

# The system of survey in the Northwest of Canada

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jotted down in their field-books without any waste of time. I beg respectfully to urge upon surveyors the desirability of becoming familiar with the modern methods of physiography developed by Professor Davis, of Harvard, and others. Such knowledge is not hard to assimilate and will add much to the interest of field work, even if it does not afford very material help in interpreting topography.

Mr. McCaw remarks upon ridges "formed by earth-crumbling," and notes their trend; and speaks of the country as a "land of ridges." These, and other features, form but the parts of a most fascinating whole. The island is a faulted plateau, and almost all the main features, including river valleys and mountain ridges, are direct expressions of geological structure, and their relationships are most elegantly expressed by the nomenclature of the "New Physiography."

The PRESIDENT stated that as a military man of some seventeen years' experience he felt sure that the camera would turn out a very useful topographical instrument for rough country. The camera, so far as he knew, was not in use in the State, and he had no personal acquaintance with it, but as we were now going in properly for defence, topographical surveys would become necessary, and where the plane table failed the camera would come into use.

Of the plane table he had had considerable experience, and he used it with much success whenever he had to design roads in a subdivision requiring special treatment. This class of preliminary work in designing did not require the use of very precise instruments, and to put elaborate theodolite work into it was a great loss of time. The plane table did the work much more expeditiously, and as the field notes to scale grew on the board, all necessary details can be filled in as required. So far as he knew, few if any of our own surveyors made use of it, but a little experience of it would soon demonstrate its value.

He would now ask the meeting to pass a vote of thanks to Mr. McCaw for writing this excellent paper, also to Dr. Woolnough for his efforts in obtaining it for us, and to Mr. Cambage for his kindness in undertaking to read it.

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## THE SYSTEM OF SURVEY IN THE NORTH-WEST OF CANADA.

By J. N. WALLACE, Dominion Land Surveyor, Calgary, Alberta.

*Read by MR. J. H. CARDEW, M.INST.C.E., at a Meeting of the Institution of Surveyors, New South Wales, on Tuesday, March 21st, 1911.*

There would seem to be many reasons why surveyors in different countries should be more interested in each others' work than is the case in other professions. The principles and practice in other professions are very similar in different parts of the Empire, but in the case of sub-dividing the public lands for settlement, the methods followed are very different. Yet although there is always a certain

interest in comparing different ways of gaining the same ends, and though the subdivision of the uninhabited parts of the Empire for settlement is a matter of the highest importance, yet individual surveyors have very little knowledge of the system pursued in other countries than their own, and possibly the following remarks (grown much longer than at first intended) on the methods carried out in Canada, may at least awaken a comparison between those methods which are a daily part of the life of Australian surveyors, and those elsewhere adopted to gain much the same end.

The system pursued in Canada can fairly claim to be the finest example of the rectangular system in the world. A somewhat similar system has been carried out in the United States of America, but it was not nearly so well devised originally, and has been marred by great inaccuracies on the ground. There the use of the compass has always been allowed, while in the North-West of Canada its use to establish any boundary has always been absolutely forbidden, Especially in recent years, under the direction of Dr. Deville, the present Surveyor-General of Dominion Lands, the accuracy of the surveys in the North-West is not surpassed in similar surveys carried out anywhere.

The territory here referred to as the North-West comprises the three Provinces, Manitoba, Saskatchewan, and Alberta, and a vast unorganised territory lying to the north and north-west of these Provinces. It does not include British Columbia, which has a somewhat different survey.

The combined area of the three Provinces is 578,000 square miles. Including all the unorganised territory, there would be a total area of about 2,000,000 square miles, but a large part of this is too far north for settlement. Considering the area for purposes of survey to extend from latitude 49deg., which is the south boundary of Canada, to about latitude 65deg., we have an area of some 1100 miles from north to south, with an average width of about 800 miles, giving a total area of 880,000 square miles, or about 563 million acres.

All of the land in the North-West here referred to, extending from the south boundary of Canada to the extreme north, belongs to the Federal, and not to the Provincial Governments, excepting, of course, whatever has already been alienated to individuals. The Provinces have no control over the unoccupied lands within their limits. The Federal Government has always conducted the surveys for settlement, and the lands have always passed to individuals directly from this Government.

