

## Discussion.

The PRESIDENT considered that the Institution was greatly indebted to the Authors for their useful and important Paper. Most engineers had more to do with the use of cement than with its manufacture, but it was interesting to know that such great strides in the method of manufacture were being made, and he hoped that in this country, as in America, engineers would now have the benefit of getting a cement of superior quality at less cost than had been hitherto the case. He was sure the members would agree with him in according to Messrs. Stanger and Blount a hearty vote of thanks for their Paper.

Mr. BERTRAM BLOUNT, having exhibited some lantern-views of the Atlas Cement Works, remarked, with reference to the Table of costs in the Paper, that it might be urged that the figures selected for the cost of fuel and of labour were not those current at the present time. He was quite aware of that, but they had been chosen as what might be considered average prices, and it was an easy matter for any one who was concerned in obtaining a proper relation between the old process and the new, at existing prices, to correct each item and to bring it down to the prices current. With regard to the Huntington mills, the inventors of the process had considered it desirable to have the same class of mill for all the pulverising apparatus, no doubt for the convenience of exchanging the parts, and the Huntington mill had been selected. Personally he was not entirely in accord with this view, and was of opinion that other mills might be found as good, or better.

Mr. F. A. WHITE observed that, as chairman of the "Associated Portland Cement Manufacturers," which now turned out, or was capable of turning out, something like 80 per cent. of the cement manufactured on the Thames and Medway, he ventured to ask the indulgence of the members for a few remarks. From the Paper it would appear that English manufacturers had been somewhat behindhand in adopting the rotatory process, and that it was only in America, and perhaps to a small degree in Germany, that the difficulties attending that process had been overcome. He could not altogether contest that view of the question, but the reasons were not very far to seek. First, there was the history of the Ransome kiln; it was widely known that that

The President.

Mr. Blount.

Mr. F. A. White.

Mr. F. A. White. had been a failure, and in consequence English manufacturers had not been inclined, having regard to the costly nature of their plant and the great expense that any remodelling of it involved, to follow in that direction. Moreover, in normal times the cost of coke in this country had enabled cement to be produced under fairly economical conditions and of very good quality. The result had been that manufacturers, who were keenly alive to the importance of improvement, had nevertheless not been in a condition to embark upon it until the various efforts that were being made in many quarters had been brought to a successful issue on something more than a laboratory scale. He would be very sorry if it were to be supposed that the English cement-makers, as a whole, were in any way satisfied with processes that were known to fall short of scientific exactness and to involve unnecessary cost. The company of which he was a director, before its absorption by the Associated Manufacturers, had been fully alive to the importance of the subject, and, as soon as it had been assured that the rotatory process had been brought to yield satisfactory results in respect of quality and cost, it had faced the question, and the directors had resolved to put themselves in a position to avail themselves of the Atlas patents. They had obtained permission to send out a commission, consisting of four competent persons, to investigate the process on the spot, and a month at least had been spent in America in a thorough inquiry into the matter. The question remaining after that investigation had been, whether the process was as applicable with the wet processes used in this country in mixing the materials as it was with the dry materials used by the Atlas Company. One of the works to which the Authors had referred, and some others to which they had not referred, had been visited by the commission; they had come home satisfied that the process was equally applicable to the wet slurry, and steps had been taken at once to erect such plant. Consequently, at the present time the Associated Cement Manufacturers had, at the largest works they had taken over, a plant, fast approaching completion, which was equivalent to the one unit referred to in the Paper, capable of an output of some 3,000 tons per week. It was hoped that before long the company would be able to show consumers of cement that they could obtain a cement made in that manner which was quite as good as any mentioned in the Paper. The manufacturers recognised the keen foresight and patient industry of those who had worked out the problem on the other side of the Atlantic, and all they asked was

that it might be recognised that, if they could not claim to be the pioneers in the matter, English manufacturers had at least not been slow to avail themselves of the skill of the American inventor, no matter at what cost, and he hoped it would not be long before the results would be visible to all. He asked permission to use the opportunity of addressing the meeting to make what he supposed in another place would be called a personal explanation, personal not to himself but to the large company which he had the honour to represent. From many quarters it had reached this company, which had absorbed some thirty firms, that it was regarded, if not as a menace, at least as a danger to the consumer of Portland cement, and as a Trust whose object had been to obtain monopoly prices and to hold the engineer and the contractor in the hollow of its hand. It was difficult for the manufacturers to get an opportunity of dispelling such fears; therefore, without wishing to transgress the rule which obviously precluded any manufacturer from coming to the Institution and employing arguments in favour of his own firm, he asked permission to explain the policy which had actuated the founders of the company, and which would guide the directors henceforth. The union had been forced upon them by the conditions of the times. It was not desired to use it in any respect in the way that had been suggested. It had been formed simply to enable them, if possible, to get a living profit, and, what was much more important to engineers, by the power obtained through union, of knowing all that had been done in English works, and all that needed to be done, to carry out on a comprehensive scale the improvements which had been alluded to. He could assure the members that that was the line on which they intended to proceed. They considered it their duty to convince all who were engaged in works of construction that on the Thames and Medway the very best cement could be purchased at the lowest possible cost, and that engineers and others who embodied special requirements in their specification might find, on the part of the manufacturers, the desire and the ability to meet them.

Mr. V. DE MICHELE asked how long the clinker lining of the burning-cylinder lasted. The lining of a kiln was one of the most costly items in cement manufacture, and it would be valuable if the Authors could say what was the duration of the linings. With regard to the mechanical difficulty of lengthening the burning-cylinder, according to the diagrams it appeared that the cylinders were supported at two points, and he would like to

Mr. F. A  
White.

Mr. V. de  
Michele.

Mr. V. de Michelé. know whether there was any difficulty in increasing the number of those supports to three or more. If there were no difficulty in doing so, he did not see why it should be more difficult to construct a cylinder 100 feet long than one 60 feet long. It seemed from the results in the Paper that with the wet process 100 feet was nearer the correct length than 60 feet.

