector's standards of weights and measures, and proceeded to show how the different measures would be used in ordinary every day commercial and industrial phases of activity.

The following account which has already appeared in the governmental reports of 1904 and 1905, on the subject, covers the ground touched upon.

2.—THE METRIC SYSTEM EXPLAINED.

The metre is the centre and base of the entire Metric system, and furnishes the standard not only for linear, superficial and solid measurements, but also with its decimal parts becomes the standard of weight and capacity. Briefly stated, the theory of the system is as follows:—

The *metre* for linear, superficial and solid measurements.

The *kilogramme* for measurements of weight.

The *litre* for measurements of capacity.

For the higher denominations of length, weight, etc., the words *deka*, *hecto*, *kilo* and *myria* taken from the Greek are prefixed to the foregoing standards to signify multiplication by 10, 100, 1,000 and 10,000 respectively. Thus the term dekametre stands for 10 metres, the term dekagramme for 10 grammes, the term dekalitre for 10 litres, the term hectometre for 100 metres, etc., etc.

The Latin prefixes *deci*, *centi*, *milli*, on the other hand, are employed to express division by 10,100 and 1,000 respectively, thus furnishing names for the lower denominations. The term decimetre accordingly stands for 1-10 metre, the term decigramme for 1-10 gramme, the term decilitre for 1-10 litre, the term centimetre for 1-100 metre, etc., etc.

By means of the Latin or Greek prefixes you know at a glance whether you are dealing with multiples or fractions of the standard *metre*, *gramme* or *litre*, as the case may be.

The kilogramme, or as it is generally called, the kilo, which is the commonest denomination among the weights, corresponds to the weight of a cubic decimetre of water. A cubic decimetre of water measures one litre.

The man to whom the Metric tables are unknown is very apt to magnify the practical difficulties involved in mastering the new names and what they stand for. In point of fact, there are only something like a dozen or so names to be learned altogether and it would be a dull man indeed who could not pick up a working knowledge of these after an evening's practice. Moreover, in actual use, a good many of these measurements have been discarded in the Metric countries. In Germany the kilometre, metre, centimetre and millimetre, among the linear measures, are found quite sufficient for all ordinary purposes. The only weights in common use are the kilogramme, the gramme, the centigramme and the milligramme.

The proper pronunciation of the Metric terms can be readily seen from the following:—

SPELLING.		PRONUNCIATION.
Metre	(meeter)	like gas-metre.
Litre	(leeter)	" pique.
Gramme	(gram)	" dram.
Are	(ar)	" barn.
Deci	(desi)	" decimal.
Centi	(senti)	" cent.
Milli	(mili)	" mill.
Deka	(deka)	" decade.
Hecto	(hekto)	" hecatomb.
Kilo	(kilo)	" kill.
Myria	(miria)	" myriad.
Quintal	(cwintal)	" quince.
Millier	(millier)	" million.
Stere	(star)	" stair.

THE METRIC TABLES.

LINEAR MEASURE.

10 millimetres	=	1 centimetre
10 centimetres	=	1 decimetre
10 decimetres	=	1 metre
10 metres	=	1 dekametre
10 dekametres	=	1 hectometre
10 hectometres	=	1 kilometre
10 kilometres	=	1 myriametre

SURFACE MEASURE.

100 square millimetres	=	1 square centimetre
100 square centimetres	=	1 square decimetre
100 square decimetres	=	1 square metre
100 square metres	=	1 square dekametre
100 square dekametres	=	1 square hectometre
100 square hectometres	=	1 square kilometre

In land measurements the square metre is usually called a centiare, the square dekametre an are, and the square hectometre a hectare.

CUBIC MEASURE.

1,000 cubic millimetres	=	1 cubic centimetre
1,000 cubic centimetres	=	1 cubic decimetre
1,000 cubic decimetres	=	1 cubic metre

The cubic metre is commonly known as the stere. 10 decisteres equal one stere, and 10 steres are spoken of as a dekastere.

MEASURES OF WEIGHT.

10 milligrammes	=	1 centigramme
10 centigrammes	=	1 decigramme
10 decigrammes	=	1 gramme
10 grammes	=	1 dekagramme
10 dekagrammes	=	1 hectogramme
10 hectogrammes	=	1 kilogramme
10 kilogrammes	=	1 myriagramme
10 myriagrammes	=	1 quintal
10 quintals	=	1 millier (Metric ton)

MEASURES OF CAPACITY.

