JULY 14TH, 1910.

LIGHTHOUSES.

SOME HISTORICAL AND DESCRIPTIVE NOTES.

(By JAMES SHIRRA.)

During the Session of 1905 the author read a paper on "Modern Lighthouse Illumination," pointing out how modern improvements in producing artificial light have been applied in this field of Engineering. In the last five years progress has still been made, and he proposed to supplement that paper by another giving a few more details of what has been done, and showing by lantern slides the greater number of the lighthouses on our New South Wales coast.

Just now, when there is a possibility of the Commonwealth Government bringing forward legislation to enable it to take over and administer this service, it should be specially interesting to know what the State has done; thus to show that the additions and improvements that will doubtless be made in future will be part of a continuous evolution that has been going on ever since Governor Macquarie erected the first Macquarie Tower at the South Head nearly a century ago.

This tower dates back, we may say, to the infancy of lighthouse engineering. It was admittedly a prolonged infancy, for lighthouses of some sort must have been in use ever since navigators left the shelter of their harbours; there must have been many a smaller sea-light erected before the classic prototype that has given its name to lighthouses in all ages since the Pharos of Alexandria. This is the first light-tower of which we have any record: it dates from about 300 B.C., and lasted 1600 years. It was reckoned one of the wonders

of the world, and far exceeded any modern or subsequent lighthouse in height, being over 400 ft. high, and said to have been visible at a fabulous distance. But the Greeks were contented for their artificial light with a lamp composed of a strand of wick floating in an open vessel of oil, a slush-lamp, as they call it in the back-blocks, a light evidently unsuitable for a beacon. The lighthouse illumination was produced by burning billets of wood in an open chaffer, and the cost of such fuel in countries like Egypt, and the labour of getting it up the tower, must have discouraged the multiplication of these structures. The lighthouse at Corunna, in the north-west of Spain, still in use, is probably older than the Pharos of Alexandria. It was built originally by the Phoenicians, and repaired by the Emperor Trajan some 1800 years ago. It is known as the Tower of Hercules, and was re-established as a lighthouse in 1634; in 1847 it had a dioptric apparatus placed in it. The tower is 159 ft. high. The early Caesars were great patrons of Harbour Engineering, and the works at Ostia, then the port of Rome, at the mouth of the Tiber, comprised docks and jetties and lighthouses of the most massive sort; but the sea has now receded from them and they are lost in the dismal marshes. The port of Claudius at Ostia was formed by two jetties, enclosing the harbour. Across the mouth or entrance was an insulated breakwater, on which stood the Pharos, built up of storey upon storey of orders of the purest classic architecture, with ingeniously contrived rooms and staircases to accommodate the staff, and a fire was lit on the approach of night in the upper storey of the lofty structure.

The mole and pharos at Centicellae, 40 miles north of Ostia, now Civita Vecchia, the modern port of Rome, were similar. The port took its name from the hundred cells or covered slips wherein the galleys of the Imperial

Navy were drawn up when out of commission—to protect them from the cobra, he presumed. An illustration of the lighthouse taken from an Italian book dated 1601, and reproduced in the "Nautical Magazine," shows the tower with a glazed lantern, so that candles or lamps were early used here in place of an open fire. A yard-arm is also shown, on which pendant balls are hung for signalling purposes, as may be seen in any seaport to-day.

