1903 route frequently since and *never* has it appeared even remotely feasible.

Consequently, in snow and ice, it is impossible to declare a route, *now* inaccessible, as having been equally so in 1885.

A further perusal of Mr. Williams's letter will, I trust, convince my friend of his error, noting especially the extracts from Williams's 1885 diary: '. . . *we followed the Scerscen* [*i.e.* "Ice-nose"] *route for 4 hours. We then made straight for the Fuorcla Scerscen-Bernina* . . .' Not a word about the western slopes of Piz Bernina. If conviction does not follow, in the most amicable manner we must agree to differ!

As regards the figures 3885 on the Siegfried map, so far as I can recollect we enquired (1908) from the Federal Topographical Bureau, Berne, to what point these were applied and were informed to the 'shoulder.' In any case, that important topographical feature is to be remeasured.—*E. L. S.*]

Report on Rope.

In 'A.J.' **43,** 325–9, there is published a report on tensile tests of two samples of climbing ropes by the National Physical Laboratory. One rope was made by British Ropes Ltd. and is known as 'Frost's' rope, the other was supplied by Beale and is known as 'Beale's' rope. The test results are of considerable interest to mountaineers, but the letter from Messrs. British Ropes Ltd., dated September 7, 1931, which is appended to the report and contains their remarks on the results, includes a statement capable of misleading interpretation, which I think it is necessary in the interests of mountaineers to correct. British Ropes point out that the elongation of their rope under load is much less than that of the other make of rope tested, and that, in their opinion, 'this is of some importance, as it would tend to prove that Beale's rope is of a more spongy nature than ours.'

This statement suggests to the reader that a rope having a minimum of stretch is the better rope. It is this interpretation which I wish to correct, because the reverse is true. Engineers know that a rope which has the greatest stretch must be the safer rope to use. This fact can, I think, be better realized by other readers if the following remarks referring to the two makes of rope tested by the National Physical Laboratory are considered.

It will be seen by the National Physical Laboratory tests that the 'Beale' rope had a stretch of about 16 per cent. up to the point of fracture, whereas the 'Frost' rope had only about 9 per cent.—that is to say, up to the load required to fracture each rope the Beale rope stretched nearly 80 per cent. more than the Frost rope.

This stretch is naturally not all elastic stretch. Some of it, after a certain load on the rope is reached, is permanent, and is due to the slipping of the fibres over each other and to the rupturing of the particles of the fibres. It is reasonably fair, however, to assume that the elastic stretch, although of a lower proportion than the figures given above, would, in the two makes of rope under consideration, bear about the same relation to each other as the ultimate total stretch, and that the elastic stretch of the 'Beale' rope is probably nearly 80 per cent. greater than that of the 'Frost' rope. Unfortunately, hemp rope does not retain all its elasticity after repeated loadings.

The tension in a rope due to a falling weight varies with the weight and with the stretch in the rope. If, for example, a man weighing 150 lb. fell 10 ft. clear, he would develop 1500 ft.-lbs. of energy. If he were attached to a rope rigidly anchored at one end and rigidly tied round his body at the other end, and if the rope be 10 ft. long between the anchor and his body, the rope in order not to break must be able to absorb the 1500 ft.-lbs. of energy less that which is required to compress his body. The resulting tension in this example is within the breaking strength of each make of rope (without knots), but according to the National Physical Laboratory tests the pull on the 'Frost' rope, having less stretch, is nearly 30 per cent. greater than that on the 'Beale' rope.

As the rope requires energy to stretch it, the more it stretches for a given load the greater will be the energy it absorbs and the less will be the energy absorbed in compressing the man's body. The National Physical Laboratory tests indicate that the 'Beale' rope absorbs about twice the energy of the 'Frost' rope when submitted to a load equivalent to that produced by the falling man in our example. The 'Frost' rope, therefore, leaves twice as much energy as the 'Beale' rope to be taken up by the man's body.

It will be seen, accordingly, that not only does the 'Frost' rope have to be subjected under the same circumstances to a greater tension, giving it less factor of safety, but it will also have a more severe effect on the man's body, and is more likely to cause injury.

It may be of interest to state that, theoretically, the height of the fall of a man (of given weight) attached to a rope (of given strength and elasticity) makes no difference to the pull on the rope, provided the rope has a length equal to the fall, the energy absorbed by the rope stretching being proportional to its length. From this statement it is also easily seen that if there be a considerable length of rope between the point of anchorage and the point on it from which the man starts to fall, the pull on the rope at the end of his fall is very much reduced, because of the greatly increased length of rope that can stretch between the anchor and the man when stopped by the rope.

