Discussion.

The President. The PRESIDENT, in moving a vote of thanks to the Author, observed that the Paper described a vast amount of work of which the profession should be very proud, and the members were grateful to the Author for having presented to them a record of such magnificent achievement.

The AUTHOR exhibited a number of lantern slides illustrating the subject of the Paper.

Sir Robert Elliott-Cooper. Sir ROBERT ELLIOTT-COOPER, K.C.B., Past-President, said no one appreciated more than he did the importance of the works described by the Author in helping to bring the war to a successful conclusion. No one who had not seen the works and the conditions under which they had been carried out, could really appreciate them from any description, however well it might be put on paper. He had had the opportunity of seeing practically the whole of the district shown on the Author's map. In 1916 the Army Council paid The Institution the compliment of requesting that a small Committee of its members should be formed to advise upon various engineering questions, both at home and, if necessary, at the front. For the first 2 years the Committee's duties related chiefly to various engineering matters at home, but in May, 1918, the Committee visited the front and inspected, in connection with various engineering problems, the district from the coast inland up to Amiens, and from Amiens running up to Arques, and so on to St. Omer. He had previously stayed for about a fortnight at St. Omer, which was then the headquarters of Lord French's Army, in 1916, but at that time there were comparatively few engineers, either Royal Engineers of the regular Army or Civil Engineers, who had taken service in the Army, doing any work in the country; in fact, as explained by Sir Gerard Heath in his recent Paper, in the early days of the war it was not appreciated what an important part engineering would play in its successful prosecution. When he was at St. Omer in 1916 his interest was chiefly in the transport, which even in those early days was marvellously conducted. On the occasion of the Committee's next visit in May, 1918, things had changed very much. At that time Amiens was being evacuated; the Committee got within a few miles of it, but could not actually enter the town, as the roads were congested with the refugees leaving the town and district. In

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1918, instead of there being only a few engineers, engineering in all its various branches had overspread the country. The Author had explained the various periods in which some of those great works were carried out. The time when the Committee really saw for themselves what had been done was in February and the beginning of March, 1919, when they motored a little more than 3,000 miles over a district bordered on the west by the sea, and running north up to about 15 or 20 miles north of Ypres, taking in the whole of the district beyond Cambrai. They were able to appreciate the enormous work for which the Author had been responsible. The Author had scarcely made it quite clear that his was the Directing Head, so far as railway construction was concerned. The Committee considered it was a marvellous undertaking, which spoke eloquently not only for the ability of the Author, who was responsible for the construction, but also for the excellent co-operation between the Royal Engineers of the regular Army and the Civil Engineers. He believed he was correct in saying that 90 per cent. of the engineers who were engaged in the great works of engineering construction, railways, waterworks, electric works, dock-works, sewerage, and all the numerous smaller items of engineering, were civil engineers who had taken service as officers in the Royal Engineers. Many of the officers whom the Committee met in 1919 had up to a short time before devoted all their energies to the work of civil life. They very quickly took up the military engineering portion of their duties and worked in a most cordial manner with the Engineers of the regular Army. He was bound to say that the manner in which the Royal Engineers co-operated with and treated the civil engineers did them the greatest credit; there was not the slightest jealousy; he had never heard a word that could suggest that one was preferred to the other. It proved conclusively that the civil engineer could quickly adapt himself to engineering work under war conditions. The Committee had the opportunity on two occasions of meeting Lord Haig, who expressed the opinion that he was convinced it was essential that Royal Engineers should have civil engineering as well as a military training. It really looked as if the day was not far distant when there would be no very great distinction between the Royal Engineer and the civil engineer, and when the two would to a large extent, and greatly to the advantage of the country, be blended into one great force, capable of being used either for military purposes in dire need or for civil work at home. He had rather digressed from the subject of works themselves, because he knew that the Army Council really wanted that view of the case emphasized, and wished to show that

