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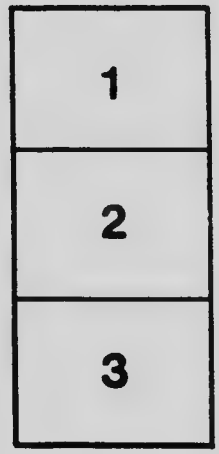

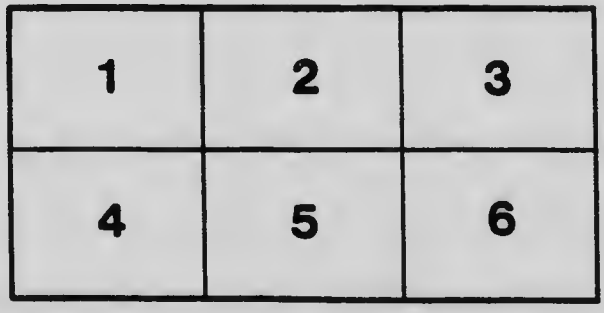

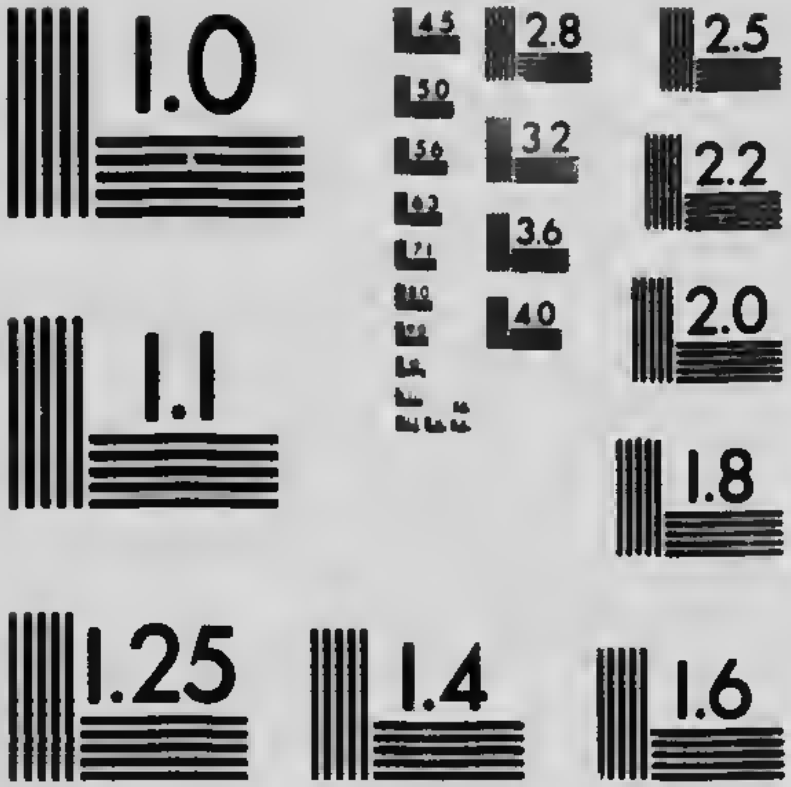

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OBSERVATORIES IN CANADA

BY

OTTO KLOTZ, D Sc., LL.D.

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OBSERVATORIES IN CANADA

By Otto Klotz

OVER a year ago I prepared and published a brief paper with the above title, and believed at the time, due to my researches in the Public Archives here, that Toronto and Quebec were the only places that had observatories of half a century ago or more. By mere chance I have learned that in early days an observatory was built at Fredericton, and also one at Kingston—the one at Montreal had not been considered, for it was a purely meteorological one originally. For these three the following data after much search and correspondence have been collected, although they are not as complete as was desired.

Fredericton.—In September, 1840, Dr. William Brydone-Jack came to King's College, Fredericton, as professor of Mathematics and Natural Philosophy. Through his efforts an observatory, a modest building, was built in 1851.* "Its fine equatorial telescope, by the famous Merz and Son, was for some time the best in British America, and the other accessories were then regarded as quite up to date. The many hundreds of careful observations that the Doctor took showed that astronomical work was to him a labour of love. Soon after the observatory was built he made practical use of the lately established line of electric telegraph, and by exchange of signals with Professor Bond of Harvard University he established the true longitude of Fredericton. He afterwards ascertained the exact longitude of Saint John and of Quebec."