The old lighthouse at Genoa, erected in the fifteenth century, was until quite recently the highest existing light-tower in the world, the building being 249 ft. high. The popular history of lighthouses, however, generally begins with the construction of the Eddystone, first in 1696, the tower now on that rock being the fourth since then. Still, the erection of the Cordouan Tower at the mouth of the Garonne, a century earlier, was a greater feat of engineering, and the lower part of the original tower is still extant, carrying a modern dioptric light. (Plate XXIII., Fig. 1.) It was begun in 1584 and finished in 1610. The rock on which it was built is very dry at low water only—a bare rock 500 fathoms long and 250 broad. On this was built a circular platform of solid masonry 135 feet diameter at the base. This was surmounted by a massive surrounding wall 12 ft. thick and high. In the middle of the circle 100 ft. in diameter as enclosed stood the tower, 50 ft. diameter at the base, and composed of four storeys, highly decorated, each of a different order of architecture. The third storey was appropriated to the chapel, of circular form, covered with a dome; internal diameter was 31 ft., and height, including dome, 40 ft. The interior was decorated with paintings and mosaics. The lantern on top of all was 5 ft. internal and 9 ft. external diameter, of stone, with a small stone lantern on top that served as a chimney to carry off the smoke from the open fire that was used.

In 1727 an iron lantern was substituted for the stone one; about 1780, argand oil lamps with silvered metallic reflectors were introduced, and in 1854 a dioptric first order flashing light was installed.

He specially referred to this tower, because it showed how for long France has taken the lead in structures of this sort; and also because it strongly showed the tendency amongst lighthouse architects of the past to forget the very raison d'etre of these erections and to fritter away money and skill on mere decoration, while the lantern itself was a mass of stonework that could not fail to obscure the light, dull at the best, within. The contrast of these massive stone mullions to the narrow gun-metal bars, arranged obliquely so as not to block the light in a vertical plane, of modern lanterns, is striking.

The modern French lighthouse authorities, however, although they do not neglect elegance and aesthetic effect, have a reputation for doing effective work without extravagant expense. They do not scruple to spend money on architectural decoration when they can legitimately do so, all the same. The modern French lighthouse at Penmarch, on the Breton coast, officially known as the "Phare d' Eckmuhl," was erected in 1897, the cost being nearly wholly defrayed by a legacy of 300,000 francs from the Marquise de Bloqueville, for a monumental tower in honour of her father, Marshal Davoust, Prince of Eckmuhl, one of the first Napoleon's faithful followers, whose statue in bronze adorns the vestibule of the tower. The light is electric, feu eclair or lightning flash, having an estimated candle power of 38,000,000—a marked improvement on the dull red glow that used to greet the homeward-bound Bordeaux vessel at Cordonan in the old days.

Another bequest of 400,000 francs has been made by M. Eugene Potron, for the construction of a light tower

on a pinnacle rock at the S.W. point of the dangers of Ushant, "la jument d' Ouessant," which is now under construction. The rock is extremely limited in area, and the tower is united to it by a great number of vertical steel bars about $1\frac{1}{4}$ in. diameter, built into the rock and the solid foundation of the tower—a method similar to that employed by Rudyard in his Eddystone tower, which answered the purpose perfectly. This was the second Eddystone tower, which stood for half a century, being eventually destroyed by fire.

These insulated rock towers, of course, present peculiar problems in constructive engineering; but the great majority of lighthouses are simply towers which require only ordinary architectural skill to design, keeping in view economy of material and facility of erecton. Penmarch tower, for instance, is on the mainland, on a rocky plateau at no great height above the sea-level. One peculiarity of the French lights of the Channel and the Bay of Biscay is the comparatively low ground on which they are erected, contrasting with the elevated headlands, in most cases, on the south coast of England, and in New South Wales. Hence high towers are needed to get a sufficient range of visibility. To be visible at 20 miles distance, with the observer's eye 15 ft. above the sea surface, the light must, in ordinary states of the atmosphere, be at least 180 ft. above sea-level. Seen at this distance, it would just appear as dipping, or touching the convexity of the sea; and as the air just above the sea surface is often much less transparent than that some feet higher up, it is advisable to give a somewhat greater height to the light than the geographical minimum required for a desired range of visibility. Penmarch is 209 ft. high to the focal plane, or centre of the lantern, Barfleur 233, and the recently-erected tower in the Ile Vierge 246, or 75 metres from the ground to the focus of the light. The old tower at

