then as it is now, and M. de Turenne devoted himself rather to shooting in mountain districts than to climbing pure and simple, though he nevertheless made no small number of ascents, especially in the Pyrenees. In 1875, being then seventy-two years of age, he reached the summit of Mont Blanc. He was one of the founders of the French Alpine Club, and was a member of the Direction Centrale till his age forced him to retire, when he was unanimously elected an honorary member. He was regarded as the *Doyen* of French mountaineers.*

CORRESPONDENCE.

THE HEIGHT OF K_2.

To the Editor of the ALPINE JOURNAL.

13 Cromwell Road, London, S.W.: December 11, 1893.

SIR,—My attention has been recently drawn to the article 'Karakoram Mountain Survey Expedition-Altitudes' in your Journal for last November. It is there stated that the height of the mountain K_2 is 27,750 feet, as measured with a theodolite by Mr. W. M. Conway from his so-called Junction Camp, of which the height was determined by observations, on five days, with a Casella's Boylean-Mariotti mercurial barometer, which had been reduced by comparison with barometric readings at Leb and at Gilgit. It is added in a foot note that the height previously ascribed to K_2 was 28,278 feet.

I would ask permission to point out that the height previously ascribed was derived from the operations of the Great Trigonometrical Survey, by independent observations from nine stations of the Kashmir Principal Series. This is shown in Synoptical Volume No. 7 of the account of the operations of the Survey. It is highly improbable that the mean of these nine independent determinations can be as much as 50 feet in error, and ridiculous to suppose that the error can be as great as 528 feet. This gross discrepancy between Mr. Conway's results and those of the Indian Survey shows clearly that there must be some error in his determination; and this error is probably due not to any error in his observations, but to the unreliability of a few days' barometric readings for the deduction of exact determinations of height.

The height of Mr. Conway's Junction Camp, as determined barometrically, is given as 15,870 feet; its distance from the mountain is shown by his map to be only 11½ miles, so his trigonometrical determination of the height of the mountain above the camp is not likely to be materially erroneous. But at the height of the camp an uncertainty of one inch in the barometric pressure causes an uncertainty of 1,500 feet in height; thus an error of only one-third of an inch in

* We are indebted for these facts to the kindness of our colleague, Monsieur Charles Durier.

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the barometer, such as is very liable to be caused by irregular fluctuations of pressure, would explain the discrepancy which has been met with.

Mr. Conway seems to have taken much pains to obtain data for the correct determination of heights from his barometric observations. There is a Government meteorological observatory at Leh, about 150 miles as the crow flies from his Junction Camp, where the barometer is read four times daily and twenty-four times on one day of each week; there was also a temporary observatory at Gilgit. He very properly reduced his own observations by combining them with the simultaneous observations at Leh and also at Gilgit, and more than this he could not have done. But the trustworthiness of the height thus deduced rests on the assumption that the barometric variations occurring simultaneously at the observing stations are of identical magnitude and direction relatively to the mean yearly values. Now though this assumption is occasionally true, and then accurate results are obtained, it certainly is not always true, and it is not to be expected when the local surroundings of the stations are as different as they are in the present instance. Leh is 11,300 feet high, in a comparatively level plateau with only low hills around; Junction Camp is 15,870 feet high, in a narrow valley with mountains rising 10,000 to 12,000 feet above it; Gilgit is only 5,000 feet high, and is very much more open than Junction Camp. One has no right to expect that the fluctuations of barometric pressure at places so differently circumstanced would be constantly identical.

It is generally so much more easy to take barometer readings at any place than to carry a chain of triangles to it, for the purpose of determining its height, that attempts have been made in Himalayan topographical surveys to obtain several additional heights barometrically as a supplement to the trigonometrical determinations. The barometers were read and compared with a barometer set up for constant reference at one of the stations; they were also read as a check at some of the trigonometrical stations. But the results were very irregular, sometimes good, but occasionally 500 feet or more in error. Consequently, the barometric heights are shown on the maps in different symbols from the trigonometrical, being much less reliable.