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the experiment of using the civil engineer in war had been a success. From an engineering point of view, the work described in the Paper, and all its many subsidiary undertakings, could hardly be fully appreciated. It amounted in length of lines constructed to something like the making of the Great Northern Railway. In 2 or 3 years engineers constructed a network of railways—quite equal in many respects to ordinary main lines—totalling several thousand miles, not only running-lines, but also groups of sidings. He was even more interested in the lay-out of the sidings required for the marshalling of the trains, and the conduct of the traffic in the most economical fashion, than he was with the remarkable manner in which temporary bridges had been constructed in a time which would have astonished a contractor at home, even with the facilities he had here. It had to be remembered that all that was carried out under the stress of war. Although some of the works were at some distance behind the fighting line, there was always the feeling that in a few days they might be called upon to pull up all the work done. Whilst the Committee were in France, an order came to pull up a large network of railways in the north, where the enemy in all probability would utilize the materials if available, if he could not use them as running-lines. He saw in one place a large shed which had been removed within sight of the enemy and almost within their grasp, and which, within a few weeks, had been re-erected behind the lines in another position. One would have thought it was a work of 6 or 8 months. All that spoke volumes for the co-operation between all branches of engineers, and all who worked with and under them, and who had at heart the carrying out of the work in the most expeditious manner, and at the same time doing it as substantially as though it was required for a war going on for several years beyond the time it did. The people of England owed a debt of gratitude to the young engineers, and to their seniors in higher positions, who gave up their careers in this country, and went to do the important and excellent work described by the Author. He, therefore, joined heartily in the appreciation of Colonel Lyell's Paper.

Sir Brodie Henderson.

Sir BRODIE HENDERSON, K.C.M.G., wished to endorse strongly the expressions of thanks to the Author, not only for the Paper, but also for the excellent and strenuous work he had carried out night and day, year after year, in France, which had helped to bring the war to a much more speedy termination than would otherwise have been possible. In the Paper the "Chief Constructional Engineer" was referred to several times, but it was not very apparent, owing to the Author's modesty, that the "Chief Constructional Engineer"

was Colonel Lyell himself. It would be noticed that the title of the Paper was: "Work done by Railway Troops in France." A great deal of the work—and some of the most difficult—was done in Belgium; work was also done in Germany, and railway troops were employed in Italy; so that a more correct title for the Paper would be: "Work done by Railway Troops on the Western Front." The engineer, during the war, had very hard and anxious work; he had to take quick decisions, work had to be done quickly, and there had to be quick results if there were to be any results at all. During the fighting, either advancing or retreating, lines had to be built and works carried out to meet the military situation, such as it was imagined it was going to be, and the result was that very frequently two railways had to be built, one of which it was known would be of no use, while over the other the traffic people would be taking their traffic before the line was finished. One of the most important new lines that the Author built was from Conchil to Candas; he did not suppose half-a-dozen trains ever passed over it, but it had to be built to meet a military situation which fortunately never arose. In the Paper there was a great deal of interesting technical matter. Designs of depôts were mentioned, of the size of which the photographs that had been shown did not give an adequate idea. They covered hundreds of acres. Fifty or 70 miles of sidings at one place was not at all uncommon, and they were all laid out to plan; standard plans were agreed and were modified slightly to suit local circumstances. If there was another war, and the soldiers' ideas proved to be correct, he thought every depôt would have to be carried out not to any regular plan. The depôts as constructed were all very regular and concentrated and visible from the air. Towards the end of the war the Author designed a very large new depôt which fortunately was never required; it was designed with the idea of fighting through Belgium, and was to be situated at Bergues, not far from Dunkirk. The depôt, instead of being a concentration of Royal Engineers stores, ordnance, and other kinds of material, was scattered. Fortunately, owing to the termination of the war, the depôt was hardly commenced. He thought in future, owing to the amount of fighting that would go on from the air, depôts would have to be laid down on the general lines of this new design, which, however, would not be so convenient for railway working. The Author referred to the fact that sand was used very largely for railway ballast; sand often saved the situation during the war, but on more than one occasion very nearly lost it. Sand ballast was easy to get and could be laid quickly; it did not answer badly in dry weather, but in the big