It is strange, most strange, that neither at Fredericton nor at Harvard are any records to be found showing that observations had been made, as well as connection by the electric telegraph, for determining the difference of longitude between the two places, although such a determination was made in 1851 between Cambridge (Harvard) and Halifax. The Quebec observatory files show letters from Prof. Jack, King's College, Fredericton, dated July 27, October 10 and Nov. 21, 1855, replying to inquiries by Lieutenant

*W. O. Raymond, Trans. Royal Society Canada, Sec. II. p. 107, 1918

E. D. Ashe, Director of the Quebec observatory, respecting the operations for determining the longitude of Fredericton by telegraphic connection with Harvard College Observatory, and giving the mode of observing, transmitting and receiving signals, instrument used, etc., but no mention is made of the results of these determinations.

Jack sends Ashe the longitude of Fredericton as: $4^h\ 26^m\ 33^s.43$. and their mean difference, Nov. 14, 15, 16, 1855, Quebec-Fredericton $0^h\ 18^m\ 15^s.14$.

Hence longitude of Quebec (Mann's Bastion, Citadel) $4^h\ 44^m\ 48^s.57$.

This value is $^s.45$ less than that obtained in 1857 directly between Quebec and Harvard whose difference was found to be $18^s.32$,

Harvard being taken as $4^h\ 44^m\ 30^s.70$.

In a letter, Aug. 23, 1855, by Lieut. Ashe to the officers of H. M. Ordnance, he says: " . . . . . and that Professor Jack has also determined the longitude of Fredericton by galvanic signals," but no dates are given when this was done. From what precedes, it would appear that the observations for longitude of Fredericton with Harvard were made in 1855.

It was considered interesting to make a comparison between the original longitude determination of Fredericton and that made by the Dominion Observatory in 1908 by the most modern instruments (transit micrometer) and methods. It is obvious that we must not use the above value of $4^h\ 26^m\ 33^s.43$, for that involves the longitude of Harvard (before cable determination), but, instead the difference Fredericton-Harvard, and add (subtract) this to the modern value of Harvard.

In a letter, October 19, 1857, by Professor W. C. Bond to Lieut. Ashe the longitude of Cambridge (Harvard) is given as $4^h\ 44^m\ 30^s.70$; now, assuming that this is the value used for Fredericton two years before, we have for the difference Fredericton-Harvard $0^h\ 17^m\ 57^s.27$.

The present accepted longitude of Harvard is $4^h\ 44^m\ 31^s.05$, hence the longitude of Fredericton, based on the 1855 difference, would be $4^h\ 26^m\ 33^s.78$. This is for the observatory at King's College.

Our astronomic station of 1908 was not at this observatory, but in the city, near the water front, not far from the corner of Regent and Campbell streets. The actual difference between the two points of observation as communicated to me by the City Clerk of Fredericton is: our station north of the observatory 3,810 feet, and west 2,150 feet, the latter equivalent to 30.45 seconds of arc, or 2.03 seconds of time. Applying this difference to the 1855 value we obtain the reduced longitude of Fredericton as $4^h\ 26^m\ 35^s.81$. This value should be in agreement or very close agreement with our 1908 value of $4^h\ 26^m\ 33^s.56$. However, a difference is found of $2^s.25$, *i.e.*, $1908-1855=-0^h\ 00^m\ 02^s.25$.

The Observatory at Kingston

It would appear that the impulse to erect an observatory in the public park at Kingston, was due to the interest aroused in astronomy by the annular eclipse of the sun on May 26, 1854, which was observed at Kingston by Lieut. Col. Baron de Rottenberg with a Dolland $2\frac{1}{4}$-in. objective, $3\frac{1}{4}$ ft. focal length; and by Fred J. Rowan with a Troughton & Simms small telescope attached to a transit theodolite. The observations were made contiguous to Murney's tower. The mean time was obtained from several double altitudes of the sun, and watches " a description to be depended upon, with a probable error of 3 or 4 seconds."

(The above data are found in "The Canadian Journal", Vol. III, p. 177, in the March number for 1855).