10 millilitres	=	1 centilitre
10 centilitres	=	1 decilitre
10 decilitres	=	1 litre
10 litres	=	1 dekalitre
10 dekalitres	=	1 hectolitre
10 hectolitres	=	1 kilolitre

The terms dekametre, hectometre, kilometre and myriametre, are employed only in measurements of distance. For other measures of length their equivalents—ten metres, one hundred metres, one thousand metres and ten thousand metres, respectively—are used. Thus, one speaks of its being so many kilometres from one town to another.

In buying ribbon or goods at the dry goods counter, however, one would speak of ten metres, forty metres, or one hundred metres, as the case may be, not of one dekametre, four dekametres or one hectometre. The myriametre is seldom used, in other than geographical calculations.

The unit of distance among surveyors is the dekametre, equal to ten metres.

Among builders the centimetre is often taken as the unit. Thus: a carpenter would speak of a board as being 140 long, meaning 140 centimetres, in other words, 1m.40. The glazier speaks of a glass 45 by 56, meaning 45 centimetres wide by 56 centimetres high. Such fine measurements as the thickness of glass or of boards are usually referred to in millimetres.

The square metre serves for the surface measurement of lumber, a yard, a garden, etc. For a larger surface, like that of a county, a country, or the world itself, the square kilometre is the unit. The square myriametre is sometimes employed for similar purposes, but less and less as the years pass. The are, hectare and centiare are applied to land measurements alone.

The cubic metre with its multiples and fractional parts is used for the measurement of stone, of masonry, of the volume of water contained in a vessel, for the capacity of a trench, etc. The terms stere, decistere and dekastere are used only in the measurement of firewood, like the word "cord" among the English measures.

Among the measures of capacity or contents, the litre is the common unit for the measurement of liquids like water, milk, wine, also for the measurement of grain and seed and for some kinds of fruits and vegetables. For larger transactions in liquids, grain and vegetables the customary unit is the hectolitre (100 litres). Fruit, potatoes, beans, etc., are often sold by the dekalitre.

The weight of ordinary commerce is the kilogramme, which is always referred to as the kilo. The decigramme, centigramme and milligramme are never heard of in everyday business. They are of service, however, in determining the weight of letters, jewellery, drugs, etc.

The obstacles that have thus far blocked the acceptance of the Metric standards among English-speaking countries have been greatly magnified. So far as Canadians, at all

events, are concerned, the principle on which calculations are made in the Metric scale is so much like that to which we are accustomed in the common arithmetic of dollars and cents that there is absolutely no reason why we should not readily pick up a working knowledge of the new units. The greatest practical difficulty would consist in getting used to something like a dozen new names. Where even brief notice, however, has been given of the introduction of the Metric system in other parts of the world the disarrangement in trade has been very slight.

When the litre replaces the quart, it ought not to take the servant girl many mornings to judge how much milk is needed in the new measurement for the daily requirements of the household. The mistress will very soon learn to figure out in metres the afternoon's shoping at the dry goods counter.

Half a kilogramme is nearly equal to our pound. The litre comes within a narrow fraction of our quart. The Metric ton and the ton now used in Canada are almost identical. In land measurement the hectare is equal to about two and a half acres; in other words, the quarter of a ten-acre field. The metre is one-tenth longer than our yard. The kilometre comes in for distances that we now state in miles. The Metric tables, as given on page 21, are purposely made full enough to serve for every use that might arise in the business of a nation. Only a small proportion of the units though, are in what one might term general use.

The Metric System has been introduced into almost every civilized nation, and into many semi-barbarous countries as well without the least trouble. In view of this fact, there is not much doubt but the change could be effected with comparative ease in a country where the standard of intelligence is as high as it is in Canada.

The lecturer then pointed out that the advocates of the metric system of weights and measures claim the following advantages for that system:—

3. ADVANTAGES OF THE METRIC SYSTEM.

1. The metric system is orderly, clear and extremely simple In the metric system there is one specific word for each unit, and this word exclusively designates the one thing it is meant to represent. From this one word, to which can be prefixed particles which are the same for all units, every multiple and sub-multiple can be expressed. In this regard the metric

has the advantage over the British system, which is complicated, unscientific and anomalous.

