DISCUSSION.

Mr. R. W. Finlayson said that, to the ordinary observer, the question of irrigation did not seem so important as that of conservation, for if there was water to distribute there would not be very much difficulty, after some little experience, in finding ways and means to do so. Grading of land, draining, trenching, channeling, damming, etc., as referred to in the Paper under discussion, required to be intelligently dealt with and were certainly very important matters, but without the indispensible water, they would not count. The conservation of water consequent on the rainfall was, without doubt, the most important element to be studied and appreciated by the man who went on to the land in this country, and to most people it was a matter of wonder why more attention had not been given to it. Personally speaking, he had been on a few stations, selections, farms, etc., where it would be impossible to secure conditions under which water could be impounded were some trouble taken in the formation of dams. No doubt, dam-making did not appeal to all of us; nevertheless, it was evident that if more attention were given to it by those most interested, much benefit would result.

The want of forethought and general interest taken in this and kindred subjects, by those who are on the land, was often manifest. "Sufficient for the day is the water thereof," might be said to indicate the policy of many. This reminded him of an incident in which he had figured some years ago. A party from away out West came down by train to Sydney one morning, called on him (the speaker) in a very great hurry, and said that he had at last decided to go in for irrigation—he added he had been thinking of it for years—and asked that the matter should be gone into at once, and the pumping machinery and pipes sent up to his station with all possible speed. His requirements included two windmills and a considerable quantity of piping, to be used for irrigation and domestic purposes. He was to leave again that night for the West, and the gear he had ordered was to follow within three days, the man's only fear being that we might delay fulfilment of the order. During the following afternoon, we received a wire from him, saying he had just arrived at the end of his railway journey, where he had been met by his manager, who informed him that they had had some splendid showers at his station, consequently he would like us to cancel the whole order, as he would not now require the plant. He (the speaker) did not know how this gentleman got along during the subsequent droughts that had been experienced.

Without going away back to Egyptian and Indian practice, he would like to call attention to the question of pumping by a natural force, namely, wind, the application of which was by a combination of the ordinary modern pump and windmill. A windmill, as a rule, suggested a very economical method of developing work with good results, and he did not think that sufficient importance had been paid to the subject in this country. There had been many windmills erected here, and many were still working, but, generally speaking, there seemed to be a want of intelligent conception as to the possibilities of this appliance. The ordinary windmill had, of course, to be elevated so far in the air that it might not always get the attention it required and deserved as to lubrication and general overhaul. Hence the reason for many failures. There is a windmill on the market, so constructed that its tower could be brought down to the ground, so that an operator could examine the gear with ease. That was the mill that was brought to the man, and not the man to the mill. He was not aware if the idea was a success, but it certainly showed the existence of that disposition to allow anything working at an altitude, to do so with as little care as possible.

A common practice in America for utilizing wind power in irrigation, was by placing as many as half a dozen mills around an earth reservoir. Small mills were found to suit better than large ones, for when the diameter of the wheel was increased above 10ft or 12ft the structural strength was considerably diminished, and the possibility of injury through storm more liable. The employment of a number of small mills, 8ft to 12ft in diameter, had, therefore, been found most economical, especially as in the event of one being injured, the others were able to continue pumping. These mills, as a rule, operated piston pumps, and, of course, the size of the pump was determined by the power at command, and the work required from it. A 4-inch piston having 10-inch stroke, would require about 11 days to pump 2 acre inches—say, 48,000 gallons. The average length of a day's work for a windmill was only about eight hours, and the speed was not likely to average more than thirty strokes per minute where single-acting pumps were used, and these pumps were generally found better in windmill practice than double-acting. A 10ft windmill, having a lift of 15ft, might irrigate about three acres two inches deep in ten days, and a 12ft mill, with a lift of 25ft, about one and a-half acres to a depth of four inches in everv ten days.

