DISCUSSION.

MR. F. A. FRANKLIN considered that the author in his interesting paper had given us a large amount of useful information generally regarding the possible use of electric lighting for street and house purposes, and his estimate covered what was practically an area of approximately 28 square miles pretty closely built over. To command this large area he proposed three sites for the establishment of the necessary machinery to secure 60,000 indicated h.p. with auxiliary additions. This item appeared to represent the bulk of the cost of such a scheme; it would, therefore, be of interest in regard to economy to take into consideration what might be done with our mountain river water, as water power was fast becoming the most important and economical force used in the transmission of energy for the purposes of electricity all over the world. In the case of Sydney it was unfortunate that a head of water, and that limited, could not be obtained nearer on an air line than a distance of 30 miles, otherwise there was no doubt a sufficient head of water existed at several points within that radius for the creation and transmission of very considerable power. At the head of navigation within the gorge of the Grose River an admirable site existed for the establishment of a water power plant, which was capable of being commanded by a 100 ft. head of water in considerable volume by the construction, at moderate cost, of about 1¼ miles of conducting works; this had been already proved by actual survey. The Wanagamba River, a little above its junction with the Nepean, offered similar facilities; and again, on a similar scale as to extent of head, but much larger as regarded volume, the magnificent sheet of water stretching from the Penrith Railway Bridge for eleven miles to the junction of the Wanagamba, stood at its present ordinary summer level 44 ft. over the corresponding level at Windsor Bridge ten miles, and, in consequence of the obstruction to river by the boulder and stone deposits at Emu Plains, it was probable the greater part of this very valuable head of water could be utilised within a distance of five miles from Penrith.

Mr. W. D. Cruickshank said he had listened to the reading of the paper with a considerable amount of pleasure. He had noticed that when a commercial comparison was made between gas and the electric light to the disadvantage of the latter, the electrical engineer's usual reply was "but we give you so much more light than gas." This was not what was wanted, as the existing gas arrangements gave quite sufficient light for what was required, and any increase must result in unnecessary expense. The recent experiments of Tesla opened up a new field entirely, and seemed likely to revolutionize the present system of electric lighting.

Mr. J. O. Callender considered that as the paper treated the subject in such general terms it was a difficult matter to discuss it. In regard to the figures given by the author, they were certainly such that electrical engineers would take exception to, but this point he would leave to others to deal with. The assumption of the author that the multiphase system was likely to be adopted was certainly startling, as the extra cost in wiring alone would be enormous, and sufficient of itself to prevent its introduction.

Mr. O. Haes said that as the paper was so very discursive it was impossible to deal with it in more than a general way. Mr. Cruickshank made some remarks on electrical engineers when confronted with the question of cost and apparently excessive lighting of streets, but he (the speaker) wished to state on the authority of the Chief Commissioner of Police of New York that every extra arc lamp in a city meant one policeman less.

The author stated that the cost of electric light at 8d. per Board of Trade unit was equal to gas at 6s. 8d. per 1,000 cubic feet, as a matter of fact it is equal to gas at 8s. per 1,000 ft., as a 16 candle power lamp consumed 60 watts in 16·6 hours. For the electric light to compete with gas at 5s. 3d. per 1,000 ft., the price charged here, it would be necessary to supply the current at 5¼d. per unit, which could not be done except at a great loss financially. But in England and other places it was found, even where the price of gas was as low as 2s. 9d. per 1,000 ft., the people adopted the electric light and were quite willing to pay the extra cost. If an installation were properly arranged, there was not nearly such a waste of light as with gas. The statement that the light could be supplied in Sydney at the same cost as in England was erroneous and absolutely impossible. The Australia Hotel plant, if the author's figures were correct, was certainly a most inefficient one.

At one of the leading central lighting stations in London they were producing a B.T.U. at 2½d., exclusive of cost of management, which amounted to 2½d., or a total cost of 5d., and were charging 7d. per unit. The author from his figures arrived at the conclusion that a central supply company ought to be able to supply the current at much less cost than the Australia Hotel, but he evidently did not consider that the cost of mains alone at large central lighting stations amounted to from 25 to 40 per cent. of the capital outlay, to which interest must be added, thus forming a most important item of expenditure.