2. In the metric system there are no specific trade tables. The same weights and measures are used for all purposes in all trades and industries.

3. The metric system of weights and measures, like our system of notation in arithmetic, which is universally adopted by civilized nations, is a decimal system and involves but the single ratio "10." For this reason, all reductions in the system are made with the minimum amount of labor, and with no more effort than that involved in the expression of a number. The advantages of the decimal system in the coinage and money of Canada are manifest, and it is claimed that it would be just as convenient to use a similar system in our weights and measures.

4. The adoption of the metric system would materially assist education by facilitating the teaching of arithmetic and setting free a considerable amount of time which would be devoted to more useful subjects than the learning and practising of our complicated and confused tables of weights and measures. Estimates made by committees of inquiry show that the work of at least two-thirds of a year in the life of every child would be saved by the adoption of the metric system of weights and measures.

5. The universal adoption of the metric system of weights and measures by scientists has greatly facilitated the development and spread of scientific knowledge.

6. The international system of electrical units is based upon the metric system. All British and American electrical engineers and workmen must, therefore, work with it, and as long as the British system of units is retained in machine construction, so long will those connected with enterprises involving a knowledge of electricity be put to the inconvenience and unnecessary labor of keeping in mind two systems of standards. It will be seen that the argument has increased force when it is realized that, as new fields of knowledge are opened up and new systems of work evolved, the claims of science will make it imperative to adopt the metric system as a basis.

7. Another claim urged on behalf of the metric system is that it is exceedingly simple in calculation. As each measure of quantity can be written down at once as a decimal or multiple of ten of the standard metrical unit, tedious reductions are avoided and computations are confined to operations involving only the simple rules of arithmetic.

The tiresome process of multiplying or dividing a quantity of tons, hundred-weights, quarters, pounds, etc., by a number, and the still more difficult task of performing a similar operation with an area containing acres, roods, square yards, etc., are well known to every one. The same problems in the metric system are done easily and quickly. The saving in energy consumed by a nation in a year or two in calculations rendered necessary by the use of our present system of weights and measures alone would warrant the universal adoption of the metric system.

8. It is claimed by the advocates of the metric system that it would be an advantage to British and to Canadian manufacturers to adopt this system, because if they are making goods for home consumption and also for export to countries using the metric system as well as to British and American markets it is necessary for them in many cases to have two sets of patterns or dies, whereas if the metric system were adopted in the British Empire and also in the United States, one set would suffice. It is also of importance to note in this connection that manufacturers are always making improvements and alterations in their articles of manufacture which necessitate the continual preparation of new patterns, models and designs, and it is just as easy to adopt the new system in new patterns as to continue the use of the older system.

9. The supporters of the metric system also claim that its adoption by the British Empire, including its dependencies, would greatly assist in preserving our foreign trade, and also constitute a most valuable means of extending it. Our consuls have frequently reported that we lose trade in consequence of our weights and measures not being understood in other countries. At the present time forty-three of the countries of the world have adopted the metric system as their sole official and legal system of weights and measures. Among these are the republics of South America, Egypt and Mauritius in Africa, Japan, Java and twenty-eight ports in China, in Asia, and in all the countries of Europe with the exception of Great Britain and Russia. The metric system has been legalized in Great Britain and Ireland, and in most of the British dependencies, as well as in the United States, but it has not yet been exclusively adopted by these countries.

It is highly probable that the time is not distant when the whole of Africa will be opened up to commerce. Stable governments will be established there, and these will almost certainly adopt the metric system. The same process will go on in China and in other portions of Asia. The commercial interests of the British Empire and of the United States are sure to be affected by the development, and the maintenance of the present system of weights and measures by these nations

will more and more be found to be a serious drawback to the extension of their foreign trade.

I. The metric system has been adopted by the following countries:—

EUROPE.

Austria-Hungary and Territories, Belgium, Bulgaria, Denmark, Finland, France, French Colonies, Germany, Greece, Holland, Italy, Norway and Sweden, Roumania, Servia, Spain, Switzerland, Portugal, Azores and Maderia, Turkey.

AMERICA.

Argentina, Bolivia, Brazil, Central America, Chili, Colombia, Costa Rica, Cuba, Ecuador, Guatamela, Hayti, Honduras, Mexico, Nicaragua, Peru, Porto Rico, Philippines, Salvador, Santo Domingo, Uruguay.

