# DISCUSSION.

Mr. W. H. German said as the one who had moved the adjournment of the discussion at the last meeting on Mr. Rae's paper, he might say that he was an entire stranger to coal mining, and would ask the members to excuse him for any shortcomings. If the paper had been read at a meeting of Newcastle or Wollongong engineers, it would, no doubt, have received a larger amount of criticism than at the hands of Sydney engineers. The enterprise shown by capitalists in engaging in such an enormous undertaking as this at Balmain was to be commended. It showed that they had great faith in the geologists who had predicted that coal would be found at such a great depth, and in that locality. When the coal was reached, the enterprise would receive a well merited reward. It was stated that there was a hundred and thirteen million of tons of coal in the mine. Asuming for the moment that the output would be two thousand tons per day, that would mean two hundred years' continuous working. A comparison might be made as to the cost of hauling from such a depth and hauling over a level. He believed that a penny per mile per ton was a customary charge for hauling over the level, and asuming that the price of boiler fuel was 10s. per ton and 2½lb. of coal consumed per horse-power per hour, he estimated that the coal could be lifted at a halfpenny per ton for half a mile. That was leaving out of the reckoning interest on capital. It would be interesting to know if Mr. Rae had taken observations of the increase of temperature as the workings got deeper. The retaining wall was a most important engineering work, and it was to be hoped that some information as to the quantities or cost would be given. The plans and specifications were most complete, and he was indebted to Mr. Rae for the loan of them when

building a wall for the Suger Refining Company at Pyrmont. It had cost about £9000, and colonial cement was used throughout. The cement was of Goodlet and Smith's make, and was found to be very satisfactory. He understood that Mr. Rae had arranged for an economiser in connection with the boilers. That was an object lesson for all manufacturers who had an installation of land boilers. If it paid coal miners to have economisers, how much more would it pay those who had to pay the enhanced price of coal? Mr. Rae had referred to the small quantity of water that he had to deal with. He believed it was 500 gals. per hour, and it came almost entirely from about the 700ft. level. There was a kind of gutter round the shaft to catch the water at that level, and then it was allowed to fall at the bottom, to be afterwards raised. That represented something like 4 h.p., not a very serious amount; but the question was whether steam pumps should be used for saving that expenditure of power. He would regard Mr. Rae's paper only as the first volume of his contribution on this subject, and hoped that as the works progressed, further instalments would be forthcoming.

Mr. Parton said that some years ago he had been asked to report on the prospects of the undertaking. This was long before the soil was touched, and he gave what he thought was an unbiassed report from a mining point of view chiefly, but also from a geological point of view. He was then of opinion that it was a feasible undertaking. From a mining point of view, and from a geological point of view, he had not the slightest doubt about it. Professor David and others had given opinions on the subject, and those opinions had since been fortified by the results of the test bore. In his professional career in the colony, extending over eleven years, he had met many engineers and others interested in coal mining, who could not get rid of a somewhat selfish feeling in regard to this project. They tried to throw cold water upon it, and one of those engineers said that there would be so many dykes and faults that it could not be worked at a profit. Dykes were as common to coalfields as were seeds, and he could scarcely mention any colliery that had no dykes. There were fewer dykes

in this area than in other parts of the colony of a similar character. As a geologist and mining engineer he had no fear of the results in the working of this mine. He had had an opportunity of going into details with Mr. Rae as to cost in connection with this mine. They had provided for all possible contingencies. Mr. Rae had gone into it so thoroughly that if he were met with contingencies of an unfavourable character, he was quite prepared to meet them. He had been in deeper mines, and the temperature had caused no difficulty. The coal had been obtained at a profit, and there was no reason why this undertaking should not be one of the most successful in the colony.