It was comparatively simple and inexpensive to sink wells and erect windmills attached to suitable pumps. The machine once provided could be operated day or night if the wind kept up, and would bring to the surface a small, but continuous, supply of water. This small stream, if turned out on the soil, would, however, only flow a short distance, and then disappear into the thirsty ground, so that irrigation directly from a windmill was impracticable, but for storing up a supply, he thought it suggested a very desirable and effective plant. That there were disadvantages he admitted, one being that most windmills were constructed to operate only in moderate winds; therefore, light breezes often passed by without starting the wheel in motion. As the strength of the wind increased, the wheel showed greater and greater efficiency, until the velocity was about 8 or 10 miles an hour. At greater speeds, the mills were usually so constructed that they began to turn out of the wind, in order to protect themselves, and thus the efficiency began to drop off rapidly as the wind became more and more powerful. When it approached a gale, the mill stopped completely, and thus, at the time when, with sufficiently strong construction, the greatest amount of water could be pumped, the machine was standing idle. One of the important inventions yet to be made was a simple, strong windmill, which would continue in operation throughout a heavy wind. Many mechanicians had tried their hand at something of this kind, but had not yet succeeded in producing a commercial article. The suggestion had been made that pumping by wind might reach its highest efficiency through the use of compressed air, the windmill operating some form of simple air compressor, from which a pipe would be led down into a well, and through it water be forced out, by means of what is known as an air lift. If such a device was practicable, windmills could be located on the highest point of the farm, and the compressed air carried down to the lower lying wells.

In irrigation schemes, under certain conditions, the centrifugal pump figured to very great advantage. Naturally, the motive power for such a pump was a steam engine—usually of the portable type—and, in fact, no question arose on this point so long as fuel was easily obtainable. The oil engine, however, has come into considerable notice recently, and in some cases it has proved a cheaper means of operating pumps.

From data in his possession, re found that at an irrigation plant in Wisconsin, U.S.A., an 8-h.p. engine—driving a 4-inch centrifugal pump, drawing from 26ft through 110ft of 6in suction pipe at the rate of $22\frac{1}{8}$ acre-inches per day—consumed one ton of Indiana block coal, at 4 dollars (sixteen shillings and eightpence) per ton. The fuel-cost for 4 acre-inches, lift 26ft high, was 72 cents. (three shillings), which made six such irrigations cost, for fuel alone, eighteen shillings. According to American reports, gasoline engines employed in irrigation would produce one applied h.p., at a cost of one to one and a-half cents. per hour for fuel. At the higher figure, the water necessary to irrigate one acre to a depth of 4 inches (about 87,000 gallons) could be lifted 20ft high, at a fuel-cost of fourteen cents., and if the irrigation were repeated six times, the total cost per acre for fuel alone would be only eighty-four cents. (three shillings and sixpence). Comparing this with the steam engine previously referred to, it was found that to do the same work, the steam engine, on the basis of a 20ft lift, would require twelve shillings and ninepence for fuel, as against three shillings and sixpence for the gasoline engine. This comparison, however, was hardly applicable when brought home to us here, inasmuch as fuel would cost on any irrigating area about the same as it would cost in America, while gasoline would naturally cost more here than in the United States. Gasoline, he understood, cost in Sydney 1/6 per gallon, and no doubt, as a rule, 1/8 before it could be put in the engine tank. Further, one pint per horse-power per hour was about the amount reckoned on as consumption, so that at that rate, the difference in favor of the oil engine would be so very little—about 6d in the six 4 acre-inches irrigations—that its employment here would not be worth considering.

The direct-acting steam pump also found its place in the irrigation field, and as was known, much had been done through its agency in irrigating for sugar and general crops.

A very complete and successful system of irrigation on a small scale, worked by a pumping plant of this character was in operation not far from Sydney; i.e., at the Hospital for Insane at Parramatta. The pump was of the direct-double-acting type, having an 8-inch steam cylinder, 7-inch water cylinder, and 12-inch stroke. Its normal capacity was 10,000 gallons per hour. It was supplied with steam from an 8-h.p. vertical boiler, working at 45lb to the square inch. The pump was placed on the banks of the river, probably about

20ft above water level, and with a length of suction pipe of about 50ft. The water was pumped to a height of 70ft above the river level, through 5-inch piping to a reservoir, the delivery pipe being about six chains in length. The reservoir contained about 600,000 gallons of water, it was partly below and partly above ground, and had puddled walls, which were faced with stone flagging. Water was drawn off as required through pipes, and into open channels, also under-ground channels, as were considered best. The supply in the reservoir was supposed to be sufficient for irrigating about sixty acres.