AFRICA.

Egypt and Mauritius.

ASIA.

China (28 ports), Java, Japan, and Philippines.

In dealing with the present position of the Metric System in Great Britain and the Colonies the remarks of the lecturer are summarized in the following statement:—

4. THE METRIC SYSTEM IN GREAT BRITAIN AND IRELAND.

"In 1864 a statute was passed making permissive the use of the Metric standards of weights and measures throughout the British Isles 'for the promotion and extension of our internal as well as our foreign trade, and for the advancement of science.' Having gone, however, that far, the reformers halted and although select committees have repeatedly counselled making the use of the Metric system compulsory, it was not till the year of Queen Victoria's Diamond Jubilee (1897) that the international metric system was made permissive for 'all' purposes by Act of the Imperial Parliament.

The Weights and Measures Committee of the House of Commons reported as far back as 1895 that Great Britain would do well to accept the international metric system as her only legal standards, giving the public two years' notice of the change in which to prepare for the new order of things.

In 1904 the House of Lords accepted all three readings of a bill to make the international metric system compulsory. The Commons ordered the measure to be printed, but failed to accept the final stages of the proposed enactment.

A number of amendments proposed by the government departments were embodied in this bill. The great support the measure received throughout the United Kingdom was shown by the enormous number of petitions in its favor. Among these were petitions from city, town and village councils representing 8,000,000 population, from 52 Chambers of Commerce, 42 Trades Unions, representing a membership of 300,000, from 60 Teachers' Associations, 30 retail trades associations, the Inspectors of Weights and Measures in 80 districts, several Chambers of Agriculture and Farmers' Associations, including the Scottish Chamber of Agriculture and Highland Society, besides petitions from a number of engineers and manufacturers."

In March, 1907, a Bill was introduced into the British House of Commons aiming at making the sole use of the Metric system in Great Britain and Ireland, compulsory, at an early date, but after being discussed for one half day the Bill was rejected by a majority of approximately two to one.

5. THE METRIC SYSTEM IN THE BRITISH COLONIES.

At the Imperial Conference in London which followed close upon the coronation of Edward VII., in 1902, it was found that representatives of the Motherland and the chief members of the colonial group were all anxious to see the Metric system brought into use as the uniform standards of weighing and measuring throughout the Empire. Common sense and business interest alike prompted the Conference accordingly in resolving:

"That it is advisable to adopt the Metric system of weights and measures for use within the Empire, and the Prime Ministers urge the governments represented at this conference to give consideration to the question of its early adoption."

Upon the conclusion of the conference the Secretary of State for the Colonies addressed a despatch to the various self-governing and Crown Colonies of the Empire, to obtain from them an expression "with regard to the advisability of adopting a Metric system of weights and measures for use within the Empire."

The replies showed that this system is already used in Mauritius and Seychelles.

The following colonies were favorable to its adoption: Australia, New Zealand, Cape of Good Hope, Transvaal, Orange River Colony, Southern Rhodesia, Gambia, Northern Nigeria, Gibraltar, British Guiana, Trinidad, Leeward Islands and Windward Islands.

Sierra Leone, Southern Nigeria, Ceylon, the Falkland Islands and Hong Kong replied that they, too, favored the

Metric system, with this reservation, that it must also be adopted in the United Kingdom or in the Empire generally.

In the response of the Canadian government, "The Minister of Inland Revenue, to whom the said despatches were referred, states that the government of Canada is prepared to introduce legislation to legalize the Metric system as the sole standards of weights and measures at such time as may be agreed upon between the government of Great Britain and the various units of the empire.

"He further states that by 34 Victoria, Chapter 24 (1871), it was provided that for the promotion and extension of the internal as well as of the foreign trade of Canada and for the advancement of science, it was expedient to legalize the use of the Metric system of weights and measures. Since that date, and up to the present time, weights and measures of the Metric system have been used in Canada, but almost exclusively in connection with scientific investigation.

"The Minister further states that in addition to the foregoing, the Department of Inland Revenue has distributed to educational institutions nearly 500 sample sets of the Metric system, and has also equipped the principal weights and measures offices with standards of the system referred to, in order that an inspection of Metric weights and measures could be made whenever the demand therefor arose."