Before continuing the story of the observatory, to preserve chronological order, we give the essentials of a communication of Dr. James Williamson of Kingston to the Editor of the "Canadian Journal" and which appeared in the November number, 1854. The article was on the longitude of Kingston. "Eclipses of the sun, it is well known, afford one of the most accurate means of determining the longitude, independently of such means as telegraphic communication with an observatory, the longitude of which has been already ascertained. The longitude of Kingston, as deduced from two eclipses of the sun, and one transit of Mercury, the time being taken from a carefully regulated clock, the pendulum having a wooden rod, is as follows:

By eclipse of sun, April 25, 1845	76° 32′ 45″
By eclipse of sun, May 26, 1854	76° 32′ 59″
By transit of Mercury, May 8, 1845	76° 31′ 45″

Another eclipse, May 6, 1845, the time being taken from a carefully regulated watch, gave 76° 31′. The mean of these observations, 76° 32′ 07″.25 W., may therefore be considered as the longitude of Kingston, very nearly.

A lunar distance, worked out from observations with two instruments only, and which may be rejected except as an approximation, gave 76° 30′. The mean longitude, deduced from twelve observations of immersions and emersions of Jupiter's satellites, a compartively imperfect mode of its determination, gives 76° 31′ 17″.....

The limit of error in the above mean of 76° 32′ 07″.25, is, in all probability, not more than a third to a half of a statute mile. I do not know how far the longitude and latitude of Toronto may be considered as ascertained."

In April, 1855, a special committee was appointed "for the special object of carrying out effectively the contemplated design of erecting an observatory, and obtaining a good telescope (and perhaps other instruments) in connection with the park".

Especially through the efforts and contributions of Baron de Rottenberg, Professor Williamson, Judge Burrowes and Dr. Yates an equatorial of 6¼-ins. was bought for $800 from Mr. Clark of Cambridge, Mass. The equatorial was received in the autumn of 1855, and was set up and adjusted on its pedestal under the dome of a small tower erected in the park in the spring of 1856.

In the following year, February, 1857, Lieut. E. D. Ashe observed at Kingston, near the new Court House, for the difference of longitude by the electric telegraph between Kingston and Quebec. The difference was found to be $0^h\ 21^m\ 05^s.50$, the longitude of Quebec, which had been connected with Harvard, $4^h\ 44^m\ 49^s.02$, thus giving the longitude of Kingston as $5^h\ 05^m\ 54^s.52$. In 1905 the longitude of Kingston was determined by the Dominion Observatory and found to be $5^h\ 05^m\ 52^s.864$. The place of observation for the latter is not the same as for the former, being on the Royal Military College grounds -- Point Frederick, about 200 ft. from

Cataraqui Bay Scaling from the city map the former is west of the latter 5,300 feet, or 72.8 seconds of arc, or 4.85 seconds of time. Applying this to the 1857 value, remembering that it rested on Quebec, and Quebec in turn on Harvard whose longitude was then taken at $4^h\ 44^m\ 30^s.70$, while the improved value is $^s.35$ greater, that is, $4^h\ 44^m\ 31^s.05$, it follows that the Kingston 1857 value based on the latter Harvard longitude, together with the above reduction of $4^s.85$ gives us Ashe's longitude for our 1905 station as $5^h\ 05^m\ 50^s.02$ or $2^s.84$ less than the definitive 1905 value of $5^h\ 05^m\ 52^s.86$.

In 1858 a series of observations was made on Donati's comet and published by Dr. Williamson. An application was made to Parliament for a grant in aid of the objects of the observatory. An annual grant of $500 was obtained in 1860, and the succeeding years. By its assistance the late observatory building in the city park was erected at an expense of about $1,400. The purchase of a transit circle and standard sidereal and mean time clocks, such as are necessary for a fully equipped observatory (costing at least fully $5,000) being wholly beyond the means of the friends of the institution, a small transit by Simms was purchased in the mean time (1863) for $180, and the loan of a larger instrument called the Beaufoy transit was obtained (March, 1864) by application to the Royal Astronomical Society, London, England.

The situation of the observatory in the city park was for various reasons unsuitable for carrying on useful work, and in consequence the observatory and instruments were moved to a small but neat observatory structure in the rear of the College, Queen's, in 1881.

The observatory suffered in 1909 a third location—its present location—being near the southwest corner of University Avenue and Stuart Street.

Montreal.—The observatory here, on the campus of McGill University, is chiefly concerned with meteorological work and is one of the chief reporting stations of the Meteorological Service of Canada. The original building, erected in 1862 and occupied in 1863 by Dr. Chas. Smallwood, consisted of a basement, one story and the beginnings of a small tower and was erected at a cost of $3,000. Smallwood's meteorological observations had hitherto been carried on at St. Martin, Isle Jesus, nine miles west of Montreal, and dated back as far as 1849. It was only after the

acquisition in 1879 by donation from Charles Blackman of an equatorial telescope of 6¼-ins. aperture and 7 feet focal length that astronomical work was entered upon more especially by the installation at the same time of a Howard mean time clock, and a 3¼-in. transit, 42 in. focus, by Jones & Sons; London; also a sidereal clock was mounted. Henceforth time was furnished to the city and to the Harbour Commissioners, as well as to the various railroads centering in the city.