All lands belonging to the Federal Government, wherever they may occur throughout Canada, are known as "Dominion Lands." Ontario and the other Eastern Provinces, and also British Columbia, own their own lands, although in the latter province the Dominion Government owns an important area known as the Railway Belt, extending for twenty miles on each side of the Canadian Pacific Railway.

When about the year 1870 it became necessary to inaugurate a system for sub-dividing such an enormous area, the survey of which was to be under one Government and unhampered by prior settlement of any kind, a splendid chance occurred for a comprehensive system,

and the result is one which is unsurpassed anywhere for its simplicity, regularity, and magnificent dimensions.

The policy of the Federal Government has always been to have the lands sub-divided well ahead of settlement, and to keep the system of survey extended with as wide a front as possible. A demand may sometimes occur for surveys in some outlying district, but in such cases the district will not be sub-divided until at least some of the lines of the system have been surveyed up to it, so as to form the necessary connection. This policy has resulted in regular boundaries, and has imposed no real hindrance to settlement, for a man must be a wanderer indeed who wants to settle ahead of where surveyors have been.

The general system of survey of Dominion Lands is rectangular, all the boundary lines running north and south, or east and west. Its foundation consists in long, straight lines accurately marked out on the ground independently of any trigonometric methods. When such an enormous area has to be covered attention must, of course, be paid to the effect of the earth's curvature, especially as the territory lies in comparatively high latitudes, and this has been done in a very simple manner, so as to cause discontinuity in as few of the lines of the system as possible.

The territory considered has a width along its southerly border of some 800 miles. The first survey lines to be marked out are the initial Meridians. These are long, straight lines commencing at the International boundary, and running due north for an indefinite distance. They are spaced at intervals apart of 4deg. of longitude, which amounts to a distance of 182 miles, measured along the south boundary. These Meridians, of course, converge as they go north, approaching nearer to each other by about five and a half miles in each hundred miles. There are six of these Meridians in all. Each of them is extended further north, from time to time, independently of the others, as the need of the general survey of the territory requires. At the present time one of them has been marked out for a length of 660 miles, another for 560 miles, and the others for distances varying from 200 to 300 miles. They are surveyed straight north, independently of the nature of the country. Lakes and rivers are crossed by local triangulations to ascertain the distances along the Meridian, but the production of the line itself is continuous. Like all other lines in the system, they are marked at every half-mile. The mark consists of an iron post, three feet long and three-quarters of an inch thick, driven into the ground. A pyramid of earth is then formed, five feet square and three feet high, the post being at its northerly angle. The earth is obtained from four pits symmetrically placed, each pit being three feet square and a foot and a half deep. It is a very lasting monument, the only objection being the extreme ease with which the post may be removed. A precisely similar monument marks all the half-mile corners in the system.

At the end of every twenty-fourth mile along an initial Meridian, a long line, called a "base line," is marked out, running west on six-mile chords of latitude, until the next Meridian to the west is reached. At the end of each six miles along the base lines a small deflection, whose exact amount depends upon the latitude of the particular base line, is made to the north, and the line then continued straight for another six miles. The deflection averages about

seven minutest of angle. The name, "base line," is somewhat misleading, as these lines have nothing to do with triangulation.

The forty-ninth parallel of latitude is known in the System as the "first base line." The next line, running parallel with it, and distant twenty-four miles to the north, is called the "second base line." The next, running parallel, and forty-eight miles to the north, is called the "third base line," and so on indefinitely, according as one base line after another is marked out.

After marking out the base lines between the initial Meridians, we have a series of lines running from east to west, at intervals of twenty-four miles apart, and these lines form a framework actually marked out on the ground on which all subsequent surveys are made to depend.

When surveying a Meridian or a base line, its course is kept on the proper azimuth by observations on the Pole Star, taken about once every four miles. A six-inch transit, having microscopes in place of verniers, and a micrometer eyepiece, is used. Observations are nearly always taken by daylight. It seldom occurs in Canada that the Pole Star is more than  $2^{\circ}$  in azimuth from the Pole, and it is not difficult, therefore, to first of all get the Star into the field of a good telescope by day, with the use of an approximate table. Observations are taken with sufficient care to give a result correct within about five seconds of azimuth. The lines are produced by successive transit stations, which would average about half a mile apart along the line. Where the line runs through a wooded country it is opened out continuously for a width of ten to fifteen feet. All distances are measured twice, using a 500 link band, and checking with a 300 foot band. A clinometer is used to read the slopes, and a temperature correction applied to the extend of correcting for every multiple of  $10^{\circ}$  from standard. When surveying in the winter in Canada, the temperature correction may often amount to as much as four links in a mile.