Genoa is 70 metres or 230 ft. high to the focal plane. Barfleur, near Cherbourg, erected in 1893, therefore slightly exceeds it; but the Ile Vierge, erected in 1902, is now unmistakably the highest—about 270 ft. to the top of ventilator. There are at least eight towers in the N. and N.W. of France over 160 ft. high, while the highest in the British Islands, Skerryvore, is only 140, and none of our New South Wales towers are much over half that. These French towers do not have to withstand the shock of the ocean waves, and are mostly built of brick or small stones, in cement. They are stable against wind pressure, but suffer from vibration to some extent. The oscillations are of small extent (about 2 m.m. or one-twelfth of an inch only), but the working has produced vertical fissures in the line of the windows in the Calais lighthouse and some others, built of brick. The tower of Ile Vierge, which is of granite, in comparatively small blocks however, is more massive and well built. Its oscillations are too small to measure; it is likely to remain intact.

The tower of les Roches Douvres, 185 ft. high, is of iron; it looks slender, but its material secures it from damage by vibration. It looks rather dismal standing up against the grey northern sky. There is a similar tower in our Southern Seas—that of Amadee I., at the entrance to the port of Noumea, in New Caledonia. It is 174 ft. high (perhaps the highest light-tower in the Southern Hemisphere), and is certainly a very graceful structure, though it may seem to waste its sweetness in the desert air in these island wastes of waters.

The iron tower in the Fiji group, at Solo I., is much less artistic than the Noumea one, but probably preferable from a utilitarian point of view. It is 90 ft. high. A new ferro-concrete tower has just been constructed in Koro I., in the Fijis, 60 ft. high, built up somewhat similarly to the cast iron one, but of "Monier"

plates, or slabs of re-inforced concrete, by Messrs. Gummow and Forrest, of Sydney.

Our Macquarie Tower, or South Head Light, was founded on July 11th, 1816, to form a lighthouse and guard room at Port Jackson Heads. The present structure was built alongside of the first one, to the same general design, in 1883, the first building being then demolished. In the waiting room of the present tower may be seen photographs of the two structures standing side by side, and the first one looks a very respectable edifice. Its masonry was inferior, however. In 1824 extensive repairs had to be effected, and the tower was hooped with iron bands. Thus strengthened, it lasted until the new one was built; but its lantern was small and its light (a white revolving one with metallic reflectors behind the oil lamp, giving its maximum effulgence every minute and a half) weak. The tower was considered not strong enough to sustain the larger and heavier lantern proposed, so the whole thing was rebuilt, the foundation-stone being laid by Sir Henry Parkes on March 1st, 1880. The catoptric or reflecting lamps of the old light were the best thing known in the early part of last century. In 1816 the Isle of May, in Scotland, which is now an electric light—the only electric one under control of the Commissioners of Northern Lights—was still illuminated by an open coal fire. Fresnel's introduction of dioptric or refracting lenses came in about 1822, and revolutionised the lighthouse system. The present lighting apparatus at Macquarie is in this dioptric system, but is already old-fashioned; a shorter flash, more frequently repeated, or recurring in groups—two, three, or four flashes at short intervals, with a longer interval of darkness between the groups—being found more penetrating and distinctive than the comparatively long flash and longer eclipse of such lights as that now at South Head.

Experiments were being made at the time of his 1905 paper, with a similar lamp, similar in principle, but quite different in detail, one of which he was able to show you in action then. This burner (Plate XXIII., Fig. 2), the invention of Messrs. Schmidt and Ford, of Sydney, having, in fact, been perfected by Mr. Ford, who is the Government Lighthouse Mechanician, has now been introduced into three of our lighthouses with excellent results, the burners having been made at the Government Dockyard workshops. They use Welsbach mantles of 55 m.m. diameter (nearly $2\frac{1}{4}$ inch).

A view of the apparatus was then shown.

He would now show lantern views from photographs of most of our State lighthouses, taking them individually from the south, northwards.