Mr. Atkinson. Mr. LL. B. ATKINSON remarked that there were a few points to which he would like to draw special attention, and among these the use of wet slurry appeared to him to be one of the most important matters for the cement manufacturers of this country to thoroughly consider. Assuming the Authors' calculations to be correct, it appeared that a very large portion of the heat required was taken up in evaporating water which, if the Authors were correct in their idea that the mixing might be done with dry materials, was unnecessary. He had visited the Atlas Cement Works in the previous autumn, and at the time of his visit there had been over fifty kilns in work, and another fifty in an advanced stage of construction. About 1,500 tons of finished cement were being turned out daily, and with some little experience of manufacturing concerns he had been much struck with the organisation and the ability shown in maintaining a regular output with all the various processes, which were necessarily dove-tailed one into another. One of the points that would strike an engineer as being most novel and important was the use of powdered fuel. He had seen before in Europe certain experiments with powdered fuel, but it had been quite a revelation to him to see 500 tons or 600 tons of fuel burnt per day, apparently without any stoking whatever. The coal, having been dried and ground in the mills, was carried automatically into the stock-box, and the stoking consisted simply in adjusting the valves of the air-supply regulating the amount of fuel going into the furnaces. The success of the particular burners used was due to several causes. The first was appreciation of the fact that the feed of coal must be a positive feed; there were screw-gears driven by small engines which could be regulated in speed, so that the actual amount of fuel fed forward was well under control. The coal-dust was mixed with air, so as to produce what he might call an emulsion of coal and air, and was then blown into the furnace with a small quantity of high-pressure air. There was a point about the use of that high-pressure air which was of importance, namely, that in addition to blowing the fuel in the direction of the length of the kiln, the air expanded, and blew the fuel to the periphery of

the kiln. All the fan-driven coal-consuming devices he had seen had the disadvantage that they projected a stream of coal along the axis of the kiln, but it did not reach the periphery where the heat was required; with the result that in many powdered-coal-burning devices working on rotatory kilns of that kind a very large amount of fuel was blown straight through the kiln and up the chimney, and was not burned in the furnace. He did not think that anything save high-pressure steam or air, expanding laterally as well as longitudinally, would achieve the result that was obtained. The temperatures that could be obtained with such a blast were surprising, and he thought he was well within the mark in saying that the difficulty in watching the furnace was to avoid melting out the whole of the fire-brick in a fluid condition. There seemed to be no practical limit to the temperature which could be obtained. The Authors described the clinker lining in the furnace as being fixed by coating the internal surface of the kiln with common salt, forming a fluxed or glazed surface to which the clinker adhered. But the practice as carried out when he had seen it had gone a stage further. As the clinker came down, while the lining was being formed, salt was placed not only on the lining of the furnace, but on the clinker, which had to be beaten down. The following was probably the explanation of the result:—Even if the temperature of the furnace were raised high enough to somewhat soften the interior lining, when the clinker was brought down on it the result was the formation of a lime glass at the union of the two surfaces, and a lime glass, speaking generally, was of a very fluid nature when it was formed. The introduction of the salt both at the lining and into the body of the clinker formed a soda-lime glass, which was of a much more plastic nature, and the result of that was twofold. There was really more adhesion between the clinker and the brick lining, but in addition, by getting a lining in that plastic condition and then beating it down, a circular arch was formed which, mechanically and quite apart from the adhesion, was complete in itself, and would hold in position. That process was in a sense equivalent to forming in place an interior lining of clinker, built into a circular arch. A previous speaker had asked what was the life of such a lining. Some of the kilns which he had seen had been running for 2 years, and had had no repairs whatever to the brick lining behind the clinker lining. A certain amount of repair was done from day to day in small patches on the clinker lining, but that was effected as the work proceeded by stopping the plant for a short time.

Mr. Atkinson.

The President. The PRESIDENT asked how the plastic clinker was beaten down in the hot cylinder.

Mr. Atkinson. Mr. ATKINSON said it was beaten down by means of a bar about 20 feet long with a heavy iron weight at the end of it—something like a puddling-bar—which was worked up and down, through an opening, by the operator outside. Only patches of about 2 square yards were done at a time. When the furnace was new it might take 4 days to complete the fixing of the lining, and then the kiln was ready for work. One of the reasons for the success of the plant was, he thought, that great care was taken in constantly checking the material put into the kiln. It was quite obvious that in a plant turning out 1,500 tons a day, and which would shortly be dealing with double that quantity, if care was not taken when the material went into the works from the quarry, a very large amount of useless cement might be produced. Samples were taken every half-hour from the actual mixture leaving the grinding-mills. It was found that as work in the quarry was carried from one point to another, the variations in the material, though not rapid, could be detected. Only the lime was determined, and the mixture was checked in that way to enable the proportion of lime to be maintained uniform. Experience showed that quite a small alteration in the quantity of lime, say,  $\frac{1}{4}$  to  $\frac{1}{2}$  per cent., whether too high or too low, might give rise to difficulty in working the kilns. It was a vital point in the process to exercise care in regard to the mixture put into the kilns, for an improper mixture of raw material produced an unsatisfactory product. Much thought and intelligence had evidently been brought to bear on the design of the plant, but with some little knowledge of grinding-machinery he thought that if anything had to be altered it would be the grinding-plant. The fact that one grinding-machine had been chosen to grind a soft substance like coal and hard stuff like cement-clinker was sufficient, to his mind, to show that convenience rather than real efficiency of the grinding-plant had been the object aimed at. The amount of power used for grinding appeared to be excessive; roughly speaking, even on the newer plant it was 80 HP. per ton of cement produced per day, which was a very large amount. The new plant was of 12,000 HP., of which quite a large part was occupied solely in grinding. The grinding, whether of coal, raw materials or cement-clinker, was done in one stage, that was, the stuff was put into the grinding-mills about the size of walnuts, and on coming out had to pass through a 100  $\times$  100-mesh sieve. He believed Mr. Hurry himself thought that great economy of power might be arrived at by doing the

grinding in two stages. Economy in power was much more important in this country than in America, because coal was much cheaper there. His criticism, however, was not founded on any experience with that particular plant, but on some experience of grinding-machinery in general. Referring again to the questions of wet slurry and of lengthening the kilns, the point arose whether a kiln of that kind was a proper place in which to evaporate moist slurry. It was well known that if coal was burnt in the flue of a Lancashire boiler, and the hot gases went out at the end, there was considerable waste of heat. It was necessary to pass the hot gases through an economizer in order really to get the heat out of them. If it was found that wet materials must be used, he thought something would have to be done in the way of pumping the materials through the equivalent of an economizer, without attempting to dispel the moisture simply in one long flue through which the gases were passing at a high velocity, which was a useful arrangement where radiant heat was available, but a poor arrangement for getting the heat out of non-radiating gases.

Mr. GILBERT R. REDGRAVE remarked that the question of burning Portland cement had undergone a wonderful change in the past few years. He had seen, some 10 years or 12 years ago, at the works of the South Wales Portland Cement Company, one of the early cylinders used for cement-burning in this country; he had watched the work for some time, and the process had given him the impression that it was bound to be a failure. The difficulties at that time in connection with the use of the cylinder had been enormous; the clinker was constantly fusing into large masses in the interior, causing great labour in the removal of the semi-fused mass and frequent interruption of the work. Moreover, in order to produce the cement in the cylinders, it was found necessary to employ a high percentage of lime, a fact which had not been known previously. He had found, on analysis, that the cement thus produced in South Wales had contained 64 per cent. of lime, and it had therefore been a treacherous material. The temperature of burning had been very high, and the question of temperature was a very important one. In the early days of cylinders for cement manufacture it had been customary to use gaseous fuel, and he believed the salvation of the burning-cylinder was due to the present use of powdered-coal fuel or oil fuel. The temperature attained with producer-gas had been excessive; and the enormous heat produced in one part of the cylinder had tended to fuse, not only the linings, but also the cement in course of manufacture.