Trigonometrical determinations are liable to error from uncertainty as regards the correction for refraction which has to be applied to the observed vertical angles. The value of the coefficient of refraction is obtained from mutual observations between the principal stations of the triangulation, and when these determinations are sufficiently numerous and satisfactory—as was certainly the case in the Kashmir triangulation—the value may be relied on with great confidence. It is improbable that any one of the nine determinations of the height of K_2 can be as much as 50 feet in error because of uncertainty in the refraction.

I should here state that the name, or rather symbol, K_2 was given to the mountain in question at the first trigonometrical station at which it was observed; but it was afterwards observed at eight other stations, and several additional peaks of the Karakoram range, to

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which it appertains, were also observed. Thus, when the final reduction of the Kashmir triangulation was undertaken—on the completion of that of the great chains of the Indian Principal Triangulation, on which it is based—the symbolic numbering of the unnamed peaks was altered, to produce continuity of numbering from right to left. Thus in Synoptical Volume No. 7 of the Great Trigonometrical Survey, which was published in 1879, the peak is entered as Karakoram, No. 13. On reference to p. 189 of that volume it will be seen that the original value of its height, 28,278 feet, has been corrected to 28,250 feet; also that the discrepancy per mile in the lengths of the common sides of the triangles to the peak is 2·7 feet. The charts show that the distances of the observing stations from the peaks range from 50 to 100 miles, and thus the discrepancy in a distance of 100 miles cannot have exceeded 300 feet. These figures show that the apex of the peak was sharp and well adapted for observation on the wires of a theodolite. The mean of the nine determinations of height is given, but not the individual values, as this could not have been done generally throughout the volume without swelling it to inordinate dimensions.

Of late years the mountain has been called Mount Godwin-Austen. This name has not been universally accepted, but I notice that it is adopted in Messrs. W. and A. K. Johnston's beautiful atlas of India, which has just been published, and which, for lowness of price and elaboration of detail, is a very remarkable production.

I am, Sir,

Your obedient Servant,

J. T. Walker, General,

Late Surveyor-General and Superintendent of the G. T. Survey of India.

While acknowledging the high authority of General Walker on matters connected with the Indian surveys, I have a few comments to make on his letter. The altitudes of the apparent summit of K_2 and of the highest point of the Golden Throne above Junction Camp, as deduced from observations made with a 3-in. transit theodolite, were 11,880 ft. and 7,730 ft. respectively. These altitudes are probably fairly accurate. The mean altitude of the base (of which more anon) was 15,870 ft. K_2 therefore comes out 27.750 ft. high, and the Golden Throne 23,600 ft. If Junction Camp was 500 ft. higher than 15,870 ft., the altitudes of both K_2 and the Golden Throne must be increased by that amount (28,250 ft. and 24,100 ft.).

The mean barometric height of Pioneer Peak was 22,560 ft. The top of the Golden Throne was approximately 800 yards distant (horizontally) from the top of Pioneer Peak, and its angle of elevation, measured very carefully with a clinometer, was 25° (with a possible error of certainly not more than 1°). Pioneer Peak is thus about 1,200 ft. lower than the Golden Throne. The Golden Throne, according to this measurement, is 23,760 ft. high—a value which

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practically agrees with that obtained at Junction Camp, and which is independent of its altitude. If K_2 is really 28,250 ft. high, the Golden Throne is 24,100 ft., and Pioneer Peak must be 22,900 ft.—a value against which I at any rate cannot be conceived of as having any prejudice.

I believe, however, that Junction Camp is not higher than 15,870 ft., but, if anything, lower, and for the following reason:—That altitude is the mean of the altitudes deduced from five separate sets of barometric observations made on the following dates of 1892: August 13, 15, 16, 17, and 29, and compared with simultaneous observations made at Gilgit and Leh. The ten several values thus arrived at are respectively below or above the mean by the following number of feet: Below, 183, 181, 150, 135, 74, 46; above, 7, 27, 287, 447. Thus the values obtained are remarkably uniform, except in the case of the last two, which are deduced from the observation taken on August 29, when the worst storm that we encountered in the mountains had been raging about us (a purely local storm, by-the-bye), and when the barometer may well have been exceptionally low on the Baltoro Glacier, though it was unaffected either at Gilgit or Leh, as the records from those places prove.

