filled from the Mediterranean in April 1867, has risen 12 centimetres, or about 4 inches, and that its waters are continually running at a slow rate into the Mediterranean; certainly this statement agreed with what we ourselves remarked, for we always found a current running northward from Lake Timsah at the rate of from half a mile to a mile an hour. Limited, however, as these tidal observations were, they were taken with great care, and appear sufficient to show that, except at the Suez end, the tides will not materially affect the passage of vessels; at that end, therefore, large vessels must regulate their time of passing; indeed, the greatest difficulty which will be experienced will be not from the tides, but from the prevailing north-east wind in the canal, which will make close steerage difficult in going from north to south."

It thus appears that the tidal column of 5 feet range in the Red Sea is reduced to 2 feet at the distance of 6 miles, and is practically annihilated by the wide expanse of the Bitter Lakes. But it would be highly interesting to have this conclusion confirmed by further systematic tidal observations.

In executing this strange work of the desert, and converting dry sands into navigable lakes, it is stated that there have been about *eighty millions* of cubic yards of material excavated, and at one time sixty dredging-machines and nearly 30,000 labourers were employed. For their use a supply of fresh water was conveyed from the Nile at Cairo, and distributed along the whole length of the canal, a work which of itself was one of no small magnitude.

The cost of the whole undertaking, including the harbours, is stated to have been about £20,000,000. The terminal harbours are important adjuncts of this great work. That on the Mediterranean is Port Saïd, which is formed by two breakwaters constructed of concrete blocks, the western one 6940 feet in length and the eastern 6020 feet, enclosing an area of about 450 acres, with an average depth of only 13 or 14 feet, excepting in the channel leading to the canal, where the depth is 25 to 28 feet. The entrance to the canal at Suez is also protected by a breakwater, and in connection with the harbour at this place there are two large basins and a dry dock.

The canal may be regarded as a highway for steamers of 400 feet in length and 50 feet beam. A delay of three days is calculated on for the passage across from Port Saïd to Suez.

It is satisfactory to learn from the report of Commander Wharton, of H.M.S. "Shearwater," "that the canal retains its depth of water. That report states that "comparing generally the depth of the canal in 1873 and 1875 it seems that it is in about the same condition, with perhaps a slight balance in favour of increased depth now; while its average minimum may be stated at 26 feet, there are yet considerable tracts where 25 feet and even as little as 24 feet will be passed over." The survey of Lieutenant Millard, also reported to the Admiralty in 1875, shows that at the entrance to Port Saïd harbour the 27, 30, and 33 feet contour lines were seaward of those obtained before, proving that some shallowing of the water at the entrance has taken place.

The use made of the canal may be judged of from the following table of the traffic passing through since its commencement[1]:—

Year.	Number of Vessels.	Gross Tonnage.	Receipts.
1870	486	654,915	£206,373
1871	765	1,142,200	359,748
1872	1082	1,744,481	656,303
1873	1173	2,085,072	915,892
1874	1264	2,423,672	994,375

The tonnage has thus been quadrupled in five years; and the best means of enlarging the canal to accommodate increasing trade must soon become an important question for its owners.

Such works as the ship canals we have been describing entirely revolutionize ocean navigation, and consequently demand the zealous attention of all nations whose interests they seem to affect. Of this zealous watchfulness the interest taken by the Powers of Europe in the distribution of the property in the Suez Canal may be cited as an example. But notwithstanding the difficulties, legal and political, which the execution of such works are almost sure to create by severing continents before united, and connecting seas before separated by thousands of miles of exposed navigation, we may safely conclude that wherever the perils and delays of ocean sailing can be lessened by forming canals these valuable helps to navigation will at all hazards be carried out. Viewing then the subject *prospectively*, we offer no apology for noticing two important short sea passages which, though still unexecuted, will doubtless in some form be eventually carried out.

One of these canals is designed to obviate the navigation of the dangerous strait between Ceylon and the mainland of India, which is shallow and narrow, and in some states of the wind has a violent current, so that it can only be navigated by vessels of small draught. Ships of the larger class have to circumnavigate Ceylon in making their passages to the eastern section of Hindustan. The importance of avoiding this detour round Ceylon of 350 miles of exposed navigation in the direct Suez route to Calcutta and Madras will be readily acknowledged, and the execution of the work cannot long be delayed.

