The causes to which I say the superiority of the Cornish engine is due are not purely theoretical, they come to us from this best practice. Keeping them before us we can make engines of correct proportion, and that is what the engineers of Cornwall learned to do by their long practice. All good engineers of our day base their calculations upon the results obtained from this and other experience, at the risk, it appears, of being called theoretical, yet they are successful.

If any of our readers feel sufficient interest in this discussion to take the papers written on the subject to some engineer who has built a real Cornish engine, doing good duty, say the builder of the Easton engine, at Bethlehem, Pa., question that gentleman, and compare his answers with the views we advocate, we shall know the truth, and shall have the satisfaction of seeing a change for the better wrought in the design and construction of the pumping engines of America.

This is not a simple or unimportant matter. It involves immense gains or losses. Where the Oliver Evans engine raises one pound a foot high, the Cornish engine raises more than six and a half pounds a foot high. The people of Philadelphia pay $6·50 for pumping water, while Cornish mining companies have paid as little as $1, if duties are reported correctly. If we doubt one, we must doubt all.

The people of West Philadelphia pay $1 for water, while the people of Easton pay but 70 cents, as shown by the duties reported by Mr. Henderson and Mr. Birkinbine.

Callao, Peru, July 25th, 1870.

SURVEY OF THE NICARAGUA ROUTE FOR A SHIP CANAL.

By Col. O. W. Childs, C. E.

(Continued from page 29.)

It will be seen by reference to the profiles of those portions of the river occupied by the canal, that the increase in the length of the cuts through the bars which a greater depth than that upon which the estimates are based would involve, consequently the ratio of increase of the expense of the canal, would be very great. Any considerable increase to the depth would require under-water excavations between the lake and the Toro Rapids, a distance of about 27 miles, to be almost continuous; it would very much lengthen the cuts on other portions of the river, and the liability of these artificial channels to receive deposits of earth to such an extent as to obstruct the navigation, would be very much greater. On the inland portions of the canal a depth of 22 feet of water, which is about equal to the greatest draught of the largest merchant sailing vessels, would, with 50 feet bottom width, give a transverse water section about 45 per cent. greater than a depth of 17 feet with the same bottom width; and the expense of the inland portions would also, by reason of the greater depth of excavation, be increased in a still higher ratio.

The advances in improvements of model are such as are deemed sufficient to justify the belief that vessels of a burthen as great as before stated, may be so constructed as to navigate the canal. The steam ship Northern Light, recently built of the greatest strength, for general sea service, is of recent improved model, and excellent finish; the dimensions of this splendid steamer are such as would permit her to pass with full freight through the locks and the canal, and her burthen, as stated by the proprietor, is about 2,200 tons. It is not known that there are any steam ships plying between the Atlantic States and the eastern coast of the Pacific, that have a draught as great as 17 feet.

Of 261 steam vessels, principally English, the largest portion with side wheels, and the remainder screw propellers, as given in Murray's treatise on marine engines and steam vessels, only 15 draw over 17 feet of water, 21 have 17 feet draught, and 235 draw less than 17 feet, each at load line.

To construct the canal of dimensions capable of admitting the passage of vessels of the largest draught now in use, of which there are comparatively so few, or by which it would be so little used, and under circumstances of so much greater cost, while, as is believed, merchant vessels of equal tonnage and less draught may be so constructed as to be well adapted to sea service and the passage of the canal, would appear to be an injudicious application of means, which, as is supposed, your company would scarcely favor, or the intersest of commerce require. The dimensions before given were therefore planned and made the basis of the estimates with due consideration of the disparity in cost and general utility, of a canal of larger dimensions, and with a view to practicability as referable to cost of construction, usefulness, and a fair remuneration for capital invested.

This canal, as projected, is of much greater dimensions than any hitherto constructed in this country. If we except that of the Chesapeake and Delaware, which has 10 feet depth, the largest known on this side of the Atlantic, and most similar to that under consideration in respect to connecting natural with artificial navigation, are those in Canada East, by which the navigation is extended past the rapids on the St. Lawrence River, and the Welland canal in the Western Province, connecting the navigation of lakes Ontario and Erie.

The canals connecting the navigable portions of the St. Lawrence with each other are 7 in number, varying in length from $\frac{3}{4}$ to $11\frac{1}{2}$ miles, with an aggregate length of 41 miles. They are 50 feet wide at bottom, and 90 feet at surface water line, excepting that at Beauharnois $11\frac{1}{4}$ miles in length, which is 80 feet at bottom, and 120 at top, and that at Cornwall $11\frac{1}{2}$ miles long, having a bottom width of 100 feet, and a surface width of 150 feet. The locks are 27 in number, of which 20 are 200 feet in length between the gates, and 45 feet in width of chamber, and 7 on the Cornwall canal, have the same length and 55 feet width of chamber. All of the locks have 9 feet depth of water on the mitre sills, excepting 2 which have a depth of 16 feet.

The Welland canal is 28 miles long, 35 feet wide at bottom, and 71 feet at top, except a small portion, which is 45 feet in bottom width, and 81 feet at the surface.

The locks on the former portion, 24 in number, are 150 by $26\frac{1}{2}$ feet, and on the latter portion, 3 in number; they are 200 by 45 feet in dimensions of chamber, all have nine feet of water on the sills. The whole fall from Lake Erie to tide water at Three Rivers on the St. Lawrence is $564\frac{1}{2}$ feet, of which $536\frac{3}{4}$ is made by 54 lock, the remainder $27\frac{3}{4}$ by natural descent of the river. The aggregate length of the inland canal is 69 miles, and the whole distance from Lake Erie to Three Rivers is about 430 miles.