Mr. Scoullar said it would be of interest to know what the raising of the coal would actually cost. An allowance of 2½lb. of coal per h.p. for raising the coal from the bottom of the pit would, he thought, be a very small amount. In many works of a similar kind the consumption goes up to as high as 4lb. of coal per h.p. Economisers were very serviceable, but in some of the recent numbers of American journals he noticed that some leading firms who had placed huge machinery for electric traction were doing away with economisers and using some other system.

Mr. Ferrier considered the paper did not go sufficiently into detail to enable them to consider the matter fully from an engineering point of view. He would like to know if in building the walls in lengths of seventy or eighty feet was there any special method of bonding the parts together. He understood that the ballast was tipped immediately behind the wall, and that it was deposited from trucks and not hand-packed as usual, and it would be interesting to know if that method is considered as good. He would also like to know something of the method of working the coal from the pit mouth to the vessel, indicating how the various qualities are to be graded and quantities stored ready for shipment.

Mr. Bolton desired to know if there were not some advantages in the way of ventilation in allowing the 500 gals. of water per hour, which accumulated at the 700ft. level, to drop to the bottom of the shaft.

Mr. Hector Kidd said that water was used for that purpose, but the quantity of water mentioned as dropping in the shaft would produce very little ventilation, and he thought it would be better to pump it from the 700ft. level than to expect to get any ventilation from it.

Mr. Hargrave did not think Mr. Rae had made any mention of the disposition of slack.

The President said that Mr. Rae's paper was one of great value to the mining community and of a special interest to the members of the Assoication who had had an opportunity of visiting the mine and seeing the works in progress. They must have been greatly impressed with the magnitude of the work, and the thorough manner in which it had been carried out. The Rev. W. B. Clark and others had given evidence of their belief that a seam of coal would be found under Sydney Harbour, and the test bores which had been subsequently put down proved the accuracy of their forecast. The excellent paper read by Mr. Rae gave a very fair description of the works now being carried out. The works had been planned and carried out with great care, and the safety of the workings had been kept constantly in view. The execution of the works now in progress reflected great credit on Mr. Rae. He had considered the question of ventilation, and the capacity of the fan was 400,000 cubic feet per minute, with a 4½in. water gauge. The figures were so striking that he had figured out the power necessary to drive the fan, and found that it worked out from 400 to 500 indicated horse-power per hour. He had pointed out to Mr. Rae that this was a very high water gauge, but he accounted for it by the fact that one cannot foretell the plan on which the mine would have to be worked, and that in working a large area a high water gauge would be got. Such a powerful fan as that would ensure a perfect circulation through all the adits, no matter how restricted or how long they might be. That was the reason why the water gauge provided for was so high. In looking up some figures he found that the average was 1.7 inches for the greater number. A great number had from 1in. to 1½in., and there was found to be sufficient suction in the fan to pro-

duce the required ventilation. There could be no doubt that the high water gauge under which the fan was intended to work would ensure a great circulation of air in all parts of the mine. Mr. Rae had given some figures showing the speed of the winding. The fastest was 20.7 miles per hour; that was the mean speed. The maximum speed would be 29 or 31 miles per hour. That was a pretty high average. While the paper was being read he remembered having seen a good article which was read before another Institution some years ago, and he looked up the figures used on that occasion. In four Lancashire mines, with a depth of 1530ft., the mean speed was 20 miles per hour, and the maximum 30. The coal raised per hour was 56 tons. In another mine, 1914ft. deep, the mean speed was 24, maximum 39.2. Coal raised per hour, 92 tons. In a 2418ft. mine, the mean speed was 30 and the maximum 51.9 miles per hour. The cage in starting from the bottom starts from a stage of rest, so that the maximum speed is within a reasonable figure of double the mean speed. The next was 1800ft., the mean speed 24.6 miles per hour, maximum 49. The coal raised, 85 tons per hour. The next was 1350ft. deep, the mean speed 19.2, the maximum 35. The coal per hour, 102 tons. The next was in Durham, 738ft. deep, the mean speed 15 per hour, maximum 27.7; coal, 100 tons per hour. The next was 1548ft. deep, mean speed 20 miles per hour, maximum 31.7; coal, 80 tons per hour. Mr. Rae had stated that he expected to discharge 200 tons per hour. That would take an engine of 1600 h.p. The estimated quantity of coal to be mined is 113,000,000 tons, and that has to be raised a distance of 3000ft. With the usual allowance it would require four indicated h.p. for every ton of coal raised to the surface. As to the installation of the economiser, he would draw special attention to the description of the boiler installation, by which it would be seen that Mr. Rae had been mindful of fuel economy. He presumed that steps had been taken for the utilisation of the exhaust steam. Mr. Scouller had stated that in America they were not using economisers, and he was surprised to hear that, but if they did not use that particular kind they might be using one of another

