the 50 acres, there is a net profit of $4,125 from the acreage planted. This is clear net profit on the cane, and does not include any charge of profit to the people owning the mill or plant. Kansas has offered a premium of 2 cents a pound for all the sugar produced in that State, and there are 150,000 acres of sorghum grown there, and nearly a million dollars' worth of machinery has been built for experiments in testing the best manner of extracting the juices. Sorghum-sugar can be raised anywhere from the Gulf to Minnesota at less than 1 cent per pound; in fact, one of the sugar engineers of Cuba, after examining the results at Fort Scott, stated that he could put up a plant which would produce sorghum-sugar at 59 cents per hundred pounds. There is no reason why a bounty of $500,000 a year should not be given to sugar, and as much more to flax, by the government. In thus co-operating with State experimental stations, an unexampled prosperity should result from these endeavors."

THE NICARAGUA CANAL.

ON April 24, 1887, the contract between the Nicaragua Canal Association and the Republic of Nicaragua was signed, and the work on this important route from the Atlantic to the Pacific will therefore soon be taken up.

The principal surveys of the route are those made by O. W. Childs, in 1850–54, on behalf of the American Atlantic and Pacific Ship Canal Company, and those of the United States Surveying Expeditions, 1872–73 and 1885, the former under Commander Hatfield and later under Commander Lull, the latter under A. G. Menocal, who was chief civil engineer of the expedition of 1872–73. Our map is compiled from the maps and profiles published in the reports of these expeditions, and shows the locations of the canal in 1872 and 1885.

Lake Nicaragua, which occupies the central part of the isthmus, will form the summit-level of the canal. Its outlet is the river San Juan, which flows to the Caribbean Sea. Near the lake the river is broad and flows through an open country. It has an average depth of nineteen feet. Twenty-eight miles below Fort San Carlos the river enters a hilly country and forms numerous rapids which obstruct navigation. The last of these are the Machuca Rapids, below which the river has a depth varying from 20 to 60 feet, with but little current: this section is called 'Agua Muerte,' or dead water. At the foot of the Agua Muerte the San Carlos is received into the river, and is the first considerable tributary. This river comes from a long distance up in the Costa Rica hills, and carries a considerable amount of detritus which consists chiefly of volcanic sands. Below the confluence the San Juan changes its character altogether, and is filled with shoals and sand-bars. An additional amount of detritus of a similar character is carried into the San Juan by the Serapiqui. While the upper course of the San Juan, which is almost exclusively fed by Lake Nicaragua, is not subject to freshets, its lower part, below the confluence of the San Carlos, partakes of the character of that river, which is a torrent during the rainy season, and has little water during the dry season. Therefore the lower part of the river cannot be made use of for navigation, and an independent canal to the Caribbean Sea must be built. In the location of 1872–73 the canal followed the river, and then crossed its delta to the lagoon of Greytown.

Thirteen miles below the confluence of the Serapiqui the delta of the San Juan begins. The principal arm of the river is the Rio Colorado, which flows to the eastward and empties into the sea. The other arm is the Lower San Juan, which passes more to the northward, and is divided into several mouths, which discharge their waters into the sea and into the lagoon of Greytown. The delta consists of the light volcanic sand carried into the San Juan by its southern tributaries. This silt has almost totally destroyed the harbor of Greytown by closing up the old entrance and filling a great part of the harbor. The silt is being carried into it by the Lower San Juan and the current. Therefore it is proposed to cut off the Lower San Juan, to send all the water through the Colorado into the sea, and to build a jetty for keeping the silt out of the harbor, which will be improved by dredging.

When the project of a canal through Nicaragua was first discussed, several routes from the lake to the Pacific Ocean were proposed. The one advocated by Napoleon ran from the lake through the Rio Tipitapa to Lake Managua, and continued to the port of Realejo. This route, as well as those to Salinas Bay and San Juan del Sur, was found impracticable, and Brito at the mouth of the Rio Grande was chosen as terminus. The upper Rio Grande offers several difficulties on account of the freshets of the river and the narrowness of its valley. This induced Commander Lull to select the Rio del Medio route, though it requires deeper cuttings, as it avoids the upper part of the Rio Grande, while Menocal favors the Rio Lajas route.

The route proposed by Mr. Menocal extends from the harbor of San Juan del Norte, or Greytown, on the Caribbean Sea, to the port of Brito, on the Pacific, a total distance of 169.8 miles, of which 40.3 miles are canal in excavation, and 129.5 miles open navigation through Lake Nicaragua, the river San Juan, and the basin of the river San Francisco, a tributary of the San Juan. Lake Nicaragua, some 90 miles long by about 40 miles wide, the surface of which is 110 feet above sea-level, has been taken as the summit-level of the canal. Leaving the harbor of Brito, the canal follows the valley of the Rio Grande with a gradual inclination of about 12 feet to the mile, ascending by means of four locks, 26 to 29 feet lift, to the summit-level extending 8.5 miles west of the lake. From that point the canal extends easterly, and, cutting across the divide with a maximum depth of 41.4 feet above the surface of the water, reaches the lake 17.27 miles from the Pacific terminus. The summit of the divide cut through by the canal, 151.4 feet above sea-level, is much the lowest depression across the American isthmus.