There are a few points whose heights were determined both by the Indian surveyors and by me. It may be interesting to compare our values. In the case of Kargil the G.T.S. figures refer to the fort, mine to the *serai* on the hill considerably above it. I am unable to compare our values for Skardo, because I do not know the position of the station to which the G. T. S. figures belong, and it is a place of many levels.

—	Indian Surveyors	W. M. C.
	Feet	Feet
Nomal	5,500	5,340
Foot of Biafo Glacier . .	10 143*	10,120
Shigar	7,640	7,760
Kargil	8,787	9,160
Shargol	10,623	10,600

General Walker, like the officers who conducted the French survey, has a high opinion of the indisputable accuracy of trigonometrical determinations of altitude. Of course serious mistakes may arise by the confusion of two peaks seen from different points of view and the creation of a third out of them (Nagyr has its Mont Iseran); but only those who have done no practical work in the field know how difficult it is to avoid that class of error, and it is not of the kind we are now discussing. If the probable error in the altitude of K_2 cannot be more than 50 ft. out of some 28.000 (about ·18 per cent.), how small should be the error in the trigonometrically determined altitudes of the Alps, where not only are the altitudes so much less, but, in a far greater ratio, the distances of the points from which the observa-

* Determined by Colonel Godwin-Austen.

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tions for them were taken. Along the Italian frontier there are many peaks whose altitudes have been trigonometrically determined twice over and quite independently by the surveyors of the countries on opposite sides of the frontier. If K_2 cannot be more than 50 ft. out, the independent measurements of none of these Alpine peaks should differ from each other by so much as 20 ft. Such, however, is not the case. Here are a few instances; hundreds more might be adduced to match them :—

—	Swiss Map	Italian Map	Austrian New Survey	Austrian Cadastral	French Map
	M.	M.	M.	M.	M.
Monte Rosa (Parrot Sp.)	4,463	4,434	—	—	—
Cima di Jazzi	3,818	3,749	—	—	—
Schwarzberg-Weissthor	3,512	3,618	—	—	—
Mittel Pass	3,155	3,047	—	—	—
Mittelrück	3,324	3,362	—	—	—
Mont Velan	3,765	3,709	—	—	—
Col de la Goletta	—	3,120	—	—	3,063
Col de Rhêmes	—	3,101	—	—	3,062
Pointe de Calabre	—	3,276	—	—	3,363
Cimon della Pala	—	—	3,186	3,343	—
Cima di Vezzana	—	—	3,191	3,317	—
Monte Cristallo	—	3,153	3,260	—	—
Ritter Pass	2,692	2,762	—	—	—
Helsenhorn	3,274	3,239	—	—	—
Kriegalpstock	2,685	2,718	—	—	—
Grieshorn	2,926	2,966	—	—	—

Moreover such errors are not confined to points of minor importance. That excellent amateur M. Ferrand once had the temerity to point out that the French surveyors must be in error in ascribing to the Cime d'Oin an altitude of 3,514 m. What followed he thus relates :—'Le commandant Rouby, alors attaché au Dépôt de la Guerre, adressa à la Direction centrale du Club une lettre de protestation qui fut insérée dans le 4e Bulletin de l'année 1877, p. 365, et où il déclarait que la Cime d'Oin était un point géodésique, dont l'altitude exacte était 3513 m. 70 centimètres. Le Club y ajouta une note sévère à l'adresse des jeunes observateurs qui introduiraient des fautes là où il n'y en avait pas, et je fus par lettres privées tancé d'importance pour avoir osé entrer en lice avec la carte de l'Etat-Major et surtout avec les points géodésiques.'