The first determination of the longitude of Montreal by the use of the electric telegraph was on the night of March 12, 1857, when Lieut. E. D. Ashe made a connection with the Quebec Observatory in the citadel. The point of observation in Montreal was the gardener's tool house in Viger Square. The difference of longitude was found to be $9^m\ 22^s.70$, which gave for the longitude of Montreal, Viger Square, $4^h\ 54^m\ 11^s.72$, based on the longitude of Quebec as $4^h\ 44^m\ 49^s.02$, and that in turn on Harvard as $4^h\ 44^m\ 30^s.70$. In 1883 a longitude campaign between Montreal, McGill Observatory, and Harvard was successfully carried out by Professors W. A. Rogers and C. H. McLeod, giving the longitude of the former as $4^h\ 54^m\ 18^s.543 \pm {}^s.045$ dependent upon Harvard Observatory (dome) of $4^h\ 44^m\ 30^s.993 \pm {}^s.041$; in 1892 a trans-Atlantic longitude campaign between Greenwich and Montreal with the intervening cable stations Waterville and Canso was undertaken and completed by Professor H. H. Turner and C. H. McLeod, Otto Klotz and H. P. Hollis. The resulting longitude of Montreal, McGill Observatory, was $4^h\ 54^m\ 18^s.62 \pm .024$. This latter value was communicated to the writer by the Astronomer Royal in a letter of 17 April, 1905.

In the U.S. Coast and Geodetic Survey Report for 1897 an adjustment is made of the longitude net of the United States by C. A. Schott, into which enters the longitude of Montreal, which is adjusted to $4^h\ 54^m\ 18^s.634$, a value slightly larger (by $^s.014$) than the value furnished by the Astronomer Royal.

It may be observed here that the latter adjusted value for Montreal (McGill) was used for the definitive longitude of Ottawa (the old Cliff-street Observatory) $5^h\ 02^m\ 50^s.022$, and on the erection of the Dominion Observatory (occupied in 1905) the value carried to the latter by observations between the two Ottawa obser-

vatories, when the value for the Dominion Observatory was found as $5^h\ 02^m\ 51^s.983$.

It will be interesting now to make a comparison between the 1857 value and that of 1897, forty years later. Lieut. Ashe connected Montreal with Quebec telegraphically on March 12, 1857, obtaining a difference, signals both ways, of

	h	m	s
Difference Quebec Observatory-structure Viger Square	0	09	22.70
Longitude of Quebec from Harvard Observatory connection	4	44	49.02
Hence longitude Montreal (Viger Square)	4	54	11.72
The Harvard longitude in 1857 was taken as	4	44	30.70
The Harvard longitude in 1897 was taken as	4	44	31.05
Hence Viger Square would become	4	54	12.07
Point of observation in Viger Square to McGill Observatory, difference in longitude 6145 ft			5.75
Hence McGill Observatory deduced from Ashe's 1857 obser's	4	54	17.82
McGill-Harvard campaign of 1883 gave	4	54	18.54
Difference 1883-1857 determinations	0	00	00.72
Difference 1892-1857 determinations	0	00	00.80
Difference 1897-1857 values (1897 adjusted value)	0	00	00.81

These differences of about three-quarters of a second are quite satisfactory remembering that they involve two telegraphic links, Montreal-Quebec and Quebec-Harvard, when longitude by telegraph was in its infancy, besides the link from Viger Square to McGill Observatory, although the length of this last link is believed to be confined to the accuracy of the scaling on the Montreal city map. The linear measure was furnished by the survey department of the city engineer's office who was fortunate in locating within a few feet the place of observation in Viger Square in 1857.

In 1907 the observatory at McGill was supplied (from government funds) with a Riefler astronomical clock with invar pendulum and air-tight case; this, with a modern Troughton & Simms astronomical transit, fitted with micrometer eyepiece, electrically recording on a chronograph, furnishes ample means for the accurate determination of time, which is at present the only astronomical function carried out by McGill Observatory.