The lake navigation extends from the mouth of the river Lajas to Fort San Carlos at the head of the river San Juan: through that distance not less than 28 feet of water can be carried to within 2,400 feet of the west shore, and eight miles of Fort San Carlos. For the former distance, dredging and rock excavation are necessary; and in the latter, dredging in mud to an average depth of 3.5 feet, to extend deep water from shore to shore. Other parts of the lake are very deep.

The canal then follows the river San Juan for a distance of 64 miles from the lake to Ochoa, just below the confluence of the river San Carlos (*v.* map). Here a dam is proposed, 1,255 feet long and 52 feet high, which will back the water of the river the entire distance to the lake, maintaining the surface of the latter at the proposed level of 110 feet. The upper part of the river thus deepened and widened will be converted into an extension of the lake, at no place less than 1,000 feet wide, and, with the exception of the first 28 miles from the lake, the depth gradually increases from 28 to 130 feet. Within those 28 miles, dredging and rock excavation to an average depth of 4 feet will be needed for a distance of 24 miles. The dam is located between rock abutments, and is proposed to be built of concrete resting on rock foundations 20 feet below the present water-level.

Just above the dam, a break between the hills confining the river on the north, affords a desirable basin at the entrance of the canal, which here leaves the river. After running a distance of .62 miles through the basin, it cuts across a broken country for a distance of 1.82 miles, and enters the valley of the creek San Francisco. This creek runs nearly parallel to the San Juan, from which it is separated by a range of hills, to a point about 9 miles from the dam, then, receiving a tributary from the north-east, turns abruptly to the south and empties into the San Juan. Its valley forms an irregular, flattened Y, with its foot resting on the San Juan, one arm extending westerly to within a short distance of the dam at Ochoa, the other easterly in the direction of Greytown. Across the stem of this Y will be built an embankment 6,500 feet long on the crest, with a maximum depth of 51 feet. This embankment will retain the waters of the San Francisco, forming an artificial lake of 30 to 50 feet depth, at the level of the river above the dam, or an extension of the summit-level. The outlines of this lake and the increase in width of the San Juan, after its waters are dammed up at Ochoa, are shown in our map according to information kindly furnished by Mr. Menocal. The extent of country which will be inundated by the San Carlos cannot be defined, as the valley has not been surveyed. As its character, however, is similar to that of the San Juan, the strip of

land will probably be very narrow. The necessary land will be granted by Costa Rica to the association. The canal route follows this deep basin to the western slope of the dividing ridge between the creek San Francisco and the river San Juanillo, 12.55 miles from the dam, and 19.48 from Greytown. Beginning at the eastern extremity of this basin, the canal cuts through the dividing ridge, the summit of which is 280 feet above sea-level, and in a distance of 14,200 feet, in which the average depth of the cutting is 119 feet above the water in the canal, strikes the eastern slope of the divide. This point is on the eastern terminus of the summit-level extending from the upper lock on the Pacific slope, a distance of 144.8 miles. Here it is proposed to carve in the solid rock, at the end of the deep cut referred to, the upper lock of the eastern branch, and drop the level of the canal 53 feet. The ground thence descends gradually to the next lock, .87 miles below, where another drop of 27 feet takes place; and the canal for a distance of about three miles is cut through a broad, slightly inclined valley to the third and last lock. This lock lowers the canal to the level of the sea, and from here it takes a direct course through the alluvial plains of the San Juanillo to the harbor of San Juan del Norte, or Greytown, a distance of 11.55 miles; from the last lock to Greytown on the east, and to Brito on the west side, the canal is enlarged, forming extensions of the harbors, where vessels can pass each other without detention. Ample provision has been made to protect the canal from surface drainage. Two basins are proposed at each lock where vessels can wait or pass each other without delay. The canal is proposed to be 80 feet wide at the bottom in deep cuts, and 120 feet in the terminal cuts and other enlarged sections; the width at the surface of the water being 80 feet in deep rock cuts, and 184, 288, and 342 feet at other points. The locks are estimated 650 feet long between mitre sills and 65 feet width of chamber. The estimated time of transit from sea to sea, on the basis of a speed of 5 miles per hour in the canal proper, 8 to 10 miles per hour in the river and lake, and 45 minutes' detention at each of the seven locks, is 30 hours. Allowing but one vessel to each lockage, 32 vessels in one day, or 11,680 in one year, can be passed through the canal. Breakwaters and dredging will be required at the harbors of Brito and Greytown to secure a free entrance.

