Mr. GREGORY, President, observed, that what had been read was merely a synopsis, as it was impossible in a single Paper to do more than allude very briefly to the numerous Appendices by which the communication was accompanied; but those who referred to the Appendices hereafter would find that it must have cost the Author much care, labour, and attention to collect together for the information of the Institution the very interesting particulars which he had submitted. These seventeen Appendices gave practical details of the variety of works which were described, besides topographical, geological, and other particulars, and several official reports. It was rarely that so large an amount of labour had been bestowed upon any one Paper as had been given by the Author in collecting all this information. Engineers interested in public works in the colonies would find it of great value, as containing full information, showing how the capabilities of a colony might be applied in carrying out such works.

Mr. HEMANS observed, that the Moorhouse tunnel, owing to the large cost of its construction, appeared to have exhausted the resources of the colony for further works. This tunnel presented interesting physical and geological features. Caverns were encountered in the centre, partly empty and partly filled with loose scoria and water. The mode of overcoming the difficulties, as well as the particulars of the construction, were fully detailed in the Appendices to the Paper. There were practically no shafts, although the tunnel was 2 miles in length; and the alignment had to be made entirely from the two ends. From this cause, too, as the gradient was constant in one direction, it was found necessary to draw the water uphill in the reverse direction to the gradient, at one end of the tunnel, which was a clumsy way of proceeding; there was no reason why the tunnel should not have been made to rise gradually to the centre, so as to let the water run off at each end.

With regard to the bridging over the mountain torrents, whose beds of shingle and boulders were gradually raised above the surface of the country, he might observe that it was found almost impossible to drive permanent piles in such places; and screw piling certainly was not adapted to penetrate far through boulders and shingle. It occurred to him that cylinders sunk by the pneumatic process might have overcome the difficulty. The northern portion of the colony was virtually without railways. A length of about 30 miles of line only had been constructed, with a gauge of 5 feet 3 inches; and as the colony must make an effort to obtain the benefits of railways, it was an important question whether a large saving might not be derived from making them on a narrower gauge, and at a less cost per mile. There were ridges and spurs from the mountains to surmount, where sharp curves would save an enormous expense; and it was worth consideration whether the kind of railways adopted in Queens-

land would not be better than that already carried out. This Paper was a most interesting communication, as showing the great energy developed by an English colony.

Mr. VIGNOLES, Vice-President, remarked on the excellent example set to young engineers who might be thrown upon their own resources in foreign countries. Great credit was due to the colony which had furnished the money; but the description of the work given in the Paper showed that a great deal of merit was due to those who had been able to effect such interesting results. With respect to the tunnel and railway, he agreed with what Mr. Hemans had said as to the inexpediency of going to so great an expense. In the colonies, and, in fact, in England, a more economical construction of railways should be inaugurated. How that might be done ought to be a matter for consideration; and if, instead of spending from £16,000 to £20,000 and £30,000 a mile, the cost could be reduced to one-third the amount, most beneficial results might be obtained. The right course had been taken by contriving lines up the hills for the mountain roads, so as to obtain the maximum advantage with the least expense. By skirting the sides of the hills, and winding round them, expensive works had been avoided. The results had proved successful, and were worthy of imitation, not merely in other colonies, but in England. Nothing was more desirable than that engineers, when they set about a particular work, should strive after the maximum advantage with a minimum of expense; and this he considered had been done in the present instance.

Mr. CARLETON BAYNES said, having spent some time in the Province of Canterbury, he could state that it would be conferring the greatest possible boon upon the colony if any practical suggestions for bridging the torrential rivers could be furnished, because they presented dangers which it was impossible fully to appreciate in England. They were called the snow rivers, and the floods came, not in rainy weather, but when the sun was hottest. They then brought down from the high lands great numbers of boulders, which gradually raised the embankments on which the beds of the rivers were situated: and by that means their courses were continually changing. Moreover, the rivers were so rapid and so cold, that the danger in crossing was excessive. The passage was not merely dangerous to the inexperienced, but to those who knew the rivers best, and who, in fact, dreaded them most. Shortly after his return to England, he heard with great regret that a man who had been twenty-five years in the colony had lost his life in endeavouring to pass one of them. They were so rapid that allowance had to be made for being carried down the stream when choosing a point for crossing, in order to avoid the boulders; for when once on them, there was no chance of escape for man or horse. He had crossed them himself, and was glad he should not have to do so