name. It was undoubted that Green's Economiser had stood the test of time. He had intended asking Mr. Rae a number of questions pertaining to the working of the plant, but as this paper dealt only with the construction of the works he would not do so. When the work was completed and in full working order, possibly Mr. Rae would be good enough to give another paper dealing with the equipment of the mine. Members were greatly indebted to Mr. Rae for his valuable paper. He would like to call attention to the analysis on page 30 of the paper. From that analysis it might be safely inferred that the coal would be in great demand for steamers. It would take a very fair draught, as it was a somewhat hard coal. Steamship owners were recognising the advantage of a good draught, and by lengthening their chimneys they would have no trouble in getting good results from the coal from the Sydney Harbour Colliery Company. He desired to express his very great appreciation of the paper. One could not help feeling all through that the conception of the whole thing had received very great attention. It had been his privilege to visit the mine twice, and he had been very much impressed with what he had seen. Everything seemed to have been thoroughly adjusted and thought out. Every detail and every matter pertaining to economy, efficiency and safety had been carefully and fully considered by Mr. Rae.

Mr. Rae said he had to thank the members for their kindly criticism of his paper. They had been very lenient with him, as in dealing with such a subject one was liable to leave out interesting points. The difficulty was not in finding material to write about, but to condense that material. In reply to what Mr. German had said in regard to the enterprise of the Company in starting these works, there was no doubt it was a plucky undertaking. Many of those interested in it were largely interested in mining at home, and deep coal mining was not new to them. They were fully satisfied with their prospects here, and they were prepared to carry out the undertaking in the best possible manner. The Chairman of the Company was a Yorkshire colliery proprietor who knew what coal mining was, and many of the other

shareholders were largely interested in coal mining. On such indisputable evidence as they had as to the existence of coal there was really after all little or no risk in the undertaking. The bores which had been put down at Cremorne were really not put down so much with a view of proving that coal was there, as of proving that the opinions formed as to the depth at which the coal would lie were reasonably correct. In estimating the cost of deep sinking and the necessary plant for winding, ventilating, etc., one had to have reasonably correct figures to go on. Mr. German had referred to the estimate that there were 113 million tons of coal available. A considerable allowance has been made in that estimate for loss in working. If they took the specific gravity of the coal and the acreage and thickness of the seam—providing the thickness of the coal seam were continuous—there would be a very much larger quantity of coal in the Company's holding than 113 million tons. In making a rough estimate, some people reckoned that 100 tons per inch per acre were sufficient. This coal has a higher specific gravity than the Newcastle coal, and in 10,000 acres a slight difference in the specific gravity of the coal would amount to a very considerable number of tons. Mr. German was right in saying that on these figures, capacity of the Company's coal-field would run into about 200 years, if they were putting out 2000 tons per day. That was a big output, and there was no colliery in this colony that put out anything like 2000 tons per day. He doubted if the largest colliery in New South Wales put out more than 1500 tons per day. It was a very big thing to say that one colliery which put out half a million tons of coal per year would last for practically 200 years. As to the comparative cost of deep hauling as compared with level hauling, Mr. German had said that the cost of level hauling was about a penny per ton per mile, and that he reckoned that the coal would probably be lifted for a halfpenny per ton, asuming that 2½lb. of coal per h.p. was consumed in the engine. It was a difficult matter to separate the exact cost of winding and to say what it was. It would require the making of minute and very careful and frequent tests of fuel and water consump-