Regarding the accuracy aimed at and attained in these lines, it must be recollected that their main purpose is to control the subsequent sub-division of a huge area for settlement, and that they are surveyed under great natural difficulties. It may be taken as a general rule that an error in azimuth seldom occurs of over fifteen seconds, or an error in chainage of over two links in a mile. The chief danger, of course, lies in the accumulation of small errors as the lines are of such great length. Especially is this so in the chainage of an initial Meridian. In a base line errors cannot accumulate beyond the particular base line. The only satisfactory check on the chainage of a Meridian is a latitude observation with the zenith telescope.

Although the primary object of these lines is in relation to settlement, yet they have been sufficiently accurately marked out to be used, and are used, for many other purposes. No trigonometric survey has yet been made over the territory in the north-western part of Canada, excepting in the Rocky Mountains, in the neighbourhood of the Canadian Pacific Railway. Over all the rest the Meridians and base lines are the very first surveys, and, in many cases, the map is almost a blank until these lines have been surveyed. They form, therefore, the only available basis for determining latitude and longitude, and of accurately establishing positions of topographical

features on maps. The enormous difficulty of transportation of heavy instruments has so far restricted the number of direct astronomical observations to a very small quantity, but where such have been taken the accuracy found in the Meridians and base lines has been very remarkable.

After the base lines have been marked out in a particular area, the next work is to establish the outlines of the six-mile squares, called "townships," into which the whole territory is to be divided. Every interval of six miles along a base line forms the side of a future township, and as base lines are twenty-four miles apart, there is a depth of four townships in a north and south direction between successive base lines. The length of a base line from one Meridian to the next, of course, becomes less as we go north. It may be taken to average about 170 miles. As the sides of the six-mile townships are laid off in succession along each base line from the easterly of two initial Meridians towards the west, a fractional length of a township side will always occur where each base line finally intersects the westerly Meridian. Any small accidental areas which may have accumulated in the base line during its survey are left in this last fractional township.

From each township corner established along the base line, lines are run due north and south for twelve miles each way, that is, midway to the adjoining base lines. These lines, called "township outlines," converge as they go north, and diverge as they go south. The result is that corresponding lines from adjoining base lines do not meet, but what is called a "jog" occurs between their ends, the end of the line run southerly from the northerly of two base lines, always falling to the west of the line run northerly from the southerly base line. This "jog" is least at the westerly side of the first township west of an initial Meridian. It accumulates directly as we go west from one township to the next, attaining its maximum in the last township before the next initial Meridian to the west is reached. The amount of the jog also increases the higher the latitude of the base line off which the township outlines are run.

The line running in an east and west direction midway between two base lines, on which these jogs occur, is called a "correction line." It is not marked directly or continuously like a base line, but is formed by successively joining the township corners which occur along it. The name is derived from the fact that any distortion due to the earth's curvature is here corrected.

As examples of the extent of a jog, it may be stated that on the correction line between the tenth and eleventh base lines, and midway between two initial Meridians, it amounts to 49.74 chains, and on the correction line between the twentieth and twenty-first base lines, near the westerly of two Meridians, it is 108.74 chains, or nearly a mile and a quarter. The effect of convergence is, therefore, considerable, and the local discontinuity caused by it in the system increases rapidly as we go west from one initial Meridian till we meet the next, and it also increases as we go farther north. Its effect, however, is locally great, only because it is concentrated at a few points. Convergence does not cause any discontinuity excepting along the correction lines, and these lines only occur once in every twenty-four miles as we go north over the territory. It will be noted that by running the outlines as straight lines for twelve lines north

and south of a base line, instead of for twenty-four miles from one base line to the next, the effect of convergence on the areas of the individual townships is more evenly balanced, one half of the townships being greater, and the other half equally less than the theoretic area. The amount of the jog would remain the same in either case.