The results of irrigation in this instance were very manifest, the cultivation paddocks, vegetable garden, and ornamental grounds evidencing a very high state of culture; in fact, cabbages and cauliflowers had been produced there up to 30lb weight. The soil varied from a stiff clay to a light sandy loam, the former necessitating a good deal of preliminary drainagle, so as to get rid of the natural tendency to sourness. In this instance it was estimated that 5 cwts of coal delivered 80,000 gallons of water, at a fuel-cost of about 5/-.

The hydraulic ram, which, as was known, was an automatic pump, was also sometimes employed, but for irrigation it was not very suitable, in consequence of its limited capacity. However, it was employed a good deal in this State for domestic purposes on stations and farms.

Although much more might easily be said, and many interesting data given regarding this very important and interesting subject, he would not speak further, beyond quoting briefly from a recent work on Irrigation, commenting on a report made by the Hon. E. A. Hitchcock, Minister of the Interior, U.S.A., to the President (Mr. Roosevelt), in 1901, which, while not exactly applicable to Australia, would show the estimation in which the subject was held in America.

It was as follows:—"The President and Secretary do not ask the Government to do something which might be better done by private enterprise. The latter has already built irrigation works sufficient to utilize nearly the whole available flow of the streams in the arid regions during the irrigation season. Further progress in irrigation can come only though the storage of flood waters in reservoirs, and nearly all of this work is absolutely impossible without Government aid. Remembering the great productiveness of irrigated lands, and that farming with irrigation is almost always intensive farming, the estimate that these reclaimed lands will provide food and homes for a population 'greater than that of our whole country to-day,' does not seem extravagant. In comparison with such a possible development, every other project or public work which the Government is asked to undertake, seems, indeed, insignificant. The dead and profitless deserts need only the magic touch of water to make arable lands, that will afford farms and homes for the surplus people of our overcrowded Eastern cities. The National Government, the owner of these arid lands, is the only power competent to carry this mighty enterprise to a successful conclusion, to divide the reclaimed lands into small farms for actual settlers and home-builders only, and to provide water for the settlers, at a price sufficient merely to reimburse the cost of the work."

MR. J. SHIRRA said that the author's remark as to the vital importance of the subject of irrigation to the people of these States was emphatically true.. If Australia was ever to realise its magnificent possibilities, it must be chiefly by conserving and utilising its rainfall. Other peoples were bestirring themselves, and we would be left a very minor power in the world, indeed, if we could not devise and practise methods of assuring our water supply.

The Federal Government of the United States, last year, committed itself to a scheme, amongst others, for irrigating the barren lands of the North-West States and territories—and incidentally of moderating the floods in the Missisippi and its tributaries—a scheme estimated to cost seven million dollars. The old irrigation works of the Incas in Peru, which, before Pizarro's conquest, supported a very large population, where now there is little but desolation, were being revived and improved on, and the rainless valleys of Peru and Chili irrigated with the snow waters of the summits of the Andes, would reproduce the fertility of irrgiated California.

The hydraulic system of California was originally developed for mining purposes—in Australia, the scarcity of water on the goldfields, no doubt, prevented such a system of flumes and channels being installed, but we might find our best models in the Pacific States of the Great Republic.

In 1894 it was estimated that there were 4000 miles of irrigation canals in California, irrigating 3,000,000 acres of land, the value of which had increased in consequence, by £140,000,000.

A paper read in 1887, nearly 20 years ago, before the Institute of Mechanical Enginers, gave valuable information as to the pumping machinery and wells then used, and the discussion on it might be read with profit by all engineers. The amount of information available to all those interested in irrigation and pumping was very great, and much might be found in the transactions of the Institution of Civil Engineers, of the Mechanical Engineers, and of smiilar bodies, as well as in special works on the subject.

Irrigation by gravitation from large storage reservoirs was the only way by which large areas of land could be made secure against drought, and a genuine attempt to institute such reservoirs, in an economical spirit, on the head waters of our great rivers, by the Federal or the State Government, would secure the loyal support of all good citizens.

Meanwhile much more might be done on a small scale by individuals. The "cockatoo" farmer was too often content