It is estimated that the canal and its accessories can be completed in six years; and its cost, including 25 per cent for contingencies, is put down at $64,043,697. The estimates are the result of an actual instrumental location of the entire line, and the surveys have been conducted with great care, and sufficiently in detail to insure a close estimate of cost.

The characteristic features of this location as compared to that of 1872–73 are the great extension of the summit-level eastward, which practically extends Lake Nicaragua to the divide between the San Francisco basin and the San Juanillo, by the high dam at Ochoa, and the embankment near the confluence of the San Francisco and San Juan, and the difference of the location of the upper part of the western division. Commander Lull recommended the Rio del Medio route, though it required cuttings of 134 feet, on account of better natural surface drainage, which is of the greatest importance for the stability of the work in a country with heavy rainfalls. On that line no water-course of considerable size would be taken in the canal, and, as its watershed is quite small, no fears were entertained of damages from freshets. On the Rio Lajas route the Rio Grande, a mountain stream of extensive and rapidly inclined watershed and precipitous channel, with a maximum flow of about 10,000 cubic feet per second, had to be passed. This difficulty has been overcome by Menocal by diverting it into the Juan Davila, a tributary of the Rio Lajas.

Dr. Polakowsky (*Petermann's Mitteilungen*, 1887, p. 138) raises several objections against this project, which, however, are not well founded. He says that it will be necessary to retain the present level of the San Carlos, as it would flood extensive parts of Costa Rica. This, however, cannot be true, as its course is very rapid, and as the lower part of its channel passes through a hilly country. Neither will the banks of the San Juan be flooded to any considerable extent, as may be seen from the accompanying map. The extent of land owned by private parties and required for the canal is very trifling, and therefore no considerable additional cost will be occasioned by this item. The lands belonging to the state of Nicaragua will be given to the association without any compensation whatever. Besides the works belonging to the canal proper, the association is obliged by contract with the Republic of Nicaragua to establish a communication between the part of the San Juan not used for canal purposes and the canal by means of locks suitable for the navigation of ships of 6 feet draught, and another canal between Lake Managua and the lower part of the Tipitapa of sufficient dimensions to admit the passage of vessels drawing 6 feet, and of 150 feet length. The difference in level between the lakes is 22.34 feet. The river Tipitapa is shown in our map: it is full of rapids, and has a fall of 13 feet above the bridge of Tipitapa. This canal will be the property of the government.

Besides the land necessary for the construction of the canal, considerable land-grants are ceded to the company. On the left bank of the river San Juan from the Atlantic to Castillo Viejo it will receive alternate lots of three miles frontage and six miles in depth; from Castillo to the lake, on the south side of the river, lots two miles frontage and two miles depth; all along the south shore of the lake to the mouth of the Rio Lajas, lots of one mile square; on the northern bank of the Rio San Juan above Castillo, lots of three miles frontage and four miles in depth; and, continuing on the east shore of the lake as far as the river Tule, lots of two miles frontage on the lake and two miles depth are ceded to the company. Furthermore, it will receive forty lots of the existing public lands, each four miles frontage by five miles deep.

Though Menocal's plan is the result of frequent and thorough investigations, it is not considered as final, but the Canal Association intends to have the routes, and particularly the divides, resurveyed in the coming winter. Operations will be taken up in the present month. So far the geological features of the country traversed by the canal are still insufficiently known, and to these particular attention will be paid. From the specimens collected by Lull's and Menocal's expeditions, it appears that metamorphic rocks form the foundation of the eastern part of the country. Overlying these, volcanic lavas, such as very compact basalts, andesites, and rhyolites, were found. Borings will be made in all the localities where cuts are proposed. Particular attention will be paid to the eastern divide, as it is considered desirable to avoid the cutting of 119 feet above the water of the canal, if possible. The results of these surveys and borings will be laid before the leading engineers of North America and Europe, and not until then the final route will be adopted. It is hoped that thus unforeseen difficulties will be avoided.

The climate of Nicaragua is an important consideration, particularly while the canal is being constructed. The western part is undoubtedly healthy, while malaria prevails in the swampy delta of the San Juan. The following description of the climate by Von Franzius will be of interest.