The dividing lines between the townships having been run north and south, as stated, corresponding corners of townships on these outlines are connected by east and west lines, and we have the whole area divided up into six mile squares. Each township is then subdivided internally into thirty-six sections, each one mile square, and these last contain four quarter sections (familiarly known as "homesteads") of 160 acres each, which may be called the unit of subdivision. For purposes of access to the lands an allowance of one chain for a road is left between every mile as we go east and west, and between every second mile as we go north and south. These extras make each township a little greater than six miles square.

Each mile and half-mile corner is marked by an iron post and mound of earth. One post only is placed to govern all four corners of four adjoining sections, whether the sections are all in one township or in adjoining townships, as there is no discontinuity. The only exception occurs along a correction line where the sections to the north overlap those to the south by the amount of the jog. In this case separate posts are placed on opposite sides of the road allowance which runs along a correction line.

Townships are numbered in regular succession from south to north. All those which immediately adjoin the south boundary of Canada are called "Number One." The next tier north of these are called "Number Two," and so on. They are further numbered in ranges from east to west from each initial Meridian to the next. The sections in each township are numbered regularly from 1 to 36, and the quarter sections are known according to their position in the section. Thus so short a designation as "The south-west quarter, section 23, township 31, range 7, west of the third Meridian," is sufficient to completely identify any one of the hundreds of thousands of homesteads in the north-west, and, moreover, when we know the numbers of any two of them we can tell, almost at a glance, their exact distance apart, no matter how many hundreds of miles may intervene. The numbers indicating the particular section, township, and range, are cut on each iron mile post with a cold chisel.

The system of first marking out a framework by the survey of the Meridians and base lines has several advantages over a system whereby each successive township is simply built up on the previous one. It avoids accumulation of errors, for the aggregate mileage required to accurately establish a distant point is much less than would be required if the intervening territory were divided up even into townships only, and this lesser mileage allows more time and expense to be allotted to the survey of these lines than could be given to so many miles of township lines. These governing lines being very accurately laid down, less rigorous methods can be followed in the subsequent sub-division. Any errors in sub-division cannot accumulate beyond certain narrow areas, and beyond such areas adjoining surveys are entirely unaffected by them. Moreover, by keeping a few lines, such as the base lines, surveyed out in advance

of all the sub-division work, if a demand should arise for sub-division in some outlying district, these lines are sufficient connection to allow isolated groups of townships to be surveyed off them with the certainty that, when the intervening territory is sub-divided in after years, all the surveys will fit in, and no break will ever occur. No doubt a simple tie line might be run into an isolated district to effect this last result, but it would itself be no future value, whereas every mile of base line will some day be part of some future township boundary. Finally, the system adopted confines the effect of the earth's curvature to certain well-defined points, and allows it to be fully dealt with there in a simple manner, thereby relieving the general sub-division of all local distortion.

The survey of Meridian and base lines is entirely done by surveyors paid by salary, the sub-division into townships almost entirely by surveyors at a contract rate of so much per mile.

The survey of base lines is very difficult. They are always surveyed far ahead of settlement, and generally in areas hardly even explored. Everything has to be transported on pack horses. Wheels of any description are out of the question, owing to the general growth of small trees, and the local areas of swampy or hilly country. The nearest source of supplies is seldom within a hundred miles of camp, with probably no means of access except some rough trail cut out by the survey party. Moreover, there are obviously many difficulties in the technical work of marking out a line which must be run straight for over a hundred miles, without any deviation, through an uninhabited and more or less unknown country. The greatest difficulty is the question of transportation, and in this the chief trouble is caused by the numerous small areas of swampy land which occur in almost every part of Northern Canada where the lands are timbered. There is, of course, no proper drainage for the surface water, and in that part of Canada, where surveys are now being extended, there is always abundance of rain, and much water from melted snow. This runs into the lower levels, and having no outlet over the surface, although neighbouring streams may be at a much lower elevation, the water lies in the lower lands till it evaporates, being unable to drain downwards on account of some impermeable stratum below. It is the combination of a wide depression with no local outlet, abundance of rain, and the slow evaporation of northern latitudes, which causes all these swampy areas. They have often good soil, the majority of them can be easily drained into some stream, and they will, no doubt, be brought under the plough some day, but in the meantime they cause endless trouble to the surveyor of base lines, as although not really flooded land, they are yet much too soft for horses to cross. These swampy areas are not individually extensive, seldom over a mile, but they may be so numerous, and so dovetailed into one another, that in the surrounding growth of small trees it is very difficult to find a route even for pack horses around them, especially when, as in surveying a base line, we cannot move camp far from the work, but must find a route somewhere within narrow limits close to the line which is being surveyed.