tion in the boilers, oils and other stores in the engines, and other matters, and he did not know that it was ever done. It was not done in the colliery pay-sheets, and the question of the actual winding of the coal was never kept wholly by itself. It took one man to handle a large winding engine raising a large output, but one might have a small engine and a small output, and it would still take one man to handle the engine. To really dissect the cost of actual winding correctly, the question of the wages of the driver and price of all engine stores used would have to be taken into account. As to the increase of temperature, notes were being made, with, he hoped, the greatest possible care. It was very seldom that a better opportunity of noting the increase of rock temperature could be had than in the sinking of these deep shafts. So impressed were the Underground Temperature Committee of the British Association for the Advancement of Science, that they sent out specially made thermometers to the mine. Professor Everett sent to Professor David specially made thermometers in copper cases. In sinking the shaft at intervals of every 50ft., two holes were made in the walls of the shaft of a depth of 5ft., one on either side of the shaft. The holes were allowed to remain open for about 36 hours, sometimes a little longer, to allow any heat generated by the percussion of the drill to escape. After that, the thermometers were inserted in the holes, which were carefully plugged up. To begin with, they used only slow-action thermometers, one in each hole, but it had afterwards occurred to them that it might be wise to use a maximum thermometer in each hole as a check on the others. They were very much like ordinary clinical thermometers that doctors use. The holes were plugged up with 6in. of greasy cotton waste placed next to the thermometer, and on top of that plastic clay was rammed in. The instruments were left in the holes sometimes for a week or a fortnight. They took them out as occasion required without hindering the work.

The Chairman desired to know if the waste were intended to be used as a non-conductor.

Mr. Rae said that the plug was that recommended by the Underground Temperature Committee. To the

cases of the thermometers there were strings attached and pliable wire to the cotton waste. The instruments were read directly they were drawn out. When placing the maximum thermometers in the holes, care was taken to see they registered a lower temperature than that likely to be recorded when taken out again. Mr. German had suggested as to the quay wall that at some future time further information could be given on this matter. Speaking for himself, it would give him great pleasure to give further information about that wall, and he thought Mr. Scott could give an interesting paper also on such work. Mr. German had mentioned that the Colonial Sugar Refining Company's wall cost £9000. The cost of their wall and of the work outside in deepening the berth for vessels was more than double that. They had over 6000 yards of concrete in the wall and 3000 to 4000 yards of excavation. He could not say from memory what the wall itself cost, because the building of it and the excavation was all one contract. In this work they also used Goodlet and Smith's colonial cement, and found it entirely satisfactory, and they were using it in all their work. In the quay wall alone there were over 6000 casks used, and in other work they expected to use about 6,000,000 bricks, which would require at least 6000 casks more. As to the fuel economiser, it was ridiculous to say it did not matter how much coal was burnt at a colliery. If a ton of coal could be saved it was better to save it and sell it; besides, the economiser, by heating the feed water, saved wear and tear in the boilers. Mr. German had asked why the water in the shaft was allowed to fall and be raised again. Mr. Bolton was correct in his surmise that the water dropping from the 700ft. level helped the ventilation. The falling of the water alone would not help the ventilation to any extent, but it certainly cooled the air current. There had been such a quantity of lime present in the water, from between the 600ft. and 700ft. levels, that the 2in. pipes originally put in to take the water down got blocked up in less than a fortnight, and he could not put his little finger into the pipe. They were, therefore, obliged to take the pipes out and replace them with wooden boxes 3in. square. These were

not of course, quite watertight, consequently there was a constant spray of water in the shaft which cooled the air considerably. When the boxes got blocked by the lime they took them to pieces and cleaned them out. The incrustation was a beautiful freak of nature.