The strait to which we allude is the Paumben passage leading from the Gulf of Manaar on the west to Palk Bay on the east, as shown in fig. 11, and many attempts have been made by blasting to clear away the rocky obstructions that at present render its navigation dangerous. But in order to provide a safe passage of the strait between Ceylon and India for the ships which now navigate the Suez Canal, nothing will suffice but a canal affording the same depth and width, though very much shorter in length than its great pioneer in shortening ocean sailing; and accordingly surveys have been made and schemes have been proposed to effect this important improvement. Mr George Robertson, Civil Engineer, when inspecting the harbours of India, was asked by the British Government to visit the locality and report on these schemes; and from his Report on Indian Harbours we find that the site he selected as most suitable is through the island of Ramaseram, about ½ a mile east from Paumben lighthouse. The distance across from sea to sea is about 2 miles, the ground being a flat sandy plain, raised on an average about 7 feet above high water, and from the borings that have been made it is not expected that much rock will be found in the course of the canal. In order to assimilate it to the Suez Canal the navigable depth should if possible be about 26 feet. On the north side the distance from high water mark to 30 feet at low water is, according to a chart by the Surveyor-General at Colombo, upwards of a mile; on the south side the distance to the same depth is still greater, so that very considerable works of dredging will be necessary in forming and afterwards maintaining the entrances to the canal. The south end of the canal is under shelter of a coral reef, but the north end may perhaps require to be protected by breakwaters. The cost of cutting the canal has been named at £440,000.

The other scheme to which we referred has a far higher importance, its object being to separate the continents of North and South America, and to give a free navigation between the Atlantic and the Pacific Oceans, by overcoming the physical difficulties presented by the climate and the geological formation of the Isthmus that separates the two

[1] *The History of the Suez Canal*, by F. de Lesseps, translated by Sir H. D. Wolff, 1876.

seas, to which has to be added the problem of making and maintaining a deep-water channel from the ocean to the entrances to the canal

This bold scheme, first proposed in the 16th century, has at various intervals been the subject of many deputations and much correspondence between the American and European powers; and more recently, in 1845, when Louis Napoleon was confined as a state prisoner at Ham, he spent much of his exile in investigating its practicability, and in making arrangements for carrying out, under the name of the "Napoleon Interoceanic Canal," a passage between the two seas from Port San Juan to Port Realejo. But we have not space to record the various early attempts to realize this project, and must therefore confine our remarks to giving an idea of the present state of negotiations regarding it.

The recent enormous growth of Californian trade has led to the revived consideration of the scheme by the United States of America, who would be the greatest gainers by the work, and therefore are its most natural promoters; and what we propose is to give a sketch of the present state of the question, as afforded by reports and documents recently issued by the Government of the United States, from which alone authentic information can be derived.

It appears from these documents that two routes have recently been investigated:—*First*, that of the Isthmus of

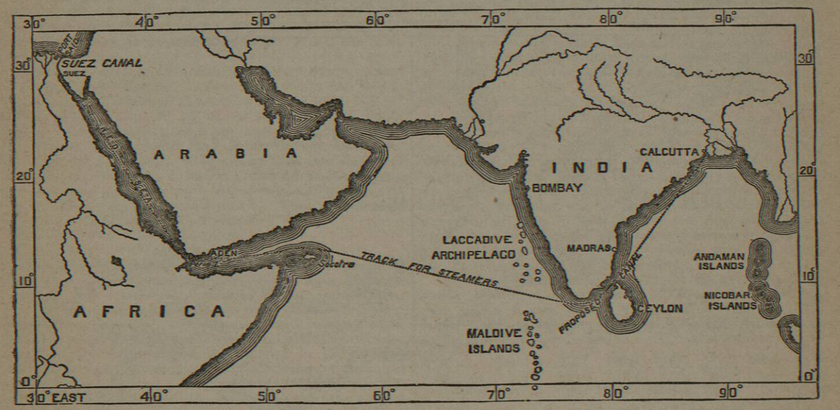

FIG. 11.—Showing Suez Canal and Proposed Canal at Ceylon.