It is this difficulty of transportation which offers the only possible argument against the general system of the survey for, in order to gain the regularity required by the system, it is a necessity



that many hundreds of miles of base lines must be run on a straight course independently of local difficulties, or of immediate requirements along their course, and, they must be run far ahead of settlement, and no matter how quickly settlement may be following, the conditions of surveying lines in advance will always be difficult. The cost of sub-dividing a local district is, of course, greater than it would be if a long line had not first to be surveyed before the particular district can be sub-divided, but this cost is not so great an item as would appear at first sight. As a base line occurs only once in twenty-four miles it is seen that, in estimating the ultimate cost of sub-division, the cost of one mile of base line should be distributed over twenty-four square miles of land. Taking this cost as about £40 per mile, this amounts to only one half-penny per acre. The assumption is, of course, here made that all the land along the base line will be subdivided, and this aspect of the cost will be referred to later.

There is another phase to this difficulty of transportation, and that is the almost unendurable isolation it imposes on the survey party, for, while where transportation is easy, it may be a small thing to be a hundred miles from settlement; yet, when conditions are such that ten or fifteen miles means a day's journey, this distance may be enough to almost completely isolate a survey party for a whole season. This rather personal element in the system of survey has so far been got over by indiscreet means, for there are always new men who, not knowing the conditions fully, are willing to stand the isolation for a few seasons, until they, like their predecessors, find they cannot stand them any longer, and so the work is continuous, although individual surveyors seldom continue on such work for more than a few seasons. The survey of a Meridian is even harder than that of a base line.

Each season the Federal Government employs about sixty surveyors on field work. Of these about six are engaged on Meridian or base line surveys, and the remainder in connection with sub-division surveys, most of the latter surveyors being paid by contract. A fair season's work on a base line is about 120 miles, the season being about eight months, from May to December, although such surveys are often continued right through the winter, as transportation is easier over snow.

A sub-division contract will embrace about eight townships, the surveyor usually having two sub-parties working at once. In a timbered country it takes about six weeks for one party to subdivide one township.

A surveyor paid by salary receives two pounds a day when engaged on Meridian or base line, and thirty-two shillings a day for other work. In addition he receives an allowance of two shillings and eightpence a day for each man in his party, with which he has to furnish all supplies and camp outfit. Anything connected with transport, such as horses, harness, etc., all cost of transportation, and the wages of the party, are paid directly by the Government, on the surveyor furnishing vouchers. For the survey of a base line the party consists of the surveyor in charge, two assistants, and about fifteen men. The assistants are usually serving their year, which is necessary to gain a license, and it seldom happens they have had any previous experience. They receive twelve shillings a day each.

The men are paid from five to eight shillings a day. At the end of the season the surveyor is paid for about another month or so, at the usual field rate, to allow him to make up his season's returns, and then he is disengaged till the next season begins.

Surveyors under contract receive so much a mile of line surveyed, and this covers everything. The rate for open prairie country is thirty shillings a mile. In such country the digging of the four pits at every half-mile is a large proportion of the work, especially where the ground is hard. Where the line runs through timber an additional two shillings is paid for each chain of timber up to ten chains, and thereafter an addition of one shilling per chain of timber up to the end of a mile. There are other extra amounts, so that for a line properly surveyed and running through continuous woods the rate totals six pounds a mile as a maximum.

The trees over Northern Canada are not large, seldom over ten inches, and usually not over six inches in diameter, but they grow thickly, so that it takes about five axemen to clear out a mile of survey line in a day.

Sub-division surveys are very much easier than base lines. They are always much nearer settlement, and the work is far less arduous and responsible, yet the anomaly exists that sub-dividers make far more total pay in a much shorter season than surveyors under salary.