Mr. Redgrave. One of the most interesting matters described in the Paper was the method of lining the tube and the protective influence of the clinker. No cement manufacturer who had watched the burning in the ordinary fire-brick kilns could fail to be impressed with the wastefulness of the present process. Without the utmost care, the destruction of the linings was very rapid, partly on account of the difficulty of regulating the draught in the kiln. Cement-makers had constantly to face the question of re-lining kilns. If by the process which had been described it was possible to make a protective lining for a kiln, or a burning-cylinder which would last for 2 years, an enormous advance was secured. Another matter which deserved great attention was the distribution of the heat in the cylinder, not merely caused by the powdered fuel, but influenced also by the action of the compressed air forced in with it. The expansion which took place in the jet at the entrance to the cylinder caused the heat to be distributed all over the tube lining. He was rather doubtful of the effect of a great length of cylinder. He had no practical experience of what was being done in America, but looking at the fact that English cement manufacturers, at any rate on the Thames and Medway, produced cement very largely from a mixture of chalk and clay, in a semi-liquid form, it seemed doubtful whether the best method was that of introducing the mixture into the long cylinder in which it would gradually become heated. He thought it might be preferable to dry the mixture by some other means rather than in the cylinder itself, but that was a matter to be decided by experience. It was interesting to know that the Associated Portland Cement Manufacturers had set themselves earnestly to work to carry out improvements in the process of manufacture. It was a question whether it would not be necessary in the near future for English cement manufacturers to face this matter very seriously indeed. The existing works were antiquated, and if it was possible by improved methods to effect a saving of 5s. per ton, it would be almost imperative to re-model them forthwith. It was not only in the matter of burning that he thought the cylinder process had a great future; there was also the question of the grinding. For years past engineers had been urging the necessity for fine cement, but English manufacturers had never really grappled seriously with the problem. Abroad and in America great attention was paid to reducing the cement to the finest possible state of sub-division. The present plan, which obtained very largely in this country, of grinding by means of millstones, was an unsatisfactory method

of attaining anything like the necessary degree of fineness. Mr. Redgrave. In tube-mills it was possible to reduce cement to a very fine state of subdivision at a small cost. Before long cement-users would not care to employ Portland cement which had not been ground to a degree of fineness hitherto undreamt of. The common specifications of engineers in this country required not more than some small percentage of residue on a 50-mesh sieve, that was, 2,500 meshes to the square inch; but the residue even on a 100-mesh sieve was of little or no use for engineering purposes, and therefore manufacturers must look to the time when specifications would require them to produce extremely finely ground material. Not only in burning, but also in grinding cement, processes which were practically novel to the English cement manufacturer would be employed in the future. It would be useful to obtain from the Authors, or from others, the results of experience of the use of an iron lining in the kiln. In some of the recent processes of burning, an unprotected iron cylinder was used, and it was stated that by distributing the air-supply to the kiln over the surface of the metal cylinder, which was used vertically, it was possible to burn Portland cement without any fire-brick lining at all. That seemed to be a direction in which cement-makers might attempt to get over the difficulties of the fusion of the fire-brick linings. There were vertical iron kilns which had no protective lining whatever; an excellent cement was said to be produced in such kilns, and by that means contamination of the cement with the products arising from the fusion and destruction of the kiln-linings was avoided. It was a pleasure to find that the experience which had been so rapidly gained in America was to be brought to bear in England, and he trusted that the experiment now being made by the Association of Portland Cement Manufacturers would be crowned with success.

Mr. WILLIAM GILBERT observed that the Schneider kiln was one Mr. Gilbert. of the most modern of fixed continuous kilns, and merited further description. He had visited cement-works in Germany and Sweden during the past 2 years, and was able to say that the Schneider kiln was an exceedingly satisfactory one. It was a vertical kiln, being practically a plain cylindrical shaft surmounted by a chimney, and it fulfilled the Authors' requirements for an economical kiln. The in-going air cooled the outgoing clinker, and the furnace-gases were used to heat the raw materials. Further, the tendency of the plastic clinker to adhere to the sides of the kiln had been overcome in a very simple manner. At the

Mr. Gilbert. Limhamn Cement Works in Sweden, the damp bricks of raw material were loaded directly into the top of the kiln, and the consumption of coke amounted to  $3\frac{3}{4}$  cwt. per ton of cement, or 19 per cent. of the weight of the clinker produced, which compared very favourably with the 30 per cent. of small coal used in the rotatory furnace. The first cost of the two fuels would however be about the same. Using the rotatory kiln the labour of loading and withdrawing the clinker was almost obviated; but in the case of the bottle kiln the charge for both those items, including picking the clinker and digging the slurry from the drying-floors, was only 1s. 9d. per ton; so that really the saving in labour was not great. For a given output, taking the coal-grinding plant into consideration, the cost of a rotatory plant would be much greater than that of a Schneider kiln plant. The rotatory kiln appeared to work very successfully in America, where the dry process was used; but in England, where the wet process was almost universal, and necessarily so, it had not yet been a success. It therefore seemed a little premature to recommend cement manufactured by it to members of the Institution.

Mr. Roberts. Mr. W. L. H. ROBERTS remarked that he had not had the advantage of seeing a rotatory-kiln plant at work, and the Paper had set his mind very much at rest as to what was going on in America. The Authors stated that Portland cement, of better and more regular quality than at present produced, could be made by the plant; but he fancied that if engineers in this country were led to believe that the cement which was going to be produced in rotatory kilns was far superior to that produced now, it would rather injure the position of English manufacturers. With regard to the tests of the cement manufactured by the Atlas Company, it would be noticed that it was particularly slow-setting, and that the results were not any better than would be produced by a slow-setting cement manufactured in a properly-regulated English cement-works. If the statements in the Paper were taken simply as they stood, engineers as a body might possibly be led into thinking that the rotatory principle would produce a better cement than that which could be made by fixed kilns. The Schneider kiln was an excellent one, well adapted to a large number of raw materials found in this country; and he believed that the cost of a properly-regulated works using the Schneider plant, or other kiln in current use in this country, would compare very favourably with that of rotatory kilns. The drawback of having to pick out the under-burnt particles was not very serious;

they could be easily picked out, especially if, as was usual, Mr. Roberts. the older men were employed to do it. If an ordinary picking-table was introduced as well, the trouble arising from underburnt clinker entirely disappeared. With regard to artificially-matured cement, no doubt it was excellent, but at the same time in this country cement had been matured by having large warehouses in which to keep fairly large stocks; and in the summer-time, when the cement was apt to set quickly, it had been the practice of many manufacturers to water the clinker. Watering the clinker was an ordinary process, and the advantage was all on the side of the manufacturer, because the cement gained about 2 per cent. in weight, and he therefore pocketed an extra 2 per cent., which purely from the manufacturer's point of view was a satisfactory result. He did not think, however, it should be allowed to go forth that the method was anything new, as it had been known and practised for years. The rotatory process might suit certain manufacturers, but even without that plant British manufacturers could produce cement just as good as, and in a large number of cases far better than, any produced by the employment of the rotatory principle.