Another reason why they did not pump the water from the 700ft. level direct was that it would eventually be used to lay the dust in the mine. They would take the water down into the workings at very high pressure and allow it to spray in very fine jets into the intake air current. The air would be thus damped, and it would lay the dust, which was an important thing in a mine where there was likely to be inflammable gas. For these reasons and on account of the trifling quantity it was thought better to deal with the water in the manner indicated in the paper.

Mr. H. Kidd asked if Mr. Rae apprehended any trouble from incrustation in the pipes for the proposed spraying of the water.

Mr. Rae said that the lime seemed to be getting less and less, and he hoped would soon entirely disappear. Referring to the establishment of the colliery, it was undisputed that to a city like Sydney the fact of having its own coal supply alongside deep water was important. The bringing of the largest vessels within 100 yards of a colliery shaft was quite unique. It had given him a great deal of pleasure to write this paper, and thought he could safely say he would promise it would not be the last. Mr. Parton had referred to his statement that the strata in the shaft agreed with the bore. The comparison was most interesting. To think that in 3½ miles there was only a difference of about 60 feet was marvellous. Every day he took careful notes of the strata as well as measurements. All the specimens they took could be seen in the Geological Museum, to which place they were sent. Mr. Parton had referred to the selfish feeling shown by some mining engineers, which was very much to be regretted. Surely in so young a country enterprise such as theirs should not be discouraged, provided it was being carried out on proper lines. There was no doubt that many of the other colliery companies had shown great jealousy. As to the question of dykes

and faults, they did not expect that they would be without them. There was nothing very hurtful in a dyke or a fault. They were common all over the coal mining world. In Sydney they had a splendid opportunity for tracing those things; they knew practically all the dykes that existed. In a large area covered with soil where the outcrops of dykes could not be traced, it was often a difficult matter to know what evisted, but there was much less chance of any trouble like that about Sydney, where—what with roads, sewers, railways, gas and water mains, etc., all requiring the carrying out of excavations in all directions—splendid sections of the country were got, and any dykes or faults had lttle chance of escaping observation. Mr. Pitman (Government Geologist) and Professor David, in their geological survey, took the greatest pains in tracing all the dykes that could be seen all round Sydney. Mr. Parton had referred to their being prepared for any emergencies. They had prepared for emergencies, at all events as far as it was possible for mortal beings to look ahead of things. Before the sinking was begun, a large sum of money was set aside for dealing with water in case it was met with, but they had not met with it. To show what trouble was sometimes experienced from heavy water, he might mention that a few years ago in Yorkshire, in a sinking pit, six pumps were at work, each throwing 70,000 gallons per hour, totalling 420,000 gallons per hour. That quantity followed them down over 300 feet. He had read of one sinking where 10,000 gallons of water had to be pumped per minute. That was twenty times as much water in a minute as they were making per hour. Mr. Parton had referred to the profit in worknig. The question of the possible profit to be made by their Company was in a nutshell. It was simply a question of saving freight. They did not pretend they were going to mine coal as cheaply as anyone else. The extra cost of mining would not be very great, and it would not cost them anything in freight from the pit to the ship. Their coal would go direct from the colliery into the ship. If they had been a couple of miles from port they would have had to look forward to spending probably £50,000 on rolling stock, and that would have to be kept in repair.