Our most southern light is that at Green Cape (Plate XXIV., Fig. 1), a fine octagonal tower of concrete, 68 ft. high, with an optical apparatus of eight panels revolving every 6 mins. 40 secs.; thus it gives a flash of $5\frac{1}{2}$ secs. every 50 seconds. The light-keepers' cottages are detached from the tower, as is the best and usual practice; there is no danger from unequal settlement, as when the heavy tower and lighter residences are in one. Here is another view from the landward side, and another of the out-buildings from the balcony of the tower. In the background is the disused post office, and the signal flagstaff; and a faint clearing may be seen, the cemetery, where the victims of the "Ly-ee-moon" wreck of 1886 are interred.

The next lighthouse is Twofold Bay, famous for whales and trained whale-hounds or killers. This is a small harbour light, fixed red, attached to the pilot or port-master's residence. Teel oil is still burnt here, in lieu of the kerosene that is used elsewhere, when gas or electricity are not available, the reason being the greater safety against fire in the narrow wooden tower.

Eden still cherishes hope of being the port of the Federal Capital, in which case a more monumental lighthouse will doubtless be required. Montague Island is the next light, a first order one, giving a flash of 5 secs. alternating with a fixed light of 33 secs. duration separated by eclipses of 16 seconds. The fixed light is really a flash of long duration, but of inferior power, and at a long distance off may be invisible while the short flash may be clearly seen. A Schmidt-Ford incandescent burner was installed here this year, which has improved the brilliancy so much that the fixed light will seldom be invisible within the geographical range. The tower is of grey granite obtained in the island; the massive granite boulders of which it is composed can be clearly seen.

Warden Head, or Ulladulla, is the next light. He had no view of this, but it is similar to Wollongong, which was shown later. It was originally on the round-head of Ulladulla Jetty, and is strongly built of iron plate and T. irons to withstand the seas, but was removed to Warden Head about 1½ miles from the jetty as a more useful position, and where it stands well above the sea-level. It is a fixed white light.

Point Perpendicular, on the north side of Jervis Bay entrance, comes next, the light at Cape St. George southward of the entrance having been dismantled when this was erected in 1897. It is an up-to-date group flashing one, giving three flashes in quick succession every 20 seconds. It has a Schmidt-Ford incandescent burner, installed last year. The optic consists of three groups of three panels each, or nine in all, the horizontal section being roughly an equilateral triangle with convex sides, each side being three panels, making very obtuse angles with each other. The effect of this is to divide the light emission into nine flashes in three groups of three; when the apparatus revolves, the three

flashes occur with an interval of about 1¼ seconds, while there is an interval of 13 seconds between the groups.

Crookhaven, the next view, is our latest lighthouse, having been erected in 1904 (excepting the small wooden lightroom at Forster, erected last year), although a light was exhibited from a wooden lighthouse here for some years. It is a fixed red light, fifth order only. The outer lantern seems large for so small a light, but is that which formerly surmounted the tower at Cape St. George. The building, tower and service room, is a good example of how elegance and economy may be combined.

At Kiama is a brick cylindrical tower, overlooking the well-known Kiama blowhole. The light is a fourth order green one, burning gas. In 1907 a 600 c.p. Kern incandescent high-power burner was installed here, which effected a great improvement in the quality of the light, the ordinary yellow gas flame having been very deficient in green rays, and the light given weak and unsatisfactory.

Wollongong is also a gas light, white fixed. A 600 c.p. Kern burner was put here in 1907 also. The pressure in the gas supply was sometimes deficient, and the full power seldom realised; but recent improvements by the Gas Company in the pipe arrangements have somewhat ameliorated this. Also, the light was formerly obscured over the Bellambi Reef; but as it was always possible to mistake some of the street lamps for the lighthouse, this was altered in 1908, and a red screen put in to show a red light over this danger. The tower is of wrought iron plates and angles, and is considerably exposed to the shock of the seas in bad weather, as the next view indicated.