Mr. H. J. HARDING asked the Authors whether the rotatory Mr. Harding. process could be employed for burning of lime as well as cement. He gathered from the Paper, supplemented by the remarks of Mr. Atkinson, that the rotatory process would be better adapted to the burning of cement made from the blue lias strata, because it would obviate the present necessity of reducing the very hard limestone to slurry. It seemed to him there was a saving of power in the first place, and also a saving of fuel in getting rid of the water which went to make the slurry. Another thing which would make it suitable for the blue lias strata was the mixing. It was generally understood that the slurry of the chalk and mud of the Thames and Medway districts contained 75 per cent. to 77 per cent. of chalk and about 25 per cent. or 23 per cent. of mud, as against a corresponding mixture in the blue lias strata of about 95 per cent. to 97 per cent. of limestone and about 5 per cent. or 3 per cent. shale. It seemed to him that there was less danger generally in mixing the latter than the former, especially under this dry system, where specific gravity must have some influence on the passage of the materials through the kilns. In other words, in the lias process nature started at about 97 per cent. or 98 per cent., and there was a mechanical introduction of only about 2 per cent. That appeared to

Mr. Harding. give a great advantage to the lias districts for that particular process of manufacture. He had obtained an analysis of the limestone of Messrs. Greaves, Bull and Lakins' quarries at Harbury in Warwickshire, which showed roughly 77.75 per cent. of carbonates (of which 1.15 was magnesia), the remainder being made up of siliceous matter, clay, water, etc. The strata of that particular quarry very closely resembled the Lyme Regis cliffs in Dorsetshire, with which he was intimately acquainted.

Mr. Ellis. Mr. R. E. ELLIS observed that no reference had been made by the Authors or by any of the speakers to Messrs. Hurry and Seaman's recent experiments. Instead of burning the cement materials to a semi-vitreous clinker, they partially calcined them and then submitted them to a temperature capable of producing complete fusion, and when solidified, powdered the product thus obtained. Though experts had differed from them in regard to that process, their experience was that when the constituents of the raw material were properly proportioned, the cement produced by the fusion was superior in its qualities to that manufactured by other methods. This was barely a year ago, and it would be very interesting if members who had visited America could say what had actually been done since then, and whether the process was still in an experimental stage.

Mr. Reid. Mr. W. F. REID considered that the rotatory furnace had been adapted from one industry to another with remarkably little change. In the first instance it had been used in the alkali industry, and, curiously enough, it was in the alkali industry that the largest output had been obtained. It was possible to make in a rotatory furnace between 80 tons and 90 tons of alkali material in 24 hours, and that material was one which acted much more on the lining of the furnace than did Portland cement. Alkali, in a semi-fused or completely fused state, was extremely corrosive of all kinds of refractory material. The first rotatory furnace had been used in the alkali trade about the year 1853, and since then it had been used in a number of other industries, perhaps the most important being the iron and steel industry, especially iron-puddling furnaces. It was almost certain that Mr. Crampton had thus obtained his idea of applying the rotatory process to the manufacture of Portland cement. Mr. Crampton had had a number of patents referring to rotatory puddling-furnaces, and if the Authors of the Paper had referred more fully to Mr. Crampton's successful experiments in that direction, rather than to the unsuccessful adaptation of the furnaces by Mr. Ransome to the

cement industry, it might have been more interesting, and Mr. Reid.  
more profitable to those who wished to apply the apparatus. Mr. Crampton had not only used the same form of furnace as Mr. Ransome, or the rotatory furnace of Messrs. Hurry and Seaman, but he had also used a jet of compressed air for injecting powdered fuel, and that also was applied in puddling-furnaces in iron-manufacture. He did not wish in any way to minimise the credit due to Messrs. Hurry and Seaman for having adapted the apparatus and carried it to a successful issue—it was sometimes much more difficult to adapt an old apparatus than it was to develop a new one—but the conditions under which the furnaces were used in America were very different from those obtaining on the Thames and Medway. The materials mentioned by the Authors were materials already partially mixed in a natural state, and that natural mixture was much finer and more intimate than could be obtained by mechanical means. Judging from the figures in the Paper, about half the carbonate of lime was already in a state of intimate admixture with the argillaceous constituents, and under those circumstances it was not only easier to burn the cement, but it took less fuel, and there was much less chance of any mishap during the burning. He had found, many years before, in establishing the cement industry in the Rugby district, where the lias materials were used, that it required much less fuel and much less careful regulation of the heat in the kiln, when making cement from lias materials than when using a mechanical mixture of chalk and clay; and manufacturers would find it much more difficult to burn a mixture of chalk and clay, such as was used in the neighbourhood of London, than material which was already intimately mixed. He would not say, however, that the difficulty might not be overcome. He had seen Mr. Ransome's process at work, and although very great care had been taken with it, the difficulty of obtaining a well-burnt, perfectly sound clinker had been almost insurmountable. Plenty of clinker could be obtained, but the tests of the cement furnished highly irregular and unsatisfactory results. It had been pointed out that the cylinder used by Mr. Ransome had been a very short one; but the length of cylinder really only meant that a longer time was needed for calcination. The coarser the materials the longer it was necessary to keep them at a high temperature, and if they were very finely sub-divided, the clinkering temperature need only be applied for a shorter time. With regard to fuel, that was an important matter for cement manufacturers, not only

Mr. Reid. in the London district, but throughout the country. It had been suggested many years ago—and the suggestion had been tried on a large scale—that the powdered fuel should be mixed with the slurry. He had made a number of experiments upon that, and had found that when the mixed materials were in masses of considerable size, it was quite hopeless to attempt to burn them by means of powdered fuel mixed with them; but, on the other hand, when the material was sub-divided into small particles about the size of hazel-nuts, the combustion was perfect. If part of the fuel was mixed in a finely powdered state with the raw materials, the burning would be much more uniform, and possibly the lining of the kiln would be less affected. The lining was, of course, always a weak part in the plant, and perhaps a very sore point with cement manufacturers. It was an important item in the expenditure of cement works, not only for materials, but also for labour and on account of the cessation of work involved by its renewal. The cylinder invented by Mr. Ransome had had projections which caught the materials, and he had noticed that the clinker caught in those projections had sometimes protected the bricks. He thought it probable that if some of the fire-bricks were allowed to project inside the lining of the kiln, sufficient clinker would be thereby arrested to protect the rest of the lining. The method adopted by Messrs. Hurry and Seaman was highly ingenious, and would mark a great advance in the manufacture of Portland cement if it turned out as well in England as it seemed to have turned out in the United States. At the same time, he was not quite sure that the materials used in this country would act in the same way as those employed in America. Many years ago it had been a constant practice among manufacturers to plaster the inside of their kilns with the slurry, which, to a large extent, protected the bricks. He had noticed that, the rougher the kiln became, the more protective was the action of the slurry. Probably the fluxed surface of the fire-bricks caused the clinker to adhere to them, and that was, to some extent, borne out by the fact that salt was added in the Hurry-Seaman process. At any rate, the plant referred to had been used successfully, and many manufacturers thought there was a considerable economy in fire-bricks; but probably the cost of labour was heavy. Another way of preventing the wearing of the lining of the kiln was by means of a water-jacket, a method which had been used a great deal in puddling-furnaces. It was possible to fuse metal in a naked steel cylinder easily if there was sufficient cooling-

