By means of the zenith telescope (to which I shall hereafter refer) I can now test the divisions of any bubble-tube with ease and accuracy, and I expect to be able to furnish you with the results in a week or two.

Meridian Mark.—A north meridian mark was erected near the Wadestown Road, on the 27th October, 1882, a little over two miles north of the Observatory. It consisted of an ordinary trig. pipe, in which a carriage-lamp was fixed for night observations. From various observations it appeared that this mark was about 4 inches west of the true meridian, so, on the 4th May last, another pipe was put in 8 inches east of the first one, and the true north point is now supposed to be midway between the two trig. pipes. At the same time, a north meridian mark was erected for the zenith telescope, at 11·27 links east of the transit instrument meridian mark, as that is the distance between the two instruments in the Observatory. During the winter the smoke over the City of Wellington prevented the north meridian mark from being observed, except at rare intervals; besides which the north meridian mark did not show against the sky, which was a great drawback. It was therefore necessary to erect a south meridian mark on a spur near Island Bay, about three miles south of the Observatory, and this was done on the 6th July, at which time a south meridian mark for the zenith telescope was also erected. These marks are both painted black, and show out in bold relief against the sky. The south meridian mark for the zenith telescope serves a double purpose, as it is very convenient for finding the error of collimation of the transit instrument. Both north and south marks are at an altitude of 40′, when viewed from the Survey Observatory on Mount Cook.

The Zenith Telescope.—This is the first instrument of the kind that has been used by the Survey Department of New Zealand for the determination of latitudes, and its use for that purpose, according to Captain Talcott's method, gives better results than can be obtained by any other portable instrument. The one in use at Mount Cook Observatory was made by Troughton and Simms, with all the latest improvements. The telescope has an aperture of $2\frac{1}{2}$ inches, and a focal length of 29 inches, two short eyepieces, with magnifying powers of 37 and 51, and a diagonal eyepiece with a power of 37. The micrometer screw carries a movable wire for the measure of the difference of zenith distances; its head is divided into 100 parts, of which tenths may be estimated. The whole number of turns are read off by means of a rack shown on the side of the field of view. There are also five fixed vertical wires, about $3\frac{1}{2}$′ apart, so that the instrument can be used as a transit instrument when required. The horizontal circle is 10 inches in diameter, graduated to read to 10″, and the verticle circle is 6 inches in diameter, and is also graduated to read to 10″. One division of the level = $1\frac{1}{3}$″ and one revolution of the micrometer = 70″. The micrometer screw has an extreme range of 105′ or 1° 45′, and may be safely used over a range of at least 1°. In America the instruments used are generally of the following dimensions, viz.: Aperture, $3\frac{1}{2}$ inches; focal length, 45 inches; magnifying power, from 60 to 120. One division of the level = $\frac{3}{4}$″, and one revolution of the micrometer = 45″, and it is not considered advisable to use the micrometer over a greater range than 15′ or 20′. It will thus be seen that the American instruments have a much higher magnifying power, the level is more sensitive, and the micrometer has a slower motion, all of which conduce to the more exact measurement of an observation. On the other hand, the English instrument has a much greater range, besides being much more portable. On the whole, I consider the English instrument the most useful, and also calculated to give the best results, owing to the fact that many pairs of stars can be observed with it that are beyond the range of the American instrument. It must also be borne in mind that there is very little advantage in having an instrument with facilities for reading off an observation with very great accuracy, unless the observation itself can be made with nearly the same degree of accuracy. For instance, if an observer cannot observe an angle nearer than, say, 1′, it is not of much advantage to him to be able to read off his angle to 1″. As it has been proved that the average error of observation with the zenith telescope is about half a second of arc (owing to atmospherical disturbances and the difficulty of perfectly bisecting the star), it will be seen that the English instrument, by which an observation can be read off to a much smaller quantity than this, is amply sufficient for all practical purposes.

I will now give some details relating to the zenith telescope in use at Mount Cook Observatory. The value of one division of the level was ascertained in connection with the micrometer screw, by means of 216 observations to a distant terrestrial mark, and found to be = 1·303″. The bubble-tube seems to have been ground internally with great care, as its indications have always been very regular. As the differences of zenith distance are measured by the micrometer, it is in the first degree important to ascertain with the greatest accuracy the value of one revolution of the micrometer. I have therefore taken 440 observations of κ Octantis at its eastern elongation, and 420 observations of ζ Octantis at its western elongation, making in all 860 observations, and the mean of all these observations gives 70″·174 as the value of one revolution of the micrometer, with a probable error of $\pm$ 0″·004. Taking a range of the micrometer screw = one degree, this probable error would amount to 0″·2 or $\frac{1}{5}$ of a second of latitude. This is an extreme case; but, on the other hand, any small error in the estimated value of the micrometer screw be may eliminated by selecting the pairs of stars, so that the positive corrections may be equal to the negative corrections. But the most practical test, after all, is, what work does the instrument turn out? And here I am happy to inform you that the results obtained by this instrument seem quite equal in accuracy to those obtained in America and elsewhere.

I forward herewith a tabulated statement of the results obtained from the observations of ninety-nine pairs of stars, from which you will see that the resulting latitude of Mount Cook Observatory is 41° 18′ 0″·59, with a probable error of 0″·05, or only 5 feet when marked on the ground.

I have, &c.,

C. W. Adams,

Geodesical Surveyor.

J. McKerrow, Esq., Surveyor-General.