The South Head Light or Macquarie Tower is the next in sequence, and with its appearance you are all familiar. Anyone interested can learn more from a visit to it and

a look at the newspaper cuttings, photographs, etc., preserved in the waiting room there, than can be given here. The electric current is generated by De Meritens dynamos with permanent field magnets, driven by Crossley gas engines. The original dynamos and engines are still working very satisfactorily; the cylinders were rebored last year and new pistons fitted, but the repairs required have been few. The optical apparatus consists of 16 panels, the eight on the landward side being nearly wholly masked by a fixed dioptric curved mirror which reflects the landward light back to the seaward panels. This is revolved by weights and clockwork once in 16 minutes, so a flash occurs every minute of eight seconds duration.

At the Inner South Head a tower, named the Hornby Light, was erected on the point after the wreck of the Dunbar in 1857. It is a catoptric or reflecting light, there being an iron frame with brackets for 20 oil lamps in it, of which ten only were used—nine seaward and one up the harbour. In 1904 these were replaced with ten ordinary incandescent gas burners, giving a much better light with less trouble and expense. The sea is encroaching on the cliff here, and no doubt the light will require shifting ere long.

The lighting of Sydney Harbour furnishes us with several interesting examples of different styles of construction and illumination. The old lightship at the Sow and Pigs Reef is the only harbour light using kerosene; it is somewhat archaic in style, but suits its purpose. He understood it is contemplated to erect a lighthouse in place of it. The leading lights at Vaucluse are gas lamps in brick towers; the beacons at the Sow and Pigs, off Shark Island, and at Goat Island, are lit by acetylene gas; the reinforced concrete towers at Bradley's and Robertson's Points have incandescent electric lamps, as have Fort Denison, Dawes' and Miller's

Point Beacons. The braced iron column and coloured sectors of the last are noteworthy.

The first lighthouse north of Sydney is Barrenjoey. The tower is built of the local sandstone, and retains its natural brown stone colour; hence it is not so conspicuous a day mark as our other lighthouses, which (excepting Hornby, which is variegated red and white) are all painted white. It is a fixed red light.

Next is Norah Head, erected in 1902, an up-to-date feu' eclair or lightning flash light. It was described in the author's 1905 paper.

Twenty-three miles north of it are the Nobby's and the lights of Newcastle. The Nobby's rock would seem meant by nature for a pedestal for a lighthouse to the Coal River, but really it is not far enough seawards, and the breakwaters extend a considerable distance beyond it, relegating it into the position of a harbour light. A red light has long been shown on the south breakwater, outside the Nobby's light, and now a new beacon is being erected outside this again, near the end of the breakwater. As it is exposed to the seas and dangerous of approach in bad weather, a permanent 31-day Wigham lamp, burning all the time, needing attention only once a month, is being installed. As at Sydney, acetylene, gas, and electricity are used for the leading lights and beacons in the harbour.

Point Stephens, at the entrance to Port Stephens, has a fine stone tower, but the light is rather old-fashioned. It consists of twelve catoptric or reflecting lamps, on a revolving iron frame, showing white and red alternately.

Seal Rocks, or Sugarloaf Point, is the next light. It is a very important landfall, besides very necessary to mark the dangers of "the rocks," and was much improved three years ago by being fitted with an incandescent petroleum vapour burner. The optic has 16

panels, like that at South Head, but no reflecting mirror; so the light is sent out in 16 simultaneous rays, or each flash is only one-sixteenth of the whole light, not half, as it is at Norah Head, where there are two large panels only. Hence the importance of a high-power burner in a lantern of this construction. The views give a poor idea of the site of the lighthouse. It should be seen from the sea, when it seems on the summit of an insulated conical rock—the summit, however, being really a ridge and the insulation not quite complete.

At Forster, or Cape Hawke, anchorage a small acetylene green fixed light was erected last year. Acetylene is much better than kerosene for green light, its white flame being much richer in green rays than the yellower oil flame.