water outside. He had had occasion to employ this method himself in a place where fire-bricks cost about 6*d.* each, and where he had had to use very inferior material; he had put a water-jacket outside, and it had stood very well. Although the corrosion of the lining in rotatory kilns might be considerable, and the consequent repairs numerous and frequent, under the wear and tear of the furnaces, yet it was not out of proportion to the output. In conclusion, he would ask the Authors how the outside of the cylinder in the rotatory process was protected where it was apparently exposed to the heat of the chamber, and probably subjected to a good deal of wear and tear. Mr. Reid.

Mr. D. B. BUTLER thought it was time English manufacturers found some more economical method of burning cement than that mainly in use at the present time. It was obvious that an immense amount of heat was wasted in the alternate heating and cooling of the ordinary type of intermittent kiln, such as was shown in *Fig. 1*, which, together with the drying-chamber, contained something like 12,000 cubic feet of brickwork and had to be cooled down after every burning, sufficiently for men to get inside to reload it. He could not quite agree with the Authors that the limitation of the percentage of lime was due to irregular burning, because he thought bad mixing of raw materials had a great deal to do with it. In cement-manufacture there were three distinct operations:—(1) the intimate mechanical mixture of the raw materials; (2) the burning of those raw materials when they were mixed, to make them combine chemically; and (3) the grinding of the clinker to enable it to combine with water and to set. The Authors stated that some form of continuous kiln was generally employed for burning raw materials treated by the dry process, but he did not think that applied to England. The Dietsch kiln had been tried in some places with very indifferent results; in one case there was always a large amount of underburnt material, usually of a yellowish-brown colour, which, when in a dusty condition, was apt to irritate the nostrils of the workmen, with the result that this particular factory came to be known locally as the “snuff-box.” The theoretical calculations of the amount of fuel required to burn cement were interesting, but there appeared to be too many assumptions to make them conclusive. For instance, 20 per cent. was allowed for radiation, and so on. The Authors were rather hard on English manufacturers for using the wet process, but he thought a good deal was to be said for it. The chalk going to the wash-mill contained about 20 per cent. of Mr. Butler.

Mr. Butler water, and the clay about 45 per cent. These materials being mixed in the ratio of about 2 of chalk to 1 of clay would give about 28 per cent. of water in the mixed material, so that only about 12 per cent. of added water had to be evaporated, since the slurry contained about 40 per cent. The cost of evaporating this small amount of added water would be fully compensated by the more ready and efficient mixture obtained by the wash-mill. Another important point in favour of the wet process was that the flints in the chalk would be practically irreducible by the ordinary method of grinding, and if the dry process were used they would require to be eliminated in the first instance by washing or by some other method entailing extra expense. The Authors appeared to attach considerable importance to the watering of the clinker and its effect on the cement; he would like to ask them if they could give any particulars as to the quality of the cement before watering and after watering. He doubted very much whether the 2 per cent. of water shown by the analysis penetrated sufficiently within the internal portions of the clinker to make it efficacious. The tests of the cement were put forward as indicating rather a superior quality; but judging from numerous samples which passed through his hands daily for testing purposes, all first-class brands of European cement made by the ordinary process were quite equal to that mentioned in the Paper. With regard to cost, the only difference in labour between the rotatory process and the ordinary intermittent process was in the loading and drawing of the kilns. The cost of labour given in the Paper was 2s. per ton of cement by the rotatory process, and 4s. 9d. per ton by the ordinary process, which left a difference of 2s. 9d. per ton; but his experience was that the dried slurry could be loaded into the kilns and the clinker drawn to the crushers for about 1s. 6d. per ton inclusive, suggesting that the Authors' figures in favour of the rotatory process were a little optimistic.

Mr. Plaister. Mr. J. F. PLAISTER remarked that the subject of rotatory kilns had occupied his attention for several years past, and he had had considerable experience as an English manufacturer in the various modern methods of cement manufacture. He believed he had been the first English manufacturer to place an order for an American rotatory kiln in this country, although one manufacturer had been ahead of him in getting one started. In the previous year he had had an opportunity of visiting thirteen American cement works, but he had not had the opportunity of seeing the Atlas Works, having been refused admission. The Authors seemed to make a great point of the automatic manner in which Messrs. Hurry and Seaman

handled the materials, as if it was peculiar to their works, but Mr. Plaister. other works in America handled their materials equally well and had their kilns working with equally good results. He had also had an opportunity of examining the books of one of the oldest cement companies in America, and he had been able to compare, in respect of cost of production, the old-fashioned method of bottle kilns and millstones, with the Continental method of a continuous coal kiln known as the Schaffer kiln, which had been running in Denmark for some years, and with the rotatory process, the grinding in the two latter systems being done with ball- and tube-mills. He had come to the conclusion that there was absolutely no economy in the rotatory process, the cost of manufacture with the Schaffer kiln being practically the same as with the rotatory kiln; but there certainly was a great improvement in the methods of burning. He could not quite agree with the figures the Authors gave as to the cost of manufacture of cement in America. He was afraid manufacturers would not stand much chance in England if the Americans progressed at that rate. He had found in the United States that the general estimate of the cost of manufacture of cement at the present time was £1 per ton by the dry process with rotatory kilns. Messrs. Hurry and Seaman might have some extraordinary method which made a great difference, but he knew from the books which he had referred to, and also from experts he had met in New York and Philadelphia, that that had been the cost in the previous year, taking coal at 8s. per ton. Therefore, unless great economy was going to be effected in other ways, he did not think any saving was to be looked for from the adoption of the rotatory plant; but no doubt a much better cement would be produced. The results given by the Authors had probably been taken from the Atlas Company's cement of 1898, but that cement was much inferior to the American cement of 1900. He had seen test-pieces withstand a tensile stress of 1,500 lbs. per square inch, neat, after 3 months. He had gone through the test-books for 4 years of one of the oldest cement-works, and had found equal results. The sand tests showed 370 lbs. at 7 days, and something like 450 lbs. at 28 days. That, he thought, proved the high quality of the cement which was being made. The standard fineness in America at the present time was 95 per cent. to pass through a 100-mesh sieve. He noticed that the Authors, in their estimate of cost, took the raw materials delivered to the mill at 1s. 9 $\frac{3}{4}$ d. per ton of cement. He did not know how they did that at the Atlas Works, because he believed that in 1898 they had had to buy considerable quantities of