Darien, shown in fig. 12, under the direction of Commander Selfridge, U.S.N.; and *second*, that of Nicaragua, also shown in fig. 12, under the direction of Commander Lull, U.S.N. To both of these expeditions were attached a large staff, including naval officers, civil engineers, surveyors, mineralogists, &c., and their surveys appear to have extended over the years 1871, 1872, and 1873.

Proposed Darien Canal.

The results of these surveys are thus summarized in the report of the Secretary to the Navy, submitted to the Government of the United States in 1873, from which we take the following information. Of the Darien route, it is said that it includes 100 miles of navigation of the River Atrato, which has been carefully sounded, and found to be fully capable of being navigated by the largest class of ocean-steamers. Between Atrato and the Pacific a canal or artificial cut must be formed of 28 miles in length. The canal for 22 miles of this distance passes through a plain having a gradual rise of 90 feet. There will then remain 6 miles to the Pacific, three of which will be in moderate open cutting, and 3 miles will be tunneling. It is estimated that the work will cost between £10,400,000 and £12,600,000, and that it can be completed in ten years. The tunnel, being for the passage of ships of the largest size, is proposed to be 112 feet high and 60 feet wide, and is to have 87 feet of clear headway above the surface of the water. The canal is to be 25 feet in depth, with a bottom width of 50 feet, and a surface width of 70 feet. The locks, twenty in number, are to be 427 feet long, 54 feet wide, with a lift of 10 feet. The water supply is to be derived from the Napipi river, and the gaugings and observations made on evaporation lead to the conclusion that there is a great excess of water above the supply required for the canal. Commander Selfridge gives two alternative schemes, by which the tunneling is increased in length and the number of the locks diminished, at an estimated cost of from £17,000,000 to £18,000,000 respectively.

The exploration of the Nicaraguan route, under Commander Lull, the position of which is also shown in fig 12, is said to have proved the existence of a practicable route, having Lake Nicaragua as its summit-level, being 107 feet above mean tide. It is proposed by this route to connect the lake with the Pacific by a canal 16·3 miles in length, beginning at the mouth of the Rio del Medio and terminating at Brito. The first 7·5 miles will require an excavation averaging 54 feet in depth, and will be the most expensive part of the whole work. Ten locks and one tide-lock will be required between the lake and the sea. There will be 56 miles of lake navigation.

Slack-water navigation in the San Juan from its head to the mouth of San Carlos is considered perfectly feasible, and it is proposed to improve the river by four dams, at Castillo Rapids, Balas Rapids, Machuca Rapids, and at the mouth of the San Carlos River, at all of which places there are excellent sites for dams. A short section of canal with

one lock will be required to get around each of the upper three dams. From the fourth dam to Greytown in the Caribbean Sea an independent canal will be required 41·9 miles in length with seven locks, which apparently presents no difficulty. The total length of the proposed canal is 61·7 miles, and no tunnel is required. The harbour of Greytown has been partially destroyed by a silt which comes from the San Carlos, and others of the lower tributaries of the San Juan, and the branch of the river leading to Greytown has become so much filled up that it is now, at the lowest stage of the water, only 324 feet wide and 6 inches deep at the fork. It is proposed to shut off this branch entirely and send all the silt-bearing water through the Colorado mouth, which empties into the sea 18 miles from Greytown, and to admit to the harbour only the water of the canal, which, being drawn from the main river above the mouth of the San Carlos, will be perfectly clean. The harbour then cleared out, will leave nothing to deteriorate it again.

Short breakwaters will be required to protect the entrances from the surf, both of which are included in the estimate for the work.

Careful gauging at the lowest stage shows that Lake Nicaragua, which has a surface area of 2700 square miles, and a drainage area of 8000 square miles, will supply thirty-eight times the maximum possible demand of water.

The depth of water is to be 26 feet, the width at bottom 72 feet, and at surface 150 feet. The locks, twenty-one in

FIG. 12.—Lines of proposed Darien and Nicaragua Canals.

number, with a lift of from 8 to 10 feet, are to be 400 feet long and 72 feet wide. The estimate is stated at £15,900,000.