Nevertheless the French Survey had ultimately to recognise an error of 237 mètres! It must in fairness be added that this gross error was in the calculations, not in the observations. I have recalled the story as a proof that the published results of an official survey are not always correct within 50 ft.

I am, therefore, still inclined to believe that the highest point of K_2, visible from the Baltoro Glacier, may measure approximately 27,750 ft., and less rather than more. The question arises, Has the peak a higher summit which is not visible from the Baltoro Glacier? To this the answer is that probably it has not.

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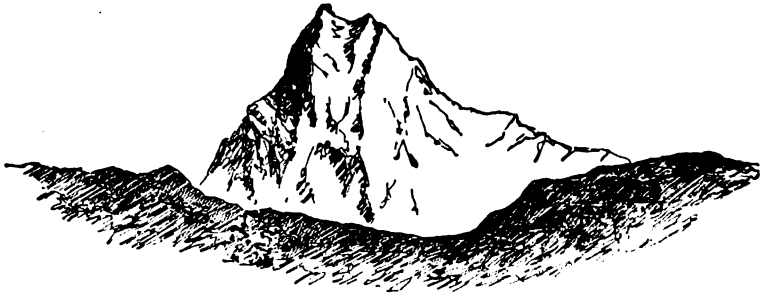
So far as I know there is only one published view of the mountain that makes any pretence to accuracy. It is on p. 370 of Drew's 'Jummoo and Kashmir' (London, 1875), and by the kindness of Mr. Edward Stanford I am enabled to reproduce it here. It has been suggested that Masherbrum is the peak depicted; but this cannot be, for Masherbrum's north face is not steep; besides, the south arête corresponds in all details with that of K_2. The view is taken from Turmik, almost due west of K_2, and at a distance of 70 miles. It shows a north point and a south point, separated from one another by a saddle, and the north point appears to be as much as 500 ft. (possibly more) higher than the south point. From the south point the south ridge drops steeply away. The summit of K_2 as we saw it, and as the photograph shows it,* consists of a ridge, gently inclined to the south and with a point at each end. If these are the north and south points, Drew's sketch exaggerates the dip between them; if they are not, then he has exaggerated the steepness of the south arête. In either case his sketch is not strictly accurate, a conclusion fully accounted for by the distance from which it was made. A comparison of the two views renders it probable that the N. and S. points (which, following



K_2 FROM TURMIK, FROM THE WEST.

Alpine custom, I should like to call the Godwin-Austen and Younghusband summits) are visible in both. If so, the point I measured is the north or Godwin-Austen point, and is the true summit of the peak.

It is, however, still just possible that a higher summit lurks behind what we saw. This can only be proved by a comparison with other views. I was recently informed, for the first time, by General Walker that several sketches of the mountain, included in profiles of the range taken from various points of view, exist in the archives of the G. T. Survey of India. Had I known of their existence when I was in India I should have taken pains to see them, and the present difficulty would not have arisen. But I was not so informed, nor indeed did I receive any help whatever from the officials of the Indian Survey. On my

* The view of K_2 is one of the illustrations drawn by Mr. MacCormick for my forthcoming book. I am enabled to introduce it here by the courtesy of Mr. T. Fisher Unwin.

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arrival in India, acting on instructions received from the Indian Government, I wrote to the heads of various departments, including the Survey, and, with the exception of the Survey, I received from all the readiest and most valuable help. The Foreign Department, the Intelligence Branch, the Botanical and Meteorological Departments, the Government of Kashmir, and the officers at all the stations I passed through gave me valuable documents, and placed every possible facility in my way. The Survey alone helped me not at all, and sent me no documents whatever. It was only after my return to England, and by the kindness of General Walker himself, that I was given access to Synoptical Volume No. 7, referred to in his letter, and the possession of which would have been invaluable to me a year sooner.

I must also point out that General Walker is not correct in contrasting as he does the surroundings of Leh, Gilgit, and Junction Camp. All three are at the bottom of holes, Leh as much as either of the others. There is no plateau at Leh, only large sloping fans making the valley-bottom broad. The place is surrounded by high peaks. Gilgit is in a deep and narrow trough.