Newfoundland answered that until Great Britain and Canada adopt the Metric system it would be inadvisable for their government to move in the matter.

The states of New South Wales, Victoria and Western Australia endorsed the suggestion individually, but together with South Australia and Tasmania considered that the matter was one for the Commonwealth to deal with.

Fiji was doubtful, but must follow Australia and New Zealand.

British New Guinea also would go with Australia.

Jamaica and British Honduras reported that the system must first be brought into force in the United States and in the Motherland, when they would gladly follow suit.

"India is already on record in favor of the Metric system, and would have accomplished the reform years ago, but for the wish of the Mother Country that the step should be postponed till England is herself ready to make the change also."

"The practice of India is important to the Straits Settlements, who would be followed in turn by Labuan. The Bechuanaland Protectorate would fall into line with the rest of South Africa in the matter.

"The replies of St. Helena, Cyprus, Lagos, Wei-Hai-Wei, Barbadoes and the Bahamas were on the whole unfavorable to the change.

"The Gold Coast and the State of Queensland were prepared to adopt, but felt that inconvenience would occur.

"Natal would not consider the subject until some general lines of legislation had been agreed upon by His Majesty's government.

"Basutoland expressed the opinion that the adoption of the Metric system would not entail any serious difficulty to its traders. They would fall into line with any system adopted by the neighboring territories.

"In 1903 the Australian Commonwealth, Cape Colony and New Zealand, through their respective parliaments and the Fifth Congress of Chambers of Commerce of the Empire, sitting in Montreal, adopted resolutions, pressing on the notice of the Imperial Parliament the wisdom of making the Metric system compulsory. In one of these instances the wording of the resolution was not quite definite. New Zealand, however, went even further than passing resolutions and adopted an Act, which will allow the Metric system to be applied within its borders as soon as the Motherland is prepared to follow suit."

Mr. Black,—

May I ask Dr. McLennan to tell us one thing, that is how close it figures out on the circumference of a circle from the diameter.

Dr. McLennan,—

The ratio of the circumference to the diameter of a circle is the same for all systems namely 3.14159.

Mr. Fletcher,—

I think the Doctor has been almost too kind to us to-night. While I attended the Technical School, yet I have been away from figures for a few years, and have been a bit at sea on this matter, however, this gentleman has been the means of setting me right again.

I hope before the Doctor goes that I shall have the pleasure of having a chat with him.

I move a hearty vote of thanks for the very able lecture given by Dr. McLennan.

Mr. Wickson,—

I have very much pleasure in seconding this vote of thanks. Unanimously carried.

Dr. McLennan, in acknowledging the vote of thanks, ex-

pressed the very great pleasure he experienced in meeting the members of the Engineers' Club, and closed his remarks by extending to the President and members a cordial invitation to visit and inspect the new Physical Laboratory when completed. This structure, which is in course of erection and promises to be exceedingly handsome and most eloborately equipped, is one of the group of buildings for which provision was made in the generous grant recently voted to the University of Toronto by the Legislature of the Province of Ontario. (Cheers).

Chairman,—

Owing to the lateness of opening the meeting and the hour now late, and the fact that Dr. McLennan has so kindly given us so much of his valuable time, unless some member has a very important question to ask of the Doctor I would suggest that we leave further discussion of this paper until a more opportune time.

I have to revert from the order of business, and wish to bring before you Article 12 in order of business,—election of new members. Under this heading we have a recommendation from the Executive Committee, which was moved by Mr. Acton Burrows, and seconded by Mr. C. A. Jefferis, that Dr. Galbraith be nominated as an honorary member of this Club. We shall put this to vote.

Chairman,—

I declare Dr. Galbraith elected as an honorary member, unanimously.

Chairman,—

The next meeting of this Club will be held the third Tuesday in September.

Adjournment,—

Moved by Mr. Fletcher and seconded by Mr. Gell that the meeting be adjourned.

..NOTICE..

Chairman Mr. J. Bannon, of the Social Evening Committee, desires to make the following announcement:—

This Committee has held two meetings and decided as follows: That a social evening be held at the Rossin House, Monday, June 24th, at 8.00 p.m., at which light refreshments will be served, entertainment Committee having made provision for songs, etc. All members are strongly urged to attend and bring their friends with them, each member present paying $1.00 to cover expenses of himself and friends, further notice of which will be sent you by the Secretary.

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