M. Lesseps, in a lecture on the Suez Canal, delivered before the Société des Gens de Lettres at Paris, has given it as his opinion that unless the Atlantic and Pacific can be united by simply piercing the Isthmus from sea to sea without locks, as at the Suez Canal, the proposed scheme cannot possibly succeed as a commercial enterprise, because of the inadequacy of a canal with locks to pass the traffic that will frequent it, and also of the uncertainty of sufficient water to supply the lockage and evaporation. This latter objection, however, seems to be disproved by the researches of the American engineers who have investigated the subject. A further difficulty arises in maintaining a sufficient sea-water depth to the canal even after it has been formed. On this point the writer of this article, judging from documents prepared under the sanction of the Government of the United States and submitted to him by an authorized official of the Government, arrived at the conclusion that there are very formidable obstacles to the establishment and future maintenance of a deep-water entrance to the proposed Nicaraguan Canal at Greytown in the Caribbean sea. These obstacles involve the engineering problem of maintaining permanent deep water through an extensive shallow foreshore composed of soft materials and exposed to heavy seas. The reports state "that at Greytown there are now islands where twenty years ago there was water enough to float a frigate." It remains to be seen whether the same difficulties apply to the entrance to the proposed Darien scheme; and, to show that such fears may not be unfounded, we may remind the reader that the difficulties exist, as we have stated, at the Mediterranean entrance to the Suez Canal.

The question as to the best route for transit between the Atlantic and Pacific is, it will be seen, still far from being solved, but the necessity for free access from sea to sea remains an acknowledged fact. Its importance, especially to the United States, but in some degree to all the world, is such that, great as are the engineering difficulties, this long-cherished bold *idea* may yet become a stupendous *reality*. (D. S.)

Reference is made to the following works:—Chapman, *On Canal Navigation*; Frisi, *On Canals*; Fulton, *On Canal Navigation*; Tatham's *Economy of Inland Navigation*; Vallancy's *Treatise on Inland Navigation*; *Principles and Practice of Canal and River Engineering*, by David Stevenson, 2d edition, A. and C. Black Edinburgh; *Report of the Secretary of the United States Navy for* 1873

CANAL, or CANALETTO, ANTONIO (1697-1768), a Venetian painter, born 18th October 1697, was bred with his father, a scene-painter at Venice, and for some time followed his father's line of art. In 1719 he went to Rome, where he employed himself chiefly in delineating ancient ruins, and particularly studied effects of light and shade, in which he became an adept. He was the first painter who made practical use of the camera lucida. On returning home he devoted his powers to views in his native city, which he painted with a clear and firm touch and the most facile mastery of colour in a deep tone, introducing groups of figures with much effect. In his latter days he resided some time in England. His pictures, in their particular range, still remain unrivalled. He died on 20th August 1768. Bellotto (commonly named Bernardo) Canaletto, 1724–1780, was his nephew and pupil, and painted with deceptive resemblance to the style of the more celebrated master.

CANANDAIGUA, a town in the United States, capital of the county of Ontario in New York, is situated at the northern end of a lake of the same name, 29 miles S.E. of Rochester by rail, in 42° 54′ N. lat. and 77° 27′ W. long. It is a railway junction of some importance, and has a court-house, an academy, and two printing-offices. Its incorporation dates from 1815. The lake is a beautiful sheet of water about 15 miles long, with a breadth varying from less than a mile to more than a mile and a half. It is about 437 feet above Lake Ontario. The population of the town is 4862, and of the township 7274.

CANANORE. See KANANORE.

CANARA. See KANARA.