There is one question I should like to ask. The G.T.S. altitude of K_2 is the mean of nine different sets of observations, and this fact is highly important; but how far did the various values thus obtained differ amongst themselves? Of course if the nine several values are in close agreement, their mean is almost certainly correct to all intents and purposes.

It seems scarcely necessary to add that the map given in the August number of the 'Alpine Journal' was in no sense the definitive result of my journey. It was merely the hand map produced by the Geographical Society for the meeting at which I read a paper, and has no pretensions to be more than such hand maps usually are—a production obviously executed in the roughest style for a single occasion. Some perversity was needed (I am not referring to General Walker) to mistake it for my finished map, which will be published in due course with the other results of my travels.

There were two unimportant misprints in the list of altitudes. Bari Rung should have been 13,980 ft. and Paipering Maidan 10,990 ft.

W. M. Conway.

THE TÄSCHHORN ACCIDENT.

To the Editor of the Alpine Journal.

Lincoln's Inn: December 15, 1893.

Dear Sir,—I desire, in all courtesy, to submit to you that the unsigned note, in the Journal for November, on the deplorable Täschhorn accident contains a condemnation of the guides which the circumstances do not warrant.

That condemnation appears to be based on two statements of fact—first, a statement that the spot where the travellers had to pass the night was only 'eight paces distant from two abysses,' and, secondly, a statement that Mr. Lucas is supposed to have rolled over the precipice in

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the course of his sleep. On such a place, we are told (in substance) that the travellers ought to have passed the night roped together, and that the death of Mr. Lucas was due to the contravention of a law to this effect.

Now, sir, 'eight paces distant from two abysses' (I note that you are not the author of this unhappy phrase) has certainly a fine epic ring, but in prose it only comes to this: that the *gîte* was 20 ft. long and abutted at two places on a cliff. As regards the supposition that the traveller turned in his sleep, rolled over the cliff, and was killed, I am tempted to ask, By whom is this supposed? It is not the opinion of Mr. Lucas's companion, Mr. Williamson, nor that of either of the guides, nor, so far as I can ascertain, that of any person who knows the spot in the forest where the accident occurred.

The fact is that, when the party were benighted, Adolf Andenmatten, who, as leading guide, was responsible for their safety, selected for a *gîte* a perfectly level grass plat, more than 20 ft. long and 12 to 14 ft. wide. Behind, the ground shelved, but not steeply, so they could and did lie down, with their bodies at right angles to the cliff, leaving a clear space of two to three yards between their feet and the rock face. Adolf and the second guide lay towards the south end of the plateau, Mr. Williamson in the middle, with Mr. Lucas on his right. Towards the north the cliff curved in a little, breaking away to a couloir. Between this curved edge and Mr. Lucas a considerable fire was built, so that between him and the precipice there was, first, a small space of flat turf, then the fire, and beyond several feet more of flat turf.

I venture to say that not only is there no law that in such a place a party should sleep roped, but that to do so under such circumstances is unheard of.

Mr. Lucas suffered from thirst, and had said that he would give five francs if they would get him a drink. He had then been told that this was impossible, because, though the *gîte* was an excellent place for sleeping in, it was dangerous to go walking about it in the dark, because of the precipices. He had, in fact, been specially cautioned by Adolf against doing so. Mr. Lucas may have had a fit of somnambulism; or, wandering about either in search of water or otherwise, he may have fallen over. But the object of sleeping roped is not to guard against such contingencies.

Mr. Williamson writes to me, 'The place was a perfectly safe one. Lucas could not have rolled over. Adolf was in no way to blame.'

This, and no other, is, I think, the proper finding on the above facts. But, sir, as your indictment of the guides for carelessness is calculated materially to injure Adolf Andenmatten, whose one defect, speaking with 15 years' knowledge of him, is excess of caution, I ask you, and I feel sure I shall not ask in vain, to submit this defence to the judgment of the Club.

I am, dear Sir, yours truly,

REGINALD HUGHES, A.C.

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