Of course, in practice, the energy developed by the falling man can be largely taken up by allowing slip at the point where the

rope is supported, and to a small extent at the other end where it is tied round the man's body. In practice also it is almost impossible to fall clear, and less energy is generated. Some energy is also dissipated in heat consequent to the rope stretching, but this is too small an amount to be worth considering.

The point which I want to emphasize is, that the more stretch a rope has the less likely is it to break, and the less likely is the climber to have his body injured.

Mr. A. L. Bird has made some interesting tests on climbing ropes at Cambridge, and has shown how the elastic stretch of ropes is impaired by the application of loads, and he has also shown how this elasticity can be recovered within limits by allowing the rope to rest after being stressed.

He has written an interesting article on this subject in the last number of the *Climbers' Club Journal*, vol. iv, No. 3, 1931, and from the results of his tests, together with consideration of the facts mentioned above, it seems desirable that the Alpine Club should initiate further research on climbing ropes, in order to find a rope which is not only light for a given strength, but one that has also a maximum and a lasting elastic stretch. This investigation should also show what material it is best to use, and to what extent it might be desirable, in certain cases, to use mechanical devices like springs or shock-absorbers, which could be inserted in the rope between adjacent climbers and designed to absorb sufficient energy to make up for want of elastic stretch in the rope, and to make it much less likely for a man to be injured by the pull round his body or for the rope to break.

It is interesting to find in the original report of the Special Committee of the A.C. on ropes, axes, etc., in 1864 (see 'A.J.' **1**) that there is reference to the advantage of elasticity in ropes, and to the value of knots with soft packing tied up in them.

I do not wish the above remarks to be taken as indicating generally that the 'Beale' rope is better than the 'Frost' rope. The makers' names are referred to only as they are given in the N.P.L. tests, and my remarks are relative to these tests.

It is quite possible that after repeating loadings on each make of rope the remaining elastic stretch will be much the same in both, and the advantage of one over the other may only occur with a new rope.

My object in writing this note is to indicate what one of a climber's requirements ought to be for the rope he uses. If the Alpine Club could, as a result of the research recommended above, draw up a specification of all the requisite qualities, it is certain that any experienced rope-maker would be able to make a rope to fulfil these requirements. At present the rope-makers do not know what climbers want, and there may be climbers who do not themselves know what is best for them !

S. B. Donkin.

[In the *Rivista Mensile*, Li, p. 54, there is a note on the report in 'A.J.' **43,** 325–9. In this it is considered that the tests prove conclusively that the 'Frost' rope is definitely superior to the 'Beale' rope; or, in other words, that twisted (*not* plaited) Italian hemp ropes are both stronger and far more suitable for mountaineers than manilla.—*Editor.*]

IN MEMORIAM.

JAMES WALKER HARTLEY.

(1852–1932.)

MOUNTAINEERS, professional and others, appear in complete agreement that this once-famous climber, who died very suddenly on January 17, in his eightieth year, was the best and most skilful amateur of his time. Allusions to his powers appear at frequent intervals in early Alpine periodicals, such as the JOURNAL, Dent's *Above the Snow Line*; *Pioneers of the Alps*, etc. But for many years Hartley had dropped out of Alpine circles and was practically unknown to modern mountaineers. In 'A.J.' **42,** 299, will be found an extract from a letter written by him on the death of his friend Seymour Hoare. Hartley was elected to the Alpine Club in 1875, on the same date as his friend and frequent companion, the late Sir Edward Davidson. With Clinton Dent, Davidson, Seymour Hoare, and his own brother Francis,[1] most of Hartley's best-known expeditions were accomplished. He had also climbed extensively with Mr. Hugh and Sir James Stirling and with the foremost guides of his generation, Alexander Burgener, Hans Jaun, Hans von Bergen, Alois Pollinger, Laurent Lanier, Peter Rubi, Melchior Anderegg, Emile Rey, and others.

Hartley's feats were very numerous and included most of the difficult ascents effected by the second generation of climbers. His greatest was probably the first ascent of the Grand Dru with Dent in 1878, after many previous attempts on the mountain, all inimitably described by Dent. Other expeditions, some of them guideless, include:

1873.—Wetterhorn, Eiger, Mönch, etc.

1874.—First recorded attempt on Mittellegi (N.E.) arête of Eiger; (a nearly successful assault on the Wetterhorn from the Hühnergutz, possibly in 1875); Jungfrau from the Wengern Alp, including the first ascent of the Klein Silberhorn; Blümlisalphorn by a new route; first crossing of Mittellegi Pass, etc.

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[1] 1843–1908. A.C.