terrace standing about 10 ft. above water-level. Across the second bridge a race could be cut, to deal with about 6,000 cubic feet of water per second. A bridge should be built over this race to connect with the road, and from the end of the race through valves the water would go direct to the turbines standing on the terrace below.

Although this spot is fifteen miles further away from Christchurch than the Waimakariri Gorge scheme, the small increase of transmission line would hardly have to be considered in view of the larger amount of horse-power to be delivered in Christchurch—about 20,000 as against 14,500 h.p.

Mr. Dudley Dobson and Mr. Hales both concur with me in my opinion that the Rakaia would be the easier scheme of the two. I should therefore strongly recommend that the City of Christchurch should give Mr. Dobson the necessary instructions to have a total and careful survey made of the Rakaia, as he did of the Waimakariri Gorge. I shall then be able to give a fuller report upon the Rakaia River than what I could do at present, when effective figures are failing. The plans and sketches are those that were drawn up to build the bridges in the Rakaia Gorge, and have been given to me by Mr. Hales.

I shall at any time be pleased to put myself at the disposal of the Government.

## OTIRA RIVER.

Accompanied by Mr. Hales and Mr. Dobson I visited the Otira Gorge with the view of ascertaining what water-power could be got from the Otira River. The Otira Gorge is a very rough piece of country, where a great many difficulties and expenses would be met in making a race of sufficient length to assure the fall sufficient to have any power to transmit. Under these circumstances I do not think the Otira Gorge can be used for large energies, as the capital cost would be too heavy to give any satisfactory financial returns.

Below the zigzag of the main road and close to the big shingle slip, and right at the foot of the rock in which it is proposed to cut the Midland Railway tunnel, there is a very narrow gorge not more than 24 ft. wide through which the Otira waters rush. The computation of these waters give the possibilities of getting a few hundred horse-power out of this place, but I should propose that this power should be used to run the trains through the tunnel by means of electrical traction, which would be of very great advantage, doing away with smoke in the tunnel. Locomotives with 2 × 64 = 128 h.p. would be sufficient to do the work on that line. Higher up, close to the source of the Otira, the falls are very rapid, and a certain amount of power—say, from 800 to 1,000—could be procured; but, taking into account the rough country, it would be rather expensive as a scheme. Unless hard pressed for power, I should not entertain any ideas of using the Otira waters in any other way than for the tunnel-construction, traction, lighting, and ventilating.

## TRANSFORMATION OF RAILWAYS BY ELECTRICAL TRACTION.

The transformation of the present system of steam railways into electrical-traction railways would certainly require a vast amount of capital, but it would also give good returns, and very greatly improve the train system of the whole country. Instead of running on the steep grades which I have noticed, combined with which steepness are many rather sharp curves, small trains either for passengers or freight, or preferably mixed trains, could be run at short intervals, thereby giving much better passenger facilities. The water-power has not to be reckoned as the present steam-power, which means outlay of coal expense for every horse-power used. Communication between north and south by several trains a day would add to the convenience of passengers and business in general.

The cost of equipping the present 3 ft. 6 in. line electrically would be the cost of trolly-wire overhead and the copper bondage of the present road-bed, which can be calculated at about £300 per mile.

The electric locomotives, containing each 2 × 64 = 128 h.p., would be sufficient to run all your ordinary trains on the existing grades. I understand that the present power used in the whole of the North Island for the railway-engines amounts to about 4,000 h.p. By taking rotary transforming units of 500 h.p. at a cost all complete of about £4,000 per unit, eight units would be required for actual working and two units as a reserve—that is, in case the whole of the transformation from steam to electricity would be made at once. As previously stated, the three-phase alternating current with 50,000 volts primary potential could be transformed on the electric locomotives into 2,000 or even 550 volts alternating three-phase current, doing away with the rotary transformers which change the alternating three-phase into 550 volt direct current, thereby saving expense and simplifying the whole system. Of course, if only part of the lines should be equipped, from one to several rotary transformation units could be put up. The electric locomotive would pull the present cars. All over the world the economy of electrical power over steam has been calculated at 40 per cent.

There are about a thousand miles of railways in the North Island south of Auckland. The equipment without the power-station can be reckoned at about £500 per mile. One thousand miles would therefore cost £500,000. As already referred to, this would greatly improve the Railway service in so far that along the trolly any number of trains could be pushed through at short intervals, increasing the number of services and the speed, and therefore the convenience of the passengers and goods carried over the line, and all this with a reduction in the present cost of railway-running.

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