It may be interesting to add the longitude determinations made by Lieut. Ashe in 1857, by means of the electric telegraph which at the time was something new in its application to astronomy. The

following extracts are taken from the Report of Progress for the year 1857, Geological Survey of Canada of which at the time Sir William E. Logan was director, while Sir Edmund Walker Head was Governor-General of British North America. The longitude differences by telegraphic circuit were all with Quebec, which in turn had been similarly connected with Cambridge Observatory (Harvard).

	h	m	s
Cambridge Observatory longitude as communicated by Professor W. C. Bond	4	44	30.70
Difference of longitude, Quebec, Mann's Bastion, Citadel, and Cambridge Observatory	0	00	18.32
Mean of signals, both ways, September 21	0	00	18.26
Mean of signals, both ways, October 9	0	00	18.38
Hence longitude Quebec Observatory	4	44	49.02
Difference longitude, Toronto, Magnetic Ob. and Quebec, mean of signals, 44.51s. and 44.31s., both ways, January 17	0	32	44.41
Hence longitude Toronto Magnetic Observatory	5	17	33.43
Difference of longitude, Kingston, near Court House, and Quebec, mean of signals (05.60s. and 05.39s.) both ways, Feb. 20	0	21	05.50
Hence longitude, Kingston	5	05	54.52
Difference of longitude, Montreal, Viger Square, and Quebec, mean of signals (23.01s. and 22.38s.) both ways, March 12.	0	09	22.70
Hence longitude, Montreal, Viger Square	4	54	11.72
Difference of longitude, Chicago (playground of the school situated to the northward of the Roman Catholic Church, Huron Street) and Quebec, mean of signals (41.44s. and 41.60s.) both ways, May 15	1	51	41.52
Hence longitude, Chicago	5	50	30.54

In the text Ashe writes, p. 235: "Chicago being placed on some charts, in a longitude differing by upwards of forty miles from that on another, it was of the greatest consequence before making a map of Canada, that the right position of Chicago should be ascertained." From this it would appear that Chicago first learned where it actually was from Canadian observations! Continuing:

"The electric current was transmitted via Toledo, Cleveland, Buffalo, Toronto and Montreal, a distance of 1,210 miles, by one entire connection between the two extreme stations, and without any intermediate repetition, and yet all the signals were heard distinctly at either end of the line; the signals occupied only .08 of a second in passing along that distance."

	h	m	s
Difference of longitude, Windsor (20 yards westward of Court House) and Quebec, mean of signals (19.04s. and 18.97s.) both ways, August 18	0	47	19.00
Hence longitude of Windsor	5	32	08.02
Difference of longitude, Collingwood (railway terminus) and Quebec, mean of signals (01.43s. and 01.59s.) both ways, Sept. 1	0	36	01.51
Hence longitude, Collingwood	5	20	50.53
Difference of longitude, Ottawa (120 yards east of flagstaff on Barrack Hill) and Quebec, mean of signals (59.24s. and 59.30s.) both ways, November 14	0	17	59.27
Hence longitude of Ottawa	5	02	48.29

Barrack Hill referred to, is what we now call Parliament Hill. The position of the flagstaff we know fairly accurately, for the flagstaff of 1857 was replaced by another and it in turn was removed from the knoll which it occupied for the present statue of Queen Victoria. From Brophy's plan of the city of Ottawa on a scale of 800 ft. to the inch, showing the position of the buildings, monuments, etc., on Parliament Hill it is found that the position of the old observatory on Cliff Street is 1,340 ft. west of the old flag staff, hence 1,340 ft. plus 120 yards or 1,700 ft. west of the astronomic station of 1857, equivalent to 1ˢ.59.

	h	m	s
Hence position Cliff Street Observatory deduced from 1857 observation is	5	02	49.88
Cliff Street Observatory 1896 determination	5	02	50.02
Difference 1896-1857	+ 0	00	00.14

In continuation of my former paper, the following two letters have been furnished me by Dr. A. Shortt, Chairman of the Board of Historical Publications, Public Archives, Ottawa.

Q. 394-1.
p. 140.

TORONTO, UPPER CANADA
13th January 1836.

My Lord,

The recall of His Excellency Sir John Colborne having arrived here at the same time with the accompanying registered N°. 361 letter to your Lordship rendered it impracticable for me to obtain His Excellency's promised support to the views of my brother.

Being conscious that my brother is perfectly capable of undertaking the office he is desirous to obtain, and naturally anxious that he should return to the service of his native country, has emboldened me to for ward his application for your Lordship's consideration.