Mr. Plaister. limestone, and that the stone obtained from their own quarries had been conveyed by carts to where it was used. No allowance was made for drying the coal, although that was a very important item; nor was there any allowance for drying the raw material, the cost of which surely could not be included in the 1s. 9 $\frac{3}{4}$ d. per ton. With regard to repairs, his experience was that their cost was a most difficult item to arrive at. The estimate for labour seemed to be about right, as the cost of ordinary unskilled labour in Pennsylvania at the present time was 6d. per hour and for engineers 10s. per day. Labour was exceptionally cheap in the Pennsylvania district. He had seen the Dietsch method of working on the Continent, and considered it an economical one, but the difficulty in England was that the necessary labour could not be obtained. He had been working the Schneider kiln for the past 12 months, and that was undoubtedly a most economical method for English manufacturers, used in conjunction with drying-floors. By putting additional floors in the existing chamber-kilns, any manufacturer could dry a sufficient quantity of slurry to keep Schneider kilns going without additional fuel, and with no additional wear and tear except on the floor itself. In the Schneider kiln it was possible to burn a first-class clinker with 3 cwt. of extra coke per ton of cement. That had been promised him when he was first shown the kiln in Germany, and since then he had proved by practical experience that this result was easily obtainable. With regard to the different classes of rotatory kiln, he had seen plain cylinder kilns, of various lengths up to 90 feet, working successfully. At one works he had seen one 40-foot, one 60-foot, and one 90-foot cylinder, alongside one another, and the manager had been of opinion that an ideal kiln for the dry process was one 60 feet in length. He thought a longer kiln would be found necessary for the wet process. Two kilns he was erecting at present were only 60 feet long, but he had not known 3 years ago as much as he knew now. With regard to cooling, it was stated in the Paper that Messrs. Hurry and Seaman were the only makers who dealt with the cooling of the clinker methodically. The general system of cooling in America was by means of a cooling-tower, a large cylinder about 32 feet in height and 8 feet in diameter having a large cast-iron pipe leading up the centre, with openings at intervals, and baffle-plates inside the tower. A large fan forced air through the cylinder, and the clinker was put in at the top and dropped out at the bottom on to a band conveyer which took it direct to the mills. In one works he had visited, the raw material was taken from the rock by trucks to the crusher, and

thereafter it was not touched by hand until it was loaded Mr. Plaister. in casks into the trucks. None of the works he had visited used anything but powdered coal; oil had been abandoned at most works in America for some time past. Coal was found, and he thought would be found, the most economical fuel for burning.

Mr. L. White.  
Mr. LEEDHAM WHITE found himself in almost complete agreement with the statements made and the deductions therefrom in the Paper. Two years ago, as Chairman of the late firm of J. Bazley White and Brothers, he had been one of a commission of four—one being a chemist, and another an engineer—who had gone to America for the express purpose of studying the rotatory kiln, and in particular of paying a prolonged visit to the Atlas Works. He might remind those who talked of having seen the rotatory system in America that if they had not seen the Atlas Works they were talking of the play of "Hamlet" with Hamlet left out. The commission had first proceeded to Michigan, and had seen the works described in the Paper and other works. At those works they had seen the burning conducted entirely by means of oil-fuel, and the manufacture carried on by the wet process only. The commission had visited those works in order to satisfy themselves that the system of burning by the rotatory kiln could be effectually employed with the wet process. They had seen the process efficiently applied to wet slurry, exactly analogous in chemical composition to the materials which were used on the Thames and Medway, and they had seen made by the wet process some of the finest cement they had ever met with. A prolonged visit had then been paid to the Atlas Works, which had been inspected very carefully. The commission had seen the dry material most successfully treated and the burning carried on by coal exactly as was described in the Paper. It did not require a very great act of faith to combine the two experiences, and to assume that the wet process could be successfully carried on in England with coal fuel instead of oil. In the result the commission had unanimously recommended their company to take up the system of rotatory kilns, which had been done, and a very large plant, modelled strictly on the Atlas system, was now on the eve of completion. So far from the rotatory principle not being well adapted to the wet process, some of the best cement he had ever seen had been made by the wet process in rotatory kilns. There was indeed one reason why that cement should be slightly better than cement made by the dry process. For some reason or other, probably because in the process of gradu-

Mr. L. White. ally drying from a thick liquid into mud, and the slow consolidation of the mud into harder lumps, the lumps were, from the beginning, so small that the clinker came out in hard, dense pieces literally about the size of filberts. He defied anyone to find finer clinker than that he had seen produced by the wet process combined with the rotatory system. He did not suppose absolute finality had been reached with the present description of kiln, and certain improvements might yet have to be introduced, and certain problems to be settled. The length, diameter, and internal shape of the cylinder—even, perhaps, the exact incline at which it was set—were all matters to be gradually thrashed out; but no doubt after a time a decision would be arrived at as to what was the most suitable cylinder for the process. Of one thing the members might be assured, namely, that the rotatory principle would endure, and it would be a long time before it was superseded by something better. It was perfectly true that it produced cement of a somewhat better character, but at the same time it was not necessary to decry too much the present system of manufacture. The adoption of the rotatory system would enable the manufacturer, with greater ease, to produce a regularity of quality which was somewhat difficult to obtain with present processes. It could not be denied that a great deal of cement was produced every day on the Thames and Medway which conformed in every respect to the increasingly stringent requirements of modern science, and gave satisfaction in every way to engineers, and to those who were in the habit of testing it. The science of cement-making had advanced greatly within the last 10 years, and better knowledge about the manufacture had of necessity gradually increased the standard of quality demanded, and the severity of the test applied. But he felt constrained to ask whether the practical advantage derived by the public had been altogether commensurate with the progress undoubtedly made in the manufacture. He was really sometimes tempted to doubt it. In the seventies and eighties, millions of tons of cement had been supplied for public works in every part of the civilised globe, and the cement supplied in those days had been such as at the present day would be summarily rejected by any tester, and no manufacturer would supply to even an ordinary customer; and yet, when he reflected that that cement had stood the ordeal of the three severest tests—time, water, and weather—he sometimes wondered whether engineers and the public had derived all the expected gain from the great scientific improvements which had been in-