again. These dangers were a serious impediment to the development of the colony. The nature of the bridges which would answer best had been often and anxiously discussed. The prevalent idea was that there was no hope of establishing permanent structures over these rivers, and that the only plan for crossing them was by a simple scaffolding, with duplicate parts on either side; that the bridge should, in fact, consist of a succession of scaffoldings, so that when one part was carried away, it could be immediately replaced; but no satisfactory mode had as yet been suggested for making them.

Mr. ABERNETHY remarked, that when engaged in the construction of the Cavour Canal, in conjunction with M. Noé, they had to cross the Sesia, and two other rivers of a like character from the Alps; but, owing to the difficulty of bridging them, and some difficulty with regard to the levels, it was decided to carry the canal under the beds of those rivers. It was worth consideration whether a similar expedient could not be adopted in the case now under discussion; and whether, if, as he imagined during a portion of the year, the beds of the rivers were comparatively dry, it would not be better to construct tunnels under the rivers than to attempt to bridge over them. He could not conceive that, either by screw piling or by sinking cylinders to any depth, a bridge could be constructed to resist the action of the torrents and the effects of the boulders.

Mr. J. M. HEPPEL stated, that some years ago, while in charge of works in the south-east of Switzerland, he had observed some Alpine streams, which, though less in degree than those described, had much the same character. They brought down large banks of boulder-shingle and mud, which formed natural embankments, standing considerably above the mean level of the valley of the Rhine, into which they fell. Where these had assumed a uniform slope terminating at the Rhine, which was the main drain of the country, it might be considered that they had attained a permanent condition; but if they impinged upon the main valley, and did not reach the Rhine, their bed being constantly raised, it would be evidently useless to attempt to cross them by any work in the nature of a bridge, because it would certainly be buried beneath the detritus which came down. He believed in some cases the method referred to by Mr. Abernethy had been adopted: the torrents instead of being bridged over had been tunnelled under; but he did not recollect what the details of the operations were.

Mr. BAYNES said the reply to that suggestion, in the Province of Canterbury, would be that the course of these rivers might change. It was possible that the river to the north of Christchurch might some day return to its old course, which was through Christchurch itself.

Mr. VIGNOLES, Vice-President, said he had recently seen a description of the effects of torrential rivers wherein mention was made of the successful manner in which an embankment was constructed by means of the boulders themselves. This was chiefly effected by the mud held in suspension by the torrent, which filled up the interstices between the boulders; and in process of time the embankment became solidified. He thought a similar plan might be adopted in the Province of Canterbury, and that embankments might be made of these boulders, so as to form two or more parallel channels in which the bed of the river might be confined, and perhaps ultimately securely. He knew of instances of the same kind in Italy. The bed of the River Po was frequently many feet above the level of the towns through which it passed, and in that case the bridges were rude structures carried up on the embankments. One or other of these plans seemed the only remedy applicable to the very difficult circumstances which had been described.

Mr. E. A. COWPER said, with reference to a rough-and-ready way of putting in piers which might answer as a temporary expedient in the situation described, that he thought it might be effected by long continuous beams of tough and strong timber, many balks being bolted together, to carry lengths of 100 feet, which might be divided into four or five bays with piers underneath. If these were merely supports under the longitudinal beams, one might be knocked away without the bridge being destroyed. It was worth considering, whether digging amongst the boulders might not be more cheaply effected by means of gunpowder. In this way a large excavation might be made for receiving iron or timber struts, and the hole could then be filled in with boulders and concrete.

Mr. GREGORY, President, expressed a hope, that the Author of the Paper would not consider, by the somewhat short discussion that had taken place upon it, that the large amount of labour he must have given to it was not appreciated. It contained very valuable information, which might be referred to with great interest.