With regard to the author's scheme for lighting Sydney, he had much over-rated the number of houses that would use the light. It was improbable that any person paying a less rental than £50 per year would make an effort to instal the electric light in their houses, and the number of these would amount to from 20 to 25 per cent. The whole of Sydney and its suburbs would not take more than 500,000 lamps for the next ten years. The number of lamps proposed for lighting suburban streets was excessive, as it was not necessary to light them to the same extent as the city streets. No practical person at the present day would think of working battery transformers in series, and it was not until it was found possible to work them in parallel that the alternating system became of any value. The multiphase system would increase the cost of the mains at least 25 per cent., the cost of the machines would be about the same, but the difficulties of regulation in such a scheme as that required for Sydney would be enormous.

On the question as to whether work of this description should be carried out by the Government, Municipal Councils, or private companies, he might say from his experience in England that there was no doubt that if carried out by the latter the consumers would be the gainers.

Mr. E. Dymond (a visitor) said the field opened up by the author was so great that it was impossible in the limits of this discussion to deal with more than a portion of it. He had touched, though only very lightly, on the schemes now afloat for lighting Sydney, and described shortly some known lighting systems, and finally advocated one which for central station work was as yet untried. He also sketched out a scheme for lighting the whole metropolitan area, and in doing so had made use of certain figures, calculations, and deductions therefrom, which he (the speaker) had gone into with some care, and desired to make some comment on them as, in his opinion, they did not agree with actual practice, nor in some cases with the requirements of Sydney. To begin with, he thought the author had been rather led away in the desire to make out a good case for Electric Light *v.* Gas in his figures as to cost. A standard 16 candle power lamp required 60 watts or 3·75 watts per candle power, and at this rate one B.T.U. would give 266 candles per hour. Now if one penny per B.T.U. was, as stated, to equal gas at 10d. per 1,000 ft., then the gas could only have an illuminating power of 13·3 candles. The recognized practice in England was to say that 1d. per unit = 1s. per 1,000 ft., and at this rate to supply an equal light at the same price as gas we must only charge $5\frac{1}{4}$d. per unit, and not 6·3d. This would make a unit at the Australia Hotel equivalent to gas at 5·$5\frac{1}{4}$d. He was not as hopeful as the author in believing that we could produce in Sydney at the same price as in London, and unless our plant was more efficient than that at the Australia Hotel we certainly could not do so. There it appeared one horse-power required 6 lbs. of coal and 20 lbs. of steam, therefore the boilers only evaporated $3\frac{1}{3}$ lbs. of water per lb. of coal. In this case the coal or the boiler must be very bad, for they were burning about three times as much as they should. Supposing steam coal to cost in London 26s., which it did not, 1 N.H.P. in London would cost 26s., but it would cost 39s. at the Australia. He wished to correct a slight error in the comparison between the private lighting capacity of the City Council's scheme and that of the Sydney Electric Light Co. The latter proposed to provide for 100,000 60 watt lamps, and the Council for 16,000, the proportion being 6 to 1. The author no doubt allowed for 100,000 30 watt lamps, though even then the proportion would be three to one, not three to two. The author's figures for his proposed stations required modification, as he appeared to have taken the ten-roomed house as the average in allowing eight 30 watt lamps, and half the lamps installed to be on at once. Since even at the very low distribution efficiency which he stated one-half, 1,100,000 lamps only required 40,250 h.p. As, however, it was the usual practice to allow eighteen 30 watt lamps to the horse-power, the actual power required would be 30,555, so that either the author had allowed an excessive margin of power or expected an abnormally full load, which in England had been found by experience to lie between one-third and one-half of the total number of lamps installed. Eight 30 watt lamps per house in 62,000 houses required 20,000 electric horse-power, but the author's allowance was 30 to

40,000 I.H.P. Taking a mean, viz.: 35,000, we obtained an efficiency of only 55 per cent. At the Australia Hotel 82 per cent. was allowed for the motive plant, which left 27 per cent. loss in distribution; if such a loss be inseparable from his scheme, then it was doomed to failure from a financial point of view. He did not quite see how the author had arrived at his figure of 12,000 H.P. for street incandescent lamps, as 438 miles, at 27 lamps mile = 11,826, and allowing 100 watts per lamp required 1,585 E.H.P. to light them, representing at the very low before mentioned efficiency of 55 per cent., 2,882 I.H.P. and not 12,000. Applying this correction and allowing the not unreasonably maximum load efficiency of 70 per cent. the figures were:—