CANARY (*Fringilla canaria*), a well-known species of Conirostral Bird, belonging to the family *Fringillidæ* or Finches. It is a native of the Canary Islands and Madeira, where it occurs abundantly in the wild state, and is of a greyish-brown colour, slightly varied with brighter hues, although never attaining the beautiful plumage of the domestic bird. It was first domesticated in Italy during the 16th century, and soon spread over Europe, where it is now the most common of cage-birds. During the 350 years of its domestication, the canary has been the subject of careful artificial selection and of crossing with allied species, the result being the production of a bird differing widely in the colour of its plumage, and in a few of its varieties even in size and form, from the original wild species. The prevailing colour of the most admired varieties of the canary is yellow, approaching in some cases to orange, and in others to white; while the most robust birds are those which, in the dusky green of the upper surface of their plumage, show a distinct approach to the wild forms. The least prized are those in which the plumage is irregularly spotted and speckled. In one of the most esteemed varieties, the wing and tail feathers are at first black—a peculiarity, however, which disappears after the first moulting. Size and form have also been modified by domestication, the wild canary being not more than 5½ inches in length, while a well-known Belgian variety usually measures 8 inches. There are also hooped or bowed canaries, feather-footed forms, and top-knots, the latter having a distinct crest on the head; but the offspring of two such top-knotted canaries, instead of showing an increased development of crest, as might be expected, are invariably bald on the crown. Most of the varieties, however, of which no fewer than twenty-seven were recognized by French breeders so early as the beginning of last century, differ merely in the colour and the markings of the plumage. Hybrids are also common, the canary breeding freely with the siskin, goldfinch, citril, greenfinch, and linnet. Some of the hybrids thus produced are, according to Darwin, almost completely fertile, but they do not seem to have given rise to any distinct breed. It is the female canary which is almost invariably employed in crossing, as it is difficult, if not impossible, to get the females of the allied species to sit on the artificial nests used by breeders. In a state of nature canaries pair, but under domestication the male bird has been rendered polygamous, being often put with four or five females; still he is said to show a distinct preference for the female with which he was first mated. It is from the others, however, that the best birds are usually obtained. The canary is very prolific, producing eggs, not exceeding six in number, three or four times a year; and in a state of nature it is said to breed still oftener. The work of building the nest, and of incubation, falls chiefly on the female, while the duty of feeding the young rest mainly with the cock bird. The natural song of the canary is loud and clear; and in their native groves the males, especially during the pairing season, pour forth their song with such ardour as sometimes to burst the delicate vessels of the throat. The males appear to compete with each other in the brilliancy of their melody, in order to attract the females, which, according to Bechstein, always select the best singers for their mates. The canary readily imitates the notes of other birds, and in Germany and especially Tyrol, where the breeding of canaries gives employment to a large number of people, they are usually placed for this purpose beside the nightingale. In England they are taught in a similar way to imitate the woodlark. They are also taught to whistle one or two airs, and even to articulate a few words. The female possesses considerable vocal powers, but her notes are weaker than the male's, and her song usually less consecutive.

CANARY ISLANDS, THE, lie in the North Atlantic Ocean, between the parallels of 27° 4′ and 29° 3′ N. lat., and the meridians of 13° 3′ and 18° 2′ W. long. The seven principal islands, with their area in English square miles, and their population in 1860, are as follows:—

	Teneriffe.	Grand Canary.	Palma.	Lanzarote.	Fuerteventura.	Gomera.	Hierro.
Area.....	877·7	758·3	718·5	323·5	326·1	169·7	82·2
Population,	93,709	68,970	31,138	15,837	10,996	11,360	5026

Fuerteventura lies nearest to the African coast, the interval being between 50 and 60 miles. Besides these there are many islets, most of which are uninhabited.

History.—There is ground for supposing that the Phœnicians were not ignorant of the Canaries. The Romans, in the time of Augustus, received intelligence of them through Juba, king of Mauritania, whose account has been transmitted to us by the elder Pliny. He mentions "Canaria, so called from the multitude of dogs of great size," and "Nivaria, taking its name from perpetual snow, and covered with clouds," doubtless Teneriffe. Canaria was said to abound in palms and pine trees. Both Plutarch and Ptolemy speak of the Fortunate Islands, but their description is so imperfect that it is not clear whether the Madeiras or the Canaries are referred to. There is no farther mention of them until we read of their rediscovery about 1334, by a French vessel driven amongst them by a storm. A Spanish nobleman thereupon obtained a grant of them, with the title of king, from Clement VI., but want of means prevented him from carrying out his project of conquest. Two expeditions subsequently set out from Spanish ports, and returned without having taken possession. At length three vessels, equipped by Jean de Bethencourt, a gentleman of Normandy, sailed from Rochelle in 1400, and bent their course to the Canaries. He landed at Lanzarote and Fuerteventura, but being opposed by the natives, and finding himself deficient in means to effect his purpose, he repaired to the court of Castile, and obtaining from Henry III. a grant of the islands, with the title of