Sea-going vessels, carrying 350 tons, pass these canals. Although steamers and other sea-going vessels of much greater burthen pass on the St. Lawrence canals, yet owing to the want of a greater depth of water, they are understood to be limited to the above burthen. The extreme load of vessels adapted to the navigation of the Welland canal and the lakes is 400 tons of freight.

The Caledonian canal, forming a navigable connection for ships, between the east and west side of Great Britain, probably approaches in its dimensions and capacity, nearer to those proposed for the ship canal between the Atlantic and Pacific Oceans, than any other. This communication extends across the central portions of Scotland from Loch-Eil, connecting with sea on the westerly side to Loch-Beauly or Murrayfrith, an arm of the sea on the easterly side. It has a length of about 59 miles, of which $21\frac{1}{2}$ is constructed inland, and $37\frac{1}{2}$ is a navigation through the four lakes named in the order they occur, from West to East Lochy, Oich, Ness and Doughfour, originally of different elevations. The surfaces of Loch-Oich and Loch-Lochy now conform to the surface of the summit level of the canal; in construction, the former about $3\frac{3}{4}$ miles in length, was extensively dredged to obtain the requisite depth for navigation, and the surface of the latter about 9 miles in length, was raised 12 feet to lessen the depth of excavation through the summits between that lake and the western termination of the canal. Extensive dredgings were also made in carrying the canal through Lake Doughfour.

The canal is 50 feet wide at bottom, 110 feet at the surface water line, and 20 feet deep. It has 24 locks, with chambers 40 feet wide, and 172 feet in length. Its summit is 90 feet above the west, and 94 feet above the east sea, and the descent is made by 12 locks on either side.

Lake Ness has a length of about 20 miles, and together with the two lakes on the summit level are subject to changes of some 6 to 8 feet in their elevation by flood and drought. These flood waters are without difficulty retained for use or otherwise disposed of as the circumstances of navigation require.

This canal is similar then to that projected in Nicaragua, in its summit lake, from which in both directions it derives its supply of water, in the amount of its lockage, its dimensions, and in its frequent changes from inland canal to the adoption for purposes of navigation, of larger waters, and as also indicated from its history, (see *Encyclopædia Brittanica*,) the country, if we except climate, presented physical features, involving greater difficulties in its construction.

That canal was constructed previous to the introduction of steam as a motive power for sea-going vessels, and was designed for merchant vessels and vessels of war, of the dimensions of a 32-gun frigate.

The locks as designed for the Atlantic and Pacific Ship Canal, are large in their horizontal dimensions; they will admit of the passage of a large class of steamships, which, as a means of transit, from their annually increasing numbers, appear to be rapidly growing in favor.

The main advantages to be realized by the use of the Nicaragua canal is the saving of distance and time, in making a passage between the two oceans; these being primary causes of the extension of commerce, will in the present instance, produce benefits to be participated in by a large portion of the people of the globe. A knowledge, therefore, of this saving, to be effected by a passage through the ship canal, in making voyages between important commercial ports of the two continents, as well as between those on opposite sides of this, becomes interesting.

The following statement shows the distance between the several places named as measured on Mitchell's map of the world, Mercator's projection, and the difference in the distances between said places, by the way of Cape Horn and the proposed canal; also the time estimated to be required to make the voyages by steam and sail vessels, and the estimated difference between the two routes, in the time of making said voyages, admitting the steam to be uniform (except on the canal) throughout the several parts of the route, and to be for the steamer at the average rate of 280 miles, and for sail vessels 110 miles per day, and on the canal at rates the same as before stated.

Between what Places.	Name of Route.	Distance in miles.	Diff. of Dist. in miles.	Time occupied by steamers.		Time occupied by sail ves'ls	
				No days of voyage.	Diff. days of voyage.	No. days of voyage.	Diff. days of voyage.
New York and California.	Via Cape Horn......	17,063		65½		155	
" " "	" Proposed Canal	5,690	11,373	23¼	42¼	53¼	101¾
" " and Valparaiso.	" Cape Horn......	10,643		41		96¾	
" " "	" Proposed Canal	5,811	4,832	23½	17½	54¼	42½
" " and Sandwich Islands..	" Cape Horn......	16,784		64½		152½	
" " "	" Proposed Canal	7,173	9,611	28¾	35¾	66¾	85¾

The sailing distances, and the time occupied by sail vessels in making outward and homeward voyages, would, on account of prevailing winds and currents, be liable to differ widely from each other, and from those given in the above statement, which are intended to represent the time averaged for the outward and homeward voyages rather than the actual time of either. In the case of steamers, the difference would be much less, and the time estimated to be occupied by both steamers and sail vessels, averaged, as above stated, for the out and return voyage, is, upon the basis assumed, believed, nearly to be correct.

(To be continued.)

IRON MANUFACTURES IN GREAT BRITAIN.

THIRD PAPER.

By R. H. Thurston,
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Iron making is the most important branch of British manufactures. With the engineer it derives special interest, not only from this circumstance, but from the fact that, having been usually the first to adopt new methods and to originate new devices in iron making, we naturally expect to find in British practice much that is instructive, and look up to British makers as our tutors in the art.

In the year 1740, at which time smelting with coal had been