Mr. Scouller had referred to the h.p. required, and suggested 2½lb. per indicated h.p. was very small. Mr. German had suggested 2½lb. It was impossible, at present, for him to say definitely what it would cost to raise coal from their shaft. He thought Mr. Scouller was right. He did not expect for a moment that the coal consumption per i.h.p. in the winding engine would be less than 6lb., indeed it might be more. It would depend whether they eventually went in for condensing. As to people doing away with economisers, he thought they were one of the best appliances for saving fuel. The figures Mr. Kidd quoted as to the saving were fully borne out. Mr. Scouller had asked what measures were used in locating the colliery. If one looked at a coal seam as one would look at a reef, the question of the location of the shaft would be a serious matter, but there is one continuous coalfield from Bulli on the south to Newcastle on the north, only dlsturbed here and there by a fault or dyke, not to a very great extent. As to the position of the shaft, if they were to sink a shaft under that room they would, he felt sure, get the coal just as they would at Cremorne or at Balmain. Mr. Ferrier had asked about the bonding of the wall. Each length was toothed and the other bonded in that way. It had proved quite satisfactory, and there was no sign of cracking at those joints. Mr. Ferrier asked why the ballast was tipped behind the walls. It was not tipped. It was lowered down in the same boxes which had been used for lowering the concrete. The boxes were lowered down behind the wall and on to the various steps. That was carried out until it had a natural slope shorewards. The rest of the stuff was afterwards tipped shorewards. As to the question of working the coal from the pit's mouth to the vessel, he had not dealt with the question of raising the coal, in his paper, which was only a description of the works already completed. On some future occasion he might describe that. Mr. Hargreaves had asked if it were proposed to go in for coke making. That also was a question for the future. In the question of ventilation the capacity of the fan was referred to by Mr. Kidd as being great. Mr. Kidd's figures as to the power required for driving the fan were correct.

Provision had been made for a high water gauge, as when the mine workings were extended to a great distance from the bottom of the shafts there would naturally be a considerable amount of friction. He knew of many cases where equally high water gauge was experienced, andhad some particulars of a similar fan to theirs in which provision was made for a five inch water gauge. Mr. Kidd referred to the speed of winding. In the paper under discussion he had quoted for the speed of winding from the sinking pit only. The speed of coal winding at their colliery would be much greater than that. Mr. Kidd had given some interesting figures in regard to this at some English collieries. The maximum he quoted was somewhere about 51 miles per hour.

Mr. Kidd said that it was in Lancashire.

Mr. Rae said that possibly the Rosebridges Colliery, near Wigan, was referred to by Mr. Kidd. At that colliery he believed the speed of winding was 5100ft. per minute, which was close on 51 miles an hour. The question of horse-power required to draw the coal had been referred to, and Mr. Kidd mentioned about 1600 per hour. In the middle of the running the engine would be developing something about that.

Mr. Scouller: How was the bucket steadied?

Mr. Rae: They had a system of guiding buckets which was entirely new to the Australian colonies, and one which had only been used in one or two cases at home. There were some features which were entirely new. The scaffold on which the bricklayers worked was made double-decked, with a hatchway for the bucket to pass through. It weighed about $4\frac{3}{4}$ tons, and was suspended by two wire ropes, which are used as guides for the bucket, and the weight of the scaffold kept them sufficiently rigid.

Mr. Howarth asked if Mr. Rae would say something as to the records of increments of temperature of the rock.

Mr. Rae said that last December, Professor David, Mr. Pittman (Government Geologist), and he had read a paper before the Royal Society of New South Wales, as to the rock temperatures at the depth then attained—1505ft. They found the increase was 1deg. for about

90¾ft., which was considerably lower than what was considered the world's average. The limit of deep mining was more a question of temperature than anything else. At the Calumet and Hecla Copper Mine, near Lake Superior, in America, where they had the lowest increase of temperature on record, they were mining at a depth of almost 5000ft.

The Chairman: Would not the temperature be affected by the spray which is proposed?

Mr. Rae: To a certain extent it would, and, of course, it would be reduced by the air current. He had been speaking of the temperature of the rock, not of the air in the shaft itself. Recent trials he had made at the 1955ft. level showed that whilst the rock temperature was about 85½deg., Fahr., the temperature of the air in the shaft was 71¾deg., the surface temperature being, at the time, 80½deg. in the shade and breeze, and 82deg. out of the breeze.

This paper is illustrated by Plate I.