Regarding the total cost of sub-division, a word must first be said as to the extent to which the lands are sub-divided. The smallest sub-division is a quarter section, that is, a square of half a mile. All four corners of a quarter section are, however, never marked. While townships have all their interior lines which run north and south marked out, and posted at every half-mile, they have only every second mile surveyed across their width, and, moreover, the corner in the centre of a section is never marked. As a result, half of the quarter sections have only two corners posted, and the other half have only three corners posted.

While it would appear to be an unreasonable expense to mark the central point of each section, the omission of the half-mile posts on alternate east and west lines which results from these alternate lines not being run through, appears to the writer to be founded on a false idea of economy.

Taking into account all field expenses from first laying out the base lines to the final subdivision, it may be stated, as an approximation, that the total cost is one penny per acre in a prairie country, and fourpence an acre in wooded country.

Regarding the extent of territory already covered by the system of survey, this cannot be stated precisely, because the outlying parts have only the Meridians and base lines surveyed, while those parts close to settlement are already sub-divided into townships and sections.

One of the initial Meridians has been surveyed for 660 miles north of the international boundary, or as far as township 110. Another for 570 miles, or to township 95. These two lines must be ranked among the long straight lines of the world.

The base lines have been surveyed as far north as the fifteenth, that is, to township 56 on the average, in some parts of the territory much farther north, and in others not so far.

As to sub-division, about 5700 townships (205,000 square miles) have been already sub-divided. These are comprised in an area bounded on the south by the international boundary, and on the north by a line drawn approximately from township 20 on the east to township 60 on the west. This is an area of 120 miles deep on the east, 360 miles deep on the west, and about 800 miles wide. Settlement has markedly gone farther north in the western than in the eastern part of the territory.

There are some features in the system which could be improved. It must be remembered it was originally framed for an essentially prairie country, and has now extended into a wooded country, without any alteration. The prairie extends for 150 to 200 miles north of the international boundary, and when the system was inaugurated it was not anticipated that land suitable for settlement existed so much farther north than the prairie.

It would have been better to have had the initial Meridians spaced nearer than four degrees. This would have been an advantage in locally extending the front of the survey. While ultimately the whole territory should present a regular and unbroken system of sub-division, yet the advance lines should be designed in such a way that the sub-division may have a very irregular front, stretching forward in some places and keeping back in others, but always connected. With Meridians 180 miles apart, the front of the system can practically only advance by sections having this very wide frontage, because base lines have to be run through from one Meridian to the next.

Another heritage received from the prairie and now a disadvantage, is the system of laying out roads in the original survey along the section lines. In the prairie this worked equitably, but in the woods such lines are never suitable for the location of roads.

In sub-division sufficient lines are not run. It would be much better to establish the lines around every section of a mile square instead of, as at present, omitting some of them.

Among the broader questions is whether six miles is a good size for a township, and 160 acres for the unit of sub-division. In both these Canada copied from the United States.

There is much to be said in favour of having the sides of townships an even number of miles, and not so many hundred chains, but the interior lines should be dependent only on the best area for the unit. In the North-West of Canada 160 acres is too small for a farm. Townships five miles square, divided into sixteen sections of 1000 acres, and 64 quarter sections of 250 acres, would in some ways be better. In such cases the base lines could be thirty miles apart.

Under the present system fifty-four miles of line must be surveyed for each township of 23,040 acres. This is one mile for every 425 acres. If all the section lines were surveyed it would be one mile for every 325 acres. With a five-mile township divided into sixteen sections of 1000 acres, it would be one mile for each 400 acres.

Some idea of the vast dimensions of the system of survey in the North-West may be obtained if we consider the number of miles of line already marked out. This amounts to 2300 miles of initial

Meridians, 14,000 miles of base lines, and in addition about 280,000 miles of township sub-division lines.

In order to extend the system as far as latitude 60deg., and there is no reason to suppose settlement will not ultimately go at least that far, there will be a total mileage of 4000 miles of Meridians, 31,000 miles base lines, more than 21,000 townships, and over a million of miles of sub-division lines. And in estimating areas from these mileages, it must be recollected that no two boundary lines are ever nearer than one mile apart.

A consideration of this enormous mileage and of the manner in which the system is marked out, would appear to justify the statement that it is unsurpassed by any similar survey in its simplicity, accuracy, and magnificent dimensions.