I have the honour to be
My Lord
Your Lordship's
Most obedient Servant
R. H. Bonnycastle
Capt[n]. Royal Engineers.

The Rt. Honb[le]. Lord Glenelg &c &c &c

Endorsed—1836 Jan[y]. 13 Capt Bonnycastle, R.E. in behalf of his brother whose Memorial he encloses—for the place of Astronomer in U. Canada.

Q. 394-1.
p. 141.

UNIVERSITY OF VIRGINIA
Dec[r]. 22[d]., 1835.

My Lord,

His Excellency Sir John Colborne having been good enough to inform me that it is the intention of the British Government to appoint an Astronomer in Upper Canada, and having with great kindness, expressed himself in favour of an application on my part, I have been induced to present myself as a candidate for the situation.

The emolument of my present Professorship, £1100 a year, seems to be considerably greater than the salary proposed, but as the office is under the Government of my own country, and is expressly created for the advancement of objects to which I have dedicated my whole attention, I should not hesitate about the sacrifice of a few hundred a year.

The recent suggestion of the British Association for the Promotion of Science, —to erect in various parts of the world, observatories for making magnetic and meteorological observations may probably have been the occasion of the appointment contemplated. Proceeding on this belief, I (p. 142) have thought myself not altogether unqualified for the station. Educated by the Admiralty for mathematical pursuits nearly connected with that branch of the service, and long devoted to the study of magnetism, I succeeded about a dozen years since in first developing the theory since further completed by Poisson & others. The notice which my publication of this theory attracted and the instant adoption of it by so competent a judge as Professor Barlow of Woolwich, leads me to suppose that I should be regarded as qualified to pursue this important branch of an observer's duties. With respect to the purely astronomical department I must appeal to the accompanying certificates. Constantly employed in this University in teaching the highest branches of the theory of Astronomy, and assisted in the practice by the command of a small observatory furnished under my directions with a few excellent Instruments I have possessed the opportunities necessary for acquiring a proficiency in this subject.

For testimonials of a more general character—I appeal to Professor Barlow of Woolwich—to the Work in Geometry which I have published in this Country, and to the accompanying papers; the latter of which will go to prove that in the offices (p. 143) of Professor of Natural Philosophy, Professor of Mathematics and Chairman, I have received whilst at this University, the full approbation of those whose duty it was to scrutinize my conduct. The fact that in an Institution

where the reputation of the Professor is allowed to govern the size of his school, my classes have always been among the largest, and of late years have been very far the largest, will I trust also support my pretensions.

Should these be thought sufficient to justify the acceptance of my tender of service, your Lordship by bringing me again under the dominion of my native country, of which I have, & shall always continue a subject, will gratify an ardent desire, but if some other person should on the contrary be found better entitled to the situation, I must request you to receive my assurances of the respectful feelings with which I shall acquiesce in your Lordship's decision.

I remain

Your Lordship's

Very obed^{t} humble Sert.

C. Bonnycastle.

The R$^{t.}$ Hon^{le}
Lord Glenelg
&c &c &c

Endorsed—1835. December 22.

M. Bonnycastle Professor of Astronomy in Virginia, wishes to be Astronomer in U. Canada.

No appointment was made and it was just half a century later—1885—when the word Astronomer was for the first time officially used by the Dominion Government on the initiation of astronomic work along the Railway Belt in British Columbia.

In a letter of October 21, 1836, by the Astronomer Royal, G. B. Airy to Mr. C. Wood, Secretary to the Admiralty, the contents of six boxes containing the instruments received (inspected and repaired) from St. Helena, are given. These were the instruments that the Admiralty was prepared to send to Upper Canada (Toronto) if Upper Canada would meet the necessary expenses of installation, but the provincial finances were at the time unsatisfactory so that nothing was done.

An abstract of the principal parts of the above contents may be interesting: A mural circle of 4 feet diameter; 6 micrometer microscopes, two of the microscopes have diagonal eye-pieces, and other accessories; observing chair; clock by Barrand, dead beat escapement; telescope 4½ inches aperture, and length 6 feet, one erecting and three astronomical eye-pieces, one dark glass, and a single wire position micrometer with two eye-pieces; and stand for telescope "admitting of nice motion by two screws, but perfectly steady. The telescope cannot however be raised to the zenith".

OTTAWA, DOMINION OBSERVATORY
MAY 27, 1919