House to house, viz., eight 30 watt lamps per house, 30 per cent. spare plant	36,000
Streets lighted by arcs	5,500
„ „ incandescent...	2,300
Total	43,800

not 57,500 as given in the paper. Turning from the figures to the scheme itself, it did not appear to him to be a financial possibility. The author had not given any estimate of first cost or working expenses, but to supply 60 or 50 1,000 h.p. engines, with boiler power to match, and suitable stations for them, together with the cost of laying mains through 700 miles of streets would involve a sum to be expressed only in millions; beyond the range of even the Government in its present financial position. Another undesirable feature was the fact that by including such a large suburban area, the city people would have to pay for the suburban lighting, in the same way as the main lines of railways had to pay for the branch lines. The London method of dividing the town into districts was the one most likely to extend the use of electric light, best serve the public, and produce the best financial results. The method described in the paper of using battery transformers was practically unworkable. To charge ten batteries in series, and discharge them on to ten separate circuits at the same time, would be certain to throw unequal work on to the different sections, and the result would be the speedy destruction of the cells. There were two methods of employing battery transformers in central station work. In the first method these were the operations:—1st—The motive plant in the central station charged half the battery in the storage station (or stations), the lighting being done by the other half. 2nd—The motive plant charged the second half of the battery while the first half did the lighting. 3rd—The charging was stopped and both batteries discharged. This system was adopted at Chelsea. The regulation and switching was, in this case, entirely automatic. The other method was to charge the battery in parallel with the lamp circuits, and to use a three wire system if two batteries were charged in series. This latter was the most usual, and was to be found at Kensington, Westminster, St. Pancras, and many other stations.

Mr. Brain (a visitor) considered that as the author in the first two paragraphs of his paper candidly acknowledged his having had no actual experience of the gigantic subject he had taken up, and confessed his object to be to call forth in discussion the information others had at their disposal upon the various points, we were justified in giving what facts and figures we had of actual experience without departing from the recognised limits of the discussion. Had the author confined himself to Sydney, with underground mains, in his remarks upon street lighting, without house to house, he would perhaps have been justified in his summary dismissal of the subject. As he had dealt with the whole question, however, he would be glad to hear some of the figures and experience in the past to which he had referred. He based his condemnation merely upon the paucity of street lamps in proportion to the length of mains required; this point, however, lost much of its force from the fact that (the street lamps being controlled from the station) special mains were required in either case. Furthermore, he overlooked the fact that such plants have nearly all the advantages he could claim for large private installations, with some additional ones. Chief amongst these was the load factor. Street lamps were all lighted at a certain hour, remained alight their full time, and were extinguished simultaneously. In other words, the load factor, which was the ratio of the average load for a given time to the maximum load during the same time was constant. These considerations were very encouraging upon paper, but it was still more so to find them endorsed by results. As American or English figures might be considered objectionable from an Australian point of view, he was glad to be in a position to give the experience of a small colonial town with a street lighting plant for about 20 miles of streets.

The total number of units generated during the year was 29,221·5, at a gross cost, including all outside expenses, lamp renewals, cleaning lanterns, etc., and after allowing for depreciation, and paying 5½ per cent. on the total capital expended throughout the whole installation, of £672, thus showing a cost of 5½d. per Board of Trade unit, which was, by the author's figures, equivalent to gas at 4s. 7d. per 1,000 feet, or, according to a fairer proportion, 5s. 6d. Now, this included absolutely every expense, while gas in the same town was being supplied to consumers at 12s. 6d. per 1,000 feet. Again, allowing for arc lights at the rate of ten incandescent for one arc, in order to institute a comparison the 16 c.p. lamps cost £2 18s. 5d. per annum each, whereas the Gas Company's charge was £8 2s. 6d. for each street light. With regard to the area, the electric lights were often placed many chains beyond the limit to which the Gas Company would carry their pipes for the street lamps. He might state that this was a low-tension two-wire system, and the fuel used was wood.

Of course, any commercial undertaking might be mismanaged or unfortunate, but these figures showed that the past experiences of street lighting did not carry the lesson the author asserted.