Crowdy Head and Tacking Point are the next two lights on the coast; they are fourth order white fixed lights. The buildings are identical with that at Clarence Heads, which was shown later.

Next is Smoky Cape, near the Macleay River entrance, 420 ft. above sea-level, the highest on our coast. Yet it is supplied with fresh water by gravitation from a reservoir on Big Smoky Hill behind it, the waterworks being originally put there by the contractor for water supply during erection. It is a first-class modern light, erected in 1895, very similar to that at Point Perpendicular, only giving its triple flash every half-minute instead of every 20 seconds.

South Solitary I. comes next, the only rock lighthouse we have, for, though dignified with the name of islands, the Solitaries are little more than rocks. Still, there is room enough for comfortable cottages for the keepers, and to enable one to stretch one's legs, and vegetation enough to pasture rabbits and a few goats. Landing on the island is always difficult, though. The author would have liked to have shown the passengers

being hoisted out of a small boat by a basket or bosun's chair by the crane and swung round on the landing-place, but he had no view of this place at all. It is a first order flashing light, with a Chance's incandescent burner.

Yamba, or Clarence River Heads, is the next light, and it is much the same as the lighthouses at Crowdy, Tacking Point, Richmond River Heads, and Fingal Point. They are fixed white lights of no great power, but their chief fault is the want of distinction. Richmond Heads, indeed, is distinguished by having a secondary light about 108 feet from it at a lower elevation.

Cape Byron Light, 14 miles north of the Richmond, is a much more imposing structure—a first-class, first order, lightning-flasher, finely situated on the most easterly point of Australia, 371 ft. above sea-level. The author regretted that he had no view of it to show.

Fingal Head Lighthouse, on a rocky spur of the spit between the Tweed River and the sea, is the most northerly light in New South Wales, the Queensland border being immediately north of the Tweed Heads, two miles from it. The light is 80 feet above sea-level and overlook the Danger Reefs, whose name sufficiently indicates their quality.

Should any of you desire to imitate the Marquise de Bloqueville or Mons. Potron, and bequeath £15,000 or £20,000 to erect a monumental lighthouse, the author recommended this site for your consideration. A first order flashing light here, 200 ft. above sea-level, would almost shake hands, so to speak, with the next light on the Coast, Cape Moreton, 70 miles off, and be a boon to seamen at this dangerous point on the east coast of Australia.

Mr. W. Reeks said it afforded him very great pleasure to rise on this occasion to thank the author for his interesting paper, and formally to propose a vote

of thanks. To say that his paper had been interesting would be, so to speak, damning it with faint praise, because it had been intensely interesting. It had given a lot of useful information, and he had done it in his usual genial style that made us almost believe we were at an evening lecture rather than at an Engineering Association meeting. To attempt to discuss the paper would be bordering on politics, which, of course, is excepted in their Association and in that room, as they all knew. But the subject that the author had brought before them was probably one of the most important of modern times, so far as our State of New South Wales is concerned. When they realised that about 20 years ago there were comparatively few very small ships on our coast, and compare them with the magnificent coastal ships of the present day (he used the term advisedly), they would realise the enormous importance of the lighthouse services. That appeared to him to have been a sufficient warrant for the author to have given them this interesting lecture. He desired to most sincerely thank Mr. Shirra for his extremely interesting and valuable paper.

Mr. H. B. Howe said he had great pleasure in seconding the proposition so ably put before them by Mr. Reeks. He must say that to one and all the paper had been most interesting, and it struck him, as one of the landsmen, it would be perhaps more instructive than others, and it must be a very great amount of benefit to those who travel up and down our coast to know and have such a description placed before them. He had great pleasure in seconding the proposition so ably put by Mr. Reeks.

The vote of thanks was carried by acclamation.

The Chairman: Although Mr. Faulkner is not present, still, I would ask you to thank him for his paper, in addition to the paper he has given us before on "Algae," and also to thank Mr. Shirra for reading it.

The vote of thanks was carried by acclamation.