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Mr. J. H. CARDEW, M.Inst.C.E., said that the paper on Canadian Surveys was an extremely interesting one, if only for illustrating to us how surveyors effect settlement surveys in another part of the world. It also enabled us to make a comparison of systems obtaining in different parts of the same Empire, and in that sense the paper had an educative value, although it comes too late in the day for us in New South Wales to profit by any virtues it may possess.

The vast areas of the north-west provinces of Canada, which were practically unoccupied up to about 1870, enabled the comprehensive system we have just heard described to be adopted. The conception of the scheme was bold and gigantic, and the mode of its delineation scientific, but whether it is economically sound is another question. It appears to me that if confined to prairie lands of uniform quality and topography, and where the unit of 160 acres is what we call a "living area," the system is an ideal one. But when it is extended to mountains and swampy regions, the subdivided squares may contain all mountainous or all swampy lands, which no farmer would occupy, so that a great deal of the subdivided land would be of no value for settlement.

The system that obtains in this State, although anything but scientific and full of accumulated errors and discrepancies, is, on the other hand, more economical, as the farms are laid out with some reference to water supply and road access, and generally may contain some inferior mountainous or swampy land—the former being useful to the farmer for cattle camping grounds and such like, and the latter as a stand-by in droughts. Hence all the land is made use of in some way. The Canadian system must be disastrous to good road-making, as the road lines appear to conform to the meridian lines irrespective of the topography. Finding some difficulty in following the author in his description of the "jog" on the rectification lines, I prepared a diagram on a large scale, illustrating a strip of country between two meridians 24 miles wide, and I have calculated and delineated the extent of the "jog" at intervals of 72 and 144 miles from the initial meridian on the right hand, which I exhibit now for the information of members.

In the United States they have adopted a somewhat similar system, but without the "jogs," making the meridian lines continuous between parallels.

The so-called squares or rectangles in the Canadian system are only such as regards the angles, the northern and southern boundaries of each rectangle being unequal, and the areas of the farms varying, some being more than 160 acres and some less.

The work of laying out the meridians and parallels appears to be of a very arduous and monotonous character, in which the surveyor is completely isolated from the world. A great deal of our work in this State has had similar drawbacks, but our climatic conditions are so greatly superior that I doubt if we should ever be tempted to leave sunny Australia.

I beg to move a vote of thanks to the author.

☐ The PRESIDENT said that he did not consider the Canadian system as expounded in that paper a suitable one. The only portion of the State in which it might be utilised would be in the Western division. It certainly would not be advantageous in the rougher parts of the country, and it was very doubtful if any system which ignored natural features was a good one. The jog, which made its appearance every now and again, was a bad feature and would be confusing. As Mr. Cardew had said, the American system avoided this jog and ran the meridians right out in all cases, the only result being that square blocks were not square, a circumstance which was of small importance so far as the shape of the land was concerned.

The discussion was adjourned to the next General Meeting.

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### **Mr. Thomas Kennedy, Assoc.M.Inst.C.E.**

WE note with pleasure that Mr. Thomas Kennedy has been appointed Engineer in charge of Railway and Tramway Surveys.

Mr. Kennedy was educated at the Sydney Grammar School, and entered the public service in 1877. He has been engaged in railway location for thirty-two years and for about two years in railway construction, as Assistant Engineer. He has made a large number of important surveys, not the least of which is the present deviation, avoiding the great Zig-Zag from Clarence Siding to Lithgow, where he succeeded in obtaining a gradient of 1 in 90 for the whole distance, in place of the old, steep line. The new route effects a saving in train time of about half-an-hour, gives greater load efficiency, and improves safety in working. For the past five years Mr. Kennedy has been engaged in exploring and reporting on proposed extensions of railways and tramways. His survey of the Spit to Manly tramway proved an interesting piece of engineering, the ascent from the Spit requiring skilful development in order to secure the ruling gradient.

Readers of this journal are aware of Mr. Kennedy's long connection with the Institution of Surveyors and of his many valuable contributions to the literature of railway location. In view of his meritorious services, members will join with us in congratulating him and wishing him every success in his appointment.

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### **Mr. R. T. McKay, Assoc.M.Inst.C.E.**

WHILE offering Mr. McKay our sincere congratulations on the important appointment which he has received as Assistant Hydraulic Engineer for Queensland, we cannot but regret that this State should lose his services and the Institution of Surveyors a Councillor of many years standing.