roduced into the manufacture. Science advanced, and must Mr. L. White advance, and it was certainly the duty, and must be to the advantage of manufacturers, to avail themselves of the best processes. He had been considerably surprised to hear a remark made by such an authority on cement as Mr. Redgrave, who, in speaking of the fine grinding of cement, had stated that manufacturers had never really grappled with the problem. There were many manufacturers on the Thames and Medway who had raised enormously their standards of fine grinding. They did not go about the world proclaiming their methods. Some were actually using the tube-mill of which Mr. Redgrave had spoken, and the Company he was concerned with were using a peculiar appliance, invented by one of their managers, which could grind cement to the greatest possible fineness. Each system had its own special advantages and disadvantages, and none was absolutely perfect ; but at the same time, if there was one thing to which the attention of English manufacturers had been directed of recent years more than any other, it was that very question of fine grinding. British manufacturers in all trades had been subjected to a constant monotonous stream of reproach for the last 10 years or 15 years on the part of consuls abroad, the press at home and distinguished statesmen, for their supineness, their backwardness, their apathy, their loss of the old English faculty of invention, and their inability to profit by the inventions of other people ; and it was said that English manufacturers were wholly behind the times and were going to sleep, while the trade of the world was passing from them. He was not concerned to deny that there might be a great deal of truth in those reproaches, but they were grossly exaggerated. He might mention just two instances. Any manufacturer engaged in the vast textile industry of Yorkshire would confess that the great development of that industry in the last 20 years, almost its resurrection, was largely due to the establishment of the Yorkshire College, and to the use made by enterprising firms of scientific information obtained there. The other instance was the rotatory kiln which was the subject of the discussion. It was not a foreign invention. The idea had occurred to two gentlemen, both members of the Institution, Mr. Crampton and Mr. Ransome. Mr. Stokes, another Englishman, had been the next to improve it ; and Mr. Hurry, who had worked like a brother with his colleague, Mr. Seaman, was an Englishman by birth who had not even taken up American nationality. The company which had first established the rotatory system on a vast scale was not a French company, a

Mr. L. White. Belgian company or a German company, but happened to be an English one. The moral he wished to point was that if British manufacturers wished to hold their own they must profit by all scientific instruction, and must avail themselves of all information they could obtain from men of science, whether in the important field of mechanics, or in the equally important field of chemistry.

The President. The PRESIDENT remarked that there was one important point in the Paper to which he wished to refer, and that was the claim for the process of getting, straight from the works, cement which was perfectly mature. Engineers who had to deal with large quantities of cement incurred great expense in providing cooling-sheds; and he had found, after handling about 50,000 tons in one place, that the cost of construction of those sheds and the labour came to about 2s. 1d. per ton. It would be a very great saving to receive from the makers cement which did not involve that expense of handling. He did not know that, as an engineer, he would care to take cement in bags straight from the manufactory and send it on to any constructive work—probably no engineer would be bold enough to do that; he would prefer to take the cement out of the bags and keep it for a week, instead of the 4 weeks or 5 weeks as at present before it was considered cool enough to put into the work. During hot dry weather it had frequently been found that the cement could not be used even after that time, but had to be kept in the cooling sheds for 7, 8, or even 10 weeks. Any process which would save the time thereby lost would be invaluable.

Mr. Stanger. Mr. W. H. STANGER remarked that personally he had not had much to do with the writing of the Paper. Whatever credit might be due for it belonged to his friend and partner, Mr. Blount, although of course he was jointly responsible for the opinions expressed in the Paper. Mr. Leedham White had practically said a great deal of what he had intended to say, and had expressed it much more satisfactorily than he could have done. A more admirable advocate from the engineer's point of view he had not heard for a long time. As a person who was responsible for something like 4,000 tons or 5,000 tons of cement a week, as one of those disagreeable people who had to examine it, to test it, and to reject a large quantity of it, he was bound to say that it was quite time English manufacturers did waken up. The old-fashioned kiln would not do; a great deal too much underburnt cement was produced by it. In the rotatory process there was practically no underburnt stuff. If there was one thing which engineers objected to more than another it was unsound cement

which needed to be turned over, involving an expenditure of 2s. or 3s. per ton. He believed that the newer process with rotatory kilns, if properly worked, would effect a great saving of cost to the manufacturers by diminishing the quantity of cement rejected, when they were dealing with specifications written by people who knew what they wanted and intended to get it. It would save not only delays and trouble in that way, but a considerable amount of money in the improvement of the product.

Mr. BERTRAM BLOUNT desired to thank the members for the interest shown in the discussion, and his partner for his generous allusion to him. He considered that the President had touched on what was really for engineers the kernel of the matter. Cement could be prepared by the manufacturers in a perfect state for the users, and could be turned out uniformly correct; it could be taken direct from the kiln to the grinding machinery, packed into bags and made into concrete, and that concrete would be sound. To members of the Institution he could not imagine a better recommendation.

In reply to questions raised in the discussion, it might be observed that the clinker lining of the burning-cylinder was patched from time to time during the working of the kiln. With such patching, which might occupy on an average 1 hour in 24, the life of the lining proper—that was, the firebrick lining—would be indefinitely prolonged. In actual practice it had been in use as long as 2 years without needing repair. A great advantage was thus secured in what was practically a permanent lining; the frequent and costly repairs of the firebrick lining of ordinary fixed kilns were abolished. With regard to the means for supporting the cylinder, the illustrations were purely diagrammatic, and were not meant to convey that the kiln was carried on only two points. As a matter of fact four points were used. The Authors concurred in Mr. Atkinson's views concerning the method of burning coal-dust used by the Atlas Company. They regarded it as one of the most striking and meritorious features of the process and as conducing largely to its success. It was well worth considering whether this method might not be usefully applied in other industries. Mr. Atkinson's suggestion as to the formation of a soda-lime glass was interesting, and should be the subject of experimental inquiry. The retention of the clinker coating in place was no doubt aided, as Mr. Atkinson had suggested, by the fact that the coating, when completed, constituted a circular arch. It was possible that a saving in fuel might be effected by drying wet slurry in an apparatus distinct from the kiln, but it would

Mr. Blount. be achieved with some sacrifice of simplicity. They agreed with Mr. Redgrave that the plant of all existing works in this country might be regarded as antiquated and indeed practically obsolete, and were of opinion that it would be necessary to substitute a well-designed rotatory process such as that described in the Paper. The Authors considered that the use of an iron lining for a rotatory kiln was wholly impracticable; the conditions were entirely different from those obtaining in fixed vertical kilns, which were sometimes constructed of this material. They feared that Mr. Gilbert had not fully grasped the true causes of the superiority of the rotatory system. These were set forth in the Paper. They were well acquainted with the Schneider kiln, which was a good example of those fixed kilns which were now on the verge of extinction. The rotatory process was as freely used in the United States on wet raw materials as on dry raw materials, and with equal success. It was scarcely reasonable to suppose that mere translation through a certain longitude would affect the working of the plant, and on no other ground with which they were acquainted could it be contended that a well-contrived rotatory process would fail to work in England. Therefore they must dissent from the suggestion that their recommendation of cement made by the rotatory system was in any way premature. It was well to receive innovations with caution, but there was a point where caution degenerated into inaction. Progress then became impossible. In reply to Mr. Harding, it should be stated that the rotatory process could certainly be employed for burning lime; it was also well fitted for treating the hard, dry, raw materials of the blue lias district. It was true that limestones naturally containing a good deal of argillaceous matter required, other things being equal, less mixing with the second raw material—*e.g.*, a shale—than did pure limestone or chalk. The mixing was partially effected before the manufacturer dealt with it at all. It was correct that experiments had been made by Messrs. Hurry and Seaman on the production of cement clinker by actual fusion in a blast-furnace. The principle was sound, but the difficulties of realising it in practice were likely to prove severe. According to the Authors' latest information the process was still in its experimental stage. Knowing the skill and perseverance of the inventors and the financial resources of their company, the Authors would not be surprised to learn of the ultimate success of the process. Concerning Mr. Reid's remarks, the Authors would point out that their Paper was on the rotatory process of cement manufacture, and not