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water-logged plains of the North, during rainy weather, great trouble was experienced. There was a reference in the Paper to the cover that was put over munition depôts. The cover was made of galvanized iron covered with a layer of sand, the idea being that if a bomb or anti-aircraft shell made a hole in it and set the munitions on fire the loose sand would pour through the hole and put the fire out. It was effective and was the Author's idea. One other point was the question of the 60-centimetre or light railways. The Author drew attention to the fact that light railways were very expensive to maintain, and gave figures of five men per mile and so on. There were over 2,000 miles of 60-centmetre line, and the war could not have been carried on without those lines. After the armistice he was told by a high authority that the 2,000 odd miles of track were to be picked up as quickly as possible and shipped to England for laying here. He ventured at the time to think that it was not a very economical method of transport, and as far as he was aware very few miles of this track had been actually brought over to this country. From considerable experience of 60-centimetre railways he did not think such light railway would be of use in England, except in favourable localities. It did not need under ordinary traffic conditions as many men for maintenance as were mentioned in the Paper, because the traffic on the lines out there was very heavy on occasions; they carried, he thought, over 200,000 tons a week, which, of course, was a very large quantity to carry over a narrow-gauge line. At the beginning of 1917 there was a dearth of material for carrying out all the big works, not only railway works but all kinds of works under the responsibility of the Director General of Transport, and he did not think the occasion should be allowed to pass without referring to the organization which Sir Eric Geddes started there and in England, because, without the organization on this side to supply the vast tonnage of material required, no efforts of the Author or anybody else would have been of any use. That organization, which took up its abode in the embankment hutments near the War Office, supplied the Transportation Department with everything needed, and supplied it quickly. It was carried on by Sir Guy Granet, and towards the end of the war by Sir Sam Fay. The department supplied material so quickly that other branches of the Army in France came asking for material to be got for them, which, of course, was not possible. The engineering features out there were not what might be called of a very heavy or intricate nature, because anything of such a kind had to be avoided. The great point was to get things done, and done quickly; anything intricate

could probably not be done quickly, and accordingly everything was simplified as much as possible. One of the great things was to look ahead as far as possible. There was one other matter he would like to mention, the destruction of a bridge on the main line near Étaples. For many months the Germans tried to bomb that bridge, knowing it to be a most important line for the conveyance of troops north and south, and the Author was for a long time anxious to make a deviation, so that if the bridge were destroyed there would be an alternative route. There was a good deal of opposition to it, as it meant rather a big work, but eventually the Author got his own way, as he generally did, and built the deviation. It was a timber pile bridge, which was the best form of bridge to resist bombing attacks, and the work was practically completed when the Germans hit the permanent bridge and destroyed it. But there was no delay, because the temporary deviation had been finished a few hours before sunset that very night. Everybody was satisfied. The Germans were exceedingly pleased that after months of bombing they had hit the bridge, and the British were satisfied because they had the deviation. The only people who suffered were two sentries, who unfortunately took shelter under the span hit by the bomb and were killed. Sir Brodie Henderson.

The AUTHOR, in reply, thanked the members very much for the way in which they had received his Paper. The feeling between the Royal Engineer (regular) and the Civil Engineer was always of the most friendly nature. The Royal Engineer recognized that the Civil Engineer had more practical experience in engineering. The Civil Engineer on his part was quite keen to learn the military part from the Royal Engineer. The Engineer-in-Chief and those under him had always been most helpful to the Railway Construction Engineer, who took his orders from the Director General of Transportation, and the railway engineers had always been ready to give assistance to the Engineer-in-Chief and those under him. As far as being a Royal Engineer or a Civil Engineer was concerned all engineers had been Royal Engineers in France, and they had all been proud to belong to the corps of Royal Engineers while they were on active service. The regular Royal Engineer had put no difficulties in the way, but it would certainly have been a help if the higher Army commands had known a little more of up-to-date engineering science. In the earlier days of the war the railway engineer was not looked on with favour by many of the Army and Corps commanders, and consequently the railway engineer found many difficulties put in his way which hindered him from giving an up-to-date service. As an instance, when light railways were first The Author.

The Author. proposed, steel rails were not permitted, as it was considered the grinding of the wheels against the rails would create a noise and attract enemy shell-fire. Wooden rails had to be used, and these could never be a success, as the trollies were constantly being derailed, due to excessive friction between the wheel and the wooden rail: the Indian soldiers who pushed the trollies made far more noise in re-railing them than would have been made by steel wheels running on steel rails. There was a gradual evolution from this primitive way of working to a very good system of light railways behind the front line in 1917. After Sir Eric Geddes came to France and took over the new transportation directorate the army commanders did not interfere in details as some of them had previously done, while the Director of Railways was under the Quartermaster General. By the time Sir Eric arrived the Somme battle was over. Towards the end of that battle, railways came into their own, as they had to be relied on almost entirely for transport, since the heavy motor-traffic had made the roads impassable. This showed plainly the great advantage of railways in modern warfare.