AN ENGINEERING TRIUMPH.

THE LAKES ENTRANCE.

The entrance from the ocean to the lake system of Gippsland looks small in a photograph, but the work is an engineering triumph. There is no other like it in the Southern hemisphere, and we are not aware of any precisely similar achievement in the old world, though, of course, it must have predecessors of some kind, or the correct design would not have been hit upon. The long wash of an Australasian sea in the process of the ages formed the stretch of sand known as the Ninety Mile Beach—a beach with a background in some places of swamp and in others of fresh water; and the problem the engineer had to solve was where to cut and how to keep permanently open a navigable channel through the sand from the lakes to the ocean. It has been solved, and there is now a passage always available, as wide as a four chain road, and between 60ft. and 70ft. deep, where previously the swell, in a very grudging spirit, allowed, at intervals, a shifting, shallow, and uncertain runlet from the saltwater to the fresh. Tide and swell were capricious in years past, sometimes permitting the break to occur at one spot, sometimes at another, sometimes letting it stand open for weeks, sometimes closing it for months. The great lake system, fed by some of the principal rivers in the colony, till the engineers came on the scene, had to be satisfied with an exit that would hardly have carried off the storm waters of Elizabeth-street, when that thoroughfare used to have its little flood. Now, but for a bar which has formed opposite the permanent entrance, at a respectful distance, the biggest steamship afloat might pass in and out. The bar will even now let in any intercolonial steamer, but forbids the entrance of an Orlando or Crescent, though between the piers there is often 70ft. of water. A glance at the map, together with the knowledge gained by an excursion over the lakes, warrants the belief that these lakes owe their existence to the sea having drawn a straight line of shore—like a bowstring—from the bluff two miles or so north of the Lakes Entrance to Port Albert. Behind the string are long, narrow strips of still water, cut off from the sea by sand hummocks, and lined on their inward edge by ti-tree flats; and behind these flats (themselves long and narrow) are the wide circles and irregular loops of water constituting the main lake system.

You get to the Lakes Entrance from Melbourne by taking the train to Sale or Bairnsdale. If you get off at Sale you walk a few yards to the head of the canal, where the steamer Dargo or Omeo waits at half-past 2 p.m. to convey you by water. You pass by the canal into the Latrobe River, thence proceeding down stream to the swing-bridge shown in the illustration. This bridge carries the traffic on the road between Sale and Port Albert. It opens for the steamer, and in about an hour, after steaming pleasantly between two lines of wattle and ti-tree (in which the bell birds by joining note to note keep up continuous music not unlike the creaking of an unoiled barrow-wheel), you discover that you are on the open water, among the cormorants and black swans. On reaching the far side of the lake you enter the narrow lane leading to Lake Victoria, which leads again to other straits and sheets of water, till in about five hours' time you find yourself (if it be summer time and still daylight) proceeding nearly due east between a lofty ridge on the left hand and ti-tree flats on the other. This is the highway named the Reeves River, which is no river, but merely a long strip of lake water. The high ridge terminates in Jimmy's Point, and a jetty marks the landing-place for Kalimna, the scene of the picturesque view given among the illustrations which suggests the "Lovers' Walk." Kalimna is said to be Gaelish, and Mr. M'Intyre, the Minister of Lands, is quoted at the Lakes Entrance as an authority for the statement. Kalimna-house (kept by Mr. Thomas Laughton) stands on the top of the ridge, 200ft. above lake-level, and it is from Jimmy's Point, in which the ridge ends, that the photograph giving a landscape view of the entrance was taken. Down by the entrance a line of houses and offices have been erected along the sheltered side of the hummocks, while the township of Cunninghame has grown up on the tongue-pointed flat, with water on each side, between Jimmy's Point and the hummocks. The Reeves River is in direct line with the entrance, and there is always a strong run of tide along it. The waters to