on rotatory furnaces generally. Also, they had confined themselves Mr. Blount to the description of processes which had been actually worked. It did not appear that the Crampton process had been put to a practical test, and, interesting as was the inventor's description, they had refrained from more than a passing reference to it. From the fears which Mr. Reid entertained as to the success of the process in this country it was evident that he had hardly realised the situation. The rotatory process was at work in America on wet raw materials—chalk and clay—identical with those used here, as well as on dry raw materials. It had been found by experience to be as easy to handle the one as the other, and the difficulties suggested were imaginary. The old plan of plastering the walls of fixed kilns with slurry differed radically from the Hurry-Seaman method of providing an efficient protective coating of clinker for the firebrick lining of a rotatory kiln. The essence of the latter procedure was the heating of the firebrick and the application thereto of plastic clinker; in the former the walls of the cold kiln were simply daubed with slurry in the hope that some might stick and hinder to some extent the action of the clinker when the kiln was heated. The suggestion of a water-jacket was interesting, but only academically so, for the lining difficulty which it was designed to overcome did not now in fact exist. The extreme lip of the kiln which projected into the burner-chamber, where it was exposed to a good deal of heat, was cooled by a water-ring in the Hurry-Seaman plant, but this was to protect the end of the metal shell, and had nothing in common with a water-jacket to serve as a substitute or protection for the lining. The Authors were glad to find Mr. Butler in agreement with them as to the necessity for abolishing the old uneconomical discontinuous process. As he had surmised, they had had in their minds chiefly Continental practice when speaking of the Dietsch kiln. It was certainly curious that English manufacturers had never taken kindly to an apparatus which had undoubted merits for appropriate materials and conditions. Mr. Butler's calculation of the quantity of water, additional to that naturally present in the raw materials, which was necessary to form a slurry, scarcely gave an adequate expression of the facts. It was true that there might be only 10 per cent. of this additional water calculated on the slurry, but it must be remembered that this corresponded with about 20 per cent. calculated on the dry raw materials, which was the real standard of comparison. An example might make this clear. If a chalk containing 20 per cent. of water were mixed

Mr. Blount. with a clay containing 45 per cent. of water in the usual proportions so as to yield a mixture which, when dry, contained three parts of dry chalk to one part of dry clay, the mixture in its natural wet state would contain water amounting to 39 per cent. of the weight of its dry constituents. If, however, this natural wet mixture was washed so as to form what was commonly termed a 40 per cent. slurry—that was, a slurry containing 60 parts by weight of dry raw materials and 40 parts by weight of water—it would contain water amounting to 67 per cent. of the weight of its dry constituents—that was to say, the water had been increased by a quantity amounting to 28 per cent. of the dry slurry, or 72 per cent. of the original quantity of water naturally present. Thus the additional water to be evaporated was a more formidable amount than would be suspected from Mr. Butler's method of expressing the same facts. The possibility of avoiding this addition of water had been touched on in the Paper, and the difficulty of removing the flints had been adverted to, but the full discussion of the question did not fall within the present intention of the Authors. The process of adding to the clinker a small and regulated quantity of water was undoubtedly advantageous. During the grinding of the clinker the water was perfectly distributed, and fulfilled its office of slaking any unsaturated lime compounds which might be present. The tests of Atlas cement quoted in the Paper certainly indicated a marked superiority to ordinary English cement made by the old process, especially in regard to that most important quality, soundness. This soundness was secured by the regularity of burning and the systematic moistening described in the Paper. Mr. Plaister's conclusions as to what constituted economical and rational manufacture of cement material might have been considerably modified had he been allowed to visit the Atlas Works. The Authors were acquainted with the practice obtaining in every typical rotatory cement-works, not only in America, but on the Continent; and they could say without hesitation that in none which they had visited, or concerning which they had obtained information, was the systematic, continuous and economical handling of materials from crushers to barrels carried out with any approach to the degree of perfection attained on the Hurry-Seaman system. In like manner, though coal was being everywhere adopted, yet there was at the present time no burner to be compared with that employed at the Atlas Works. There was no reason to suppose that improvements in this and other respects would not be made, but obviously the Authors must confine themselves to a description

of the industry in its present state, and not indulge in vaticination. Had Mr. Plaister had access to the sources of information open to themselves he would have been less surprised at the statement of costs which had been given. The Authors concurred with Mr. Leedham White's view that manufacturers of cement had of late years shown themselves eager to improve their methods both in point of economy and in quality of product. The present enterprise of the Associated Portland Cement Manufacturers in adopting rotatory kilns was certainly commendable, and they hoped that, before long, many of the other works under the control of that body would be provided with modern plant.

### Correspondence.

Mr. E. CANDLOT, of Paris, remarked that there was no doubt the rotatory process of burning marked a considerable advance in the manufacture of Portland cement; but the resulting economy should not be exaggerated. The figures given by the Authors for the quantity of fuel required by the older process for power and for burning, viz.,  $17\frac{1}{2}$  per cent. and 43 per cent. respectively, might be correct for English manufactories, but they were certainly not so for French, German, or Belgian works. The maximum consumption of fuel by a well-equipped Continental manufactory, using wet materials containing 45 per cent. of water, was 10 per cent. to 12 per cent. for power and 28 per cent. to 30 per cent. for burning. In works using dry materials it was 15 per cent. for power and 18 per cent. to 20 per cent. for burning (with Schneider or Timm kilns using bricks direct from the presses and containing 9 per cent. of water). This would considerably affect the calculations of the advantages of the rotatory process. He believed also that the figure given in the Paper for the amount of fuel required for burning by that process (30 per cent.) was too low. In all American works which he had visited the amount had been greater, and had sometimes reached 60 per cent. This of course referred to kilns 60 feet in length; an important economy of fuel was obtainable with longer furnaces; but he did not think that the consumption could be reduced below 35 per cent. The fuel required for power purposes appeared to him to have been under-estimated, as rotatory furnaces required a considerable amount of motive power, not only for rotating the