strong run of tide along it. The waters to the left used in former days to lead to the old shifting entrance in the dim distance, but they are now only "backwater," for, since the permanent entrance was cut, this shifting one has been for ever closed. Before going on to the works it is convenient to state here that the return journey, if made by Bairnsdale, takes, by water, about three hours; the course would be almost straight but for the detour to Paynesville, at which the steamer J. C. D. always calls. From the lakes you pass into the Mitchell, a more stately river than the Latrobe, with high banks (flooded on great occasions), adorned with wattles, brambles (which are a wonderful protection against the scouring of the current in flood time), and patches of cultivation. All the rivers entering the lakes have formed training walls for themselves, and the primeval banks are not met with until the steamer has ascended several miles of stream. In the background, on the right bank, there is a bluff forming the terminal point of the ancient river boundary. Probably the waves of the sea once broke upon its base. Here the suburban residences and the fields of potatoes, maize, and hops begin, and high up there is a neat dwelling, with trim fences, gravelled paths, and full-stocked garden, said to be the summer abode of the widow of an old colonist who divides the year between Sydney and Bairnsdale. A view is given of the scenery on the Mitchell. Bairnsdale, like Sale, is close to the water, and a short drive by cab takes you from the steamer to the train. There used to be a wharf, but the December floods have, by eating away the bank, crumpled the woodwork into a switchback, and an old punt is the landing place. A parting word about the steamers. They are neat, commodious, and comfortable, and the captains in charge of them as obliging men as one would wish to meet anywhere, especially the compact captain of the Omeo.

A reference to our map will show that from Jimmy's Point (official name Mount Barkly, rarely heard of) to Roadknight's Bluff the Reeves River is separated from the ocean by a long and very narrow strip of sand. The entrance to the lakes, or their connection with the ocean, fixed itself from time to time, and as a result of natural causes, anywhere within this space of four or five miles. He would have had some courage who would have prophesied and backed his opinion that the opening would remain in one place for three months. Then there were the intervals, not unheard of, during which there was no opening at all, when, in fact, what must have been a very much reduced river volume was disposed of apparently after entering the lakes by ordinary evaporation. The rule of the entrance—so far as a rule can be applied to such a very wayward place—seems to have been that in times of prolonged drought and general placidity of weather the river water not evaporated meandered down past the site of the present Cunninghame, and emerged at the eastern extremity of Ninety Mile Beach, or Roadknight's Bluff already mentioned. At such times the water on the bar would vary from 18in. to 3ft. 6in. in depth. In periods of heavy rains in the watershed, however, the lakes, previously at their minimum level, would become filled, and a pressure exerted against the sandspit, the tendency always being to find a near cut to the sea. An accident of wind might—and, no doubt, often did—aid this effort, and on many occasions the outlet of one day has been some miles from that of the previous day. A new opening always indicated "good" water for a time, and afforded the mariner his opportunity; but in due course, with a reduction in the lakes level, shallow-draught craft and "bumping across" would again become the rule. In 1862-3 a few small schooners, mostly built on the lakes and of only 3ft. 6in. draught when fully laden, traded between the lakes and Melbourne; when not choosing to "bump across" or when that process seemed inexpedient, they could be towed in by a diminutive steamer, the Lady of the Lake. In the latter year an effort was made to establish steam communication with Melbourne, when a flat-bottomed paddle steamer, the Trio, was built for the trade; but she was not a success in any way. About the same time the Gippsland Steam Navigation Company took up the running, and in the face of all difficulties, first of getting into, then in getting out of the lakes and often being stuck on the bar, such steamers as the Charles Edward, the Murray, and Avon (paddles), and the s.s. Rosedale, and the well-known names of Captain Stewart Patrick, still the grand old man of the Hygiea, Darly, Clarke, and Stalker, became familiar as household

the Hygiea, Darly, Clarke, and Stalker, became familiar as household names on Gippsland waters. Owing to stranding, bumping, and rolling, the trade was risky and never profitable, but enough was done by these pioneers to induce Government to consider the possibility of forming a permanent entrance for any vessel likely to find its way through the broad expanses—but generally shallow depths—of the lakes.

The investigations were conducted by Mr. W. W. Wardell, M. Inst. C. E., at that time inspector-general of public works, and the late Mr. W. H. Steel, M. Inst. C. E., then engineer of marine works, P.W. D., and who eventually succeeded Mr. Wardell as I.G. Mr. Steel took great interest in the development of the scheme until his untimely death about four years ago.

It appears to have been determined by these gentlemen at an early date that a permanent entrance was a feasible project, and a site for it was chosen opposite Jimmy's Point, or as near to the source of the outflow waters as the outline of the country would permit. The works now occupy this site, the result indicating the wisdom of the selection. Sir John Coode, writing in 1869, says:—"But it was evident from the first that Mr. Wardell, in selecting the site for the entrance to the lakes, upon which training-piles were afterwards driven, had shown a wise discretion," &c. Matters so advanced that in 1869 the first contract was let for constructing the sides of a new channel, to consist of timber-piles and framing, to form an entrance 400ft. wide across the hummocks. This was completed in 1872. In 1873 a further contract was let for excavating a channel from the river to the sea along the east wall, evidently with the idea that once the river water found an exit it would soon scour away the whole sand-mass between the walls. But just as the opening was made a gale from the south-west came up and filled the excavation up again. The works were stopped for the time being, and in 1875 it appears to have been realised that sheeted walls through the hummocks would not suffice to maintain an open waterway, and to make the work a success the sides would have to be extended in the shape of piers into fairly deep water. Even then, however, it is doubtful if it were anticipated that they would ever be required to attain to their present magnitude. The whole business was allowed to remain in abeyance until, in 1878, advantage was taken of Sir John Coode's visit to Australia to obtain authoritative advice on the project.

Sir John advised adhering to the site as already chosen, on which some £18,000 had been expended, utilising the frame and pile work through the hummocks, while from the seaward termination of these walls he proposed that two piers should be run out, the western one to be 650ft. long, and the eastern 500ft.; not at right angles, but forming an angle of 65deg. with the coast-line. Sir John Coode's recommendations were almost in their entirety given effect to, and in these piers no deflection was permitted. Having to withstand the fierce gales of Bass's Straits and the Southern Ocean it can well be understood that their construction is of great stability, while their care and maintenance demand never-ceasing vigilance. Each pier is formed of two parallel walls, 30ft. apart, of close round piling, each pile being about 2ft. in diameter on top; they are driven with a rake outwards, and are strongly framed with huge walings both inside and outside. In addition, at intervals of 30ft. measured longitudinally along the piers, are crosswalls or "bulk heads," also of close round piling stiffened with walings as in the outer walls, and bound into them, thus dividing the piers into cells or compartments, technically termed "cribs," of 30ft. square. The piles range in length from 30ft. to 50ft. These cribs were filled in with rubble, large rough stones, which had to be quarried near Sarsfield, and transported by tramway and barges some 25 miles to the works. And the filling in did not end with one or two efforts. To this day the stone sinks in the cribs, evidently becoming absorbed in the underlying sand, and contracts for the supply of additional stone to make good the wants thus caused are nearly continuously running.

It is not within the cribs alone that stone is required. Some very unlooked-for features have developed themselves in connection with the Lakes Entrance. In 1889, the piers having been advanced seawards almost to completion, arrangements were made by the Public Works Department to dredge out the mass of sand between

the Public Works Department to dredge out the mass of sand between the training walls through the hummocks. A commencement was actually made, when on the night of the 14th June, 1889, what is locally described as a "tidal wave" broke through from the sea between the piers and walls, and swept away the whole mass of sand, first into the Reeves River, and then by the recoil out to sea. Thus was saved to the Government an expenditure of many thousands of pounds, but the dredge and plant were with difficulty prevented from following the retreating waters and sand out to sea. Again, Sir John says:—"I apprehend that when the works have been completed a navigable depth of about 12ft. in the centre of the channel at low water will be maintained on almost all occasions." There must be some natural conditions in operation to which Sir John did not give full consideration, for the depth in mid channel varies between 65 and 75 feet. From a maintenance point of view this is very serious, for it is evident that the bottom must be lower than the toe of the piles composing the piers. Such is the fact. Now to counterbalance the thrust of the rubble from within, and to give these piles a footing, it is necessary to throw in stone in vast quantities to take the place of the sand into which they were originally driven. The measure of this work is by thousands of pounds sterling per year, and though the demand for more stone is falling off, it cannot be foretold when it will cease.

But in the works as they stand a splendid engineering success is manifest. There has been expended on them about £120,000. A ship of any draught could go in between the piers, but one drawing over 10 feet could not go far. Notwithstanding the scour at the outlet, where the velocity of the outflow is often six miles per hour, the lakes do not vary in depth to any great degree, but for vessels of the Despatch, Maitland, and Queenscliff class the navigation up to Bairnsdale is always open, and a fleet of schooners maintain a trade to Mossiface, near Bruthen, the port of East Gippsland, as well as to Sale. More improvements in the lakes are yet sought, it being the gospel of every loyal Lakelander that their chief trade should be direct to Sydney with East Gippsland produce.