In the north-eastern part of Central America the north-easterly trade-winds are the rainy winds from November until February. They lose their humidity on the eastern slope of the mountains, and reach the south-west side as dry winds. Particularly from November to January the trade-winds bring rain on the north-east side, in February and March rain is scarce, and in April there is none whatever. In the beginning the rain is even carried across the mountains to the south-western slope, where it extends a considerable distance down the valleys. Particularly in the saddles of the mountain ranges the rain extends south-westward. In November and December the rainy spells sometimes last for two or three weeks. They are called 'Navidades.' At the same season, when in October and November the north-easterly trade-winds make their first appearance and bring the first rain on the north-east side, the rainy season is at an end on the south-west side. The sky is clearing up, and the trade-winds begin to blow, at first squally, later on as a strong breeze. There are no thunder-storms during this season, which is called 'Verano.' The mountains are seen through a blue haze, while the air is very transparent and clear during the rainy season. The short period of calm weather crosses Central America twice, — first in March following the receding trade-winds, and then in October. The trade-winds reach the northern parts of Central America about the end of September. In the beginning of October they begin to blow in Guatemala, about the end

of October in Nicaragua, and in the beginning of November in Costa Rica and Panama. In Guatemala they blow from the middle of October until the end of April, in Costa Rica from the beginning of November until the end of March. At the end of this season, calms prevail for two or three weeks; then the south-westerly monsoon sets in, and tropical thunder-storms with heavy rains occur every day. This period begins in Panama and Costa Rica in April, in Nicaragua in May, and in Guatemala in June.

It is difficult to estimate the traffic that would make use of a canal through the American isthmus, as its opening would result in a complete revolution of trade. The route through the Suez Canal is taken by about two-thirds of the ships plying between Europe and Asia. According to C. Eggert the whole traffic of Europe with India, East Asia, and Australia, in 1883, required 5,707 ships of 7,773,658 tonnage.

From May 1, 1882, to April 30, 1883, 3,154 steamships, of 4,889,928 tons, and from May 1, 1883, to April 30, 1884, 3,407 steamships, of 5,585,504 tons, passed through the canal. Therefore it will be safe to suppose that in the beginning about two-thirds of the whole traffic which might avail itself of the American canal would make use of it. It may be that the figure will be a little lower, as some seamen will object to the locks of the canal, but this objection will readily be overcome. According to statements furnished by the Bureau of Statistics, the number and tonnage of vessels that could use a canal through Central America, amounted, in 1879, to 2,647 vessels, of 2,671,886 tons; in 1885, to 4,139 vessels, of 4,252,434 tons. From data furnished by the Statistical Bureau of Hamburg, the same traffic amounted, in 1883, to 2,404 vessels, of 2,337,346 tons. In these compilations the figures for the trade between the United States and foreign ports fairly agree, as the following table will show. The first line refers to vessels entered at and cleared from Atlantic coast ports of the United States in trade with foreign countries west of Cape Horn; the second, to vessels entered at and cleared from Pacific coast ports of the United States in trade with foreign countries east of Cape Horn. The first and third columns are according to the Bureau of Statistics of the Treasury Department; the second, from the Hamburg Bureau of Statistics.

	1879.		1883.		1885.	
	Vessels.	Tons.	Vessels.	Tons.	Vessels.	Tons.
1	273	247,567	462	462,767	721	734,236
2	455	551,929	629	792,180	714	957,784

The figures showing the trade between European ports and foreign countries other than the United States, and using the route around Cape Horn, do not agree as well: —

1879.		1883.		1885.	
Vessels.	Tons.	Vessels.	Tons.	Vessels.	Tons.
1,644	1,462,897	1,313	1,082,393	2,473	2,210,675

In the figures compiled from the data of the Hamburg Bureau the traffic between the Pacific and Atlantic ports of North America is not included; but there can be no doubt that this trade will rapidly develop after the opening of the canal, and that it will form one of the most important items of income of the canal. The United States Bureau of Statistics states that vessels of 4,252,434 tons might have passed the canal in 1885. If the increase should continue at the same rate, 6,506,214 tons might use the canal when opened, on Jan. 1, 1893. The Suez Canal route is used by two-thirds of the whole traffic; but it must be considered, that, on account of the winds of the Red Sea, sailing-ships cannot make use of the canal, while on the coast of Nicaragua the winds are more favorable. But, even if we suppose that from 70 to 80 per cent of the whole traffic will take this route, the income will be very considerable. Taking 70 per cent of the whole probable traffic of 1893 passing the canal, not less than about 4,700,000 tons would take this route. But to this must be added the trade between the interior of the United States and eastern Asia, the greater part of which takes now the route of San Francisco, and part of the transcontinental trade: therefore it is probable that the figure is too low rather than too high.

The figures given above show that the tonnage of the vessels which will use this canal averages about 1,000 tons. Therefore the traffic would amount to about 3,500 vessels annually. The average tonnage, however, will rapidly increase after the canal is once open to navigation, as was the case with vessels passing the Suez Canal. The average tonnage of vessels passing that canal is given here: —

Years...	1870	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883
Tons....	898	995	1,073	1,166	1,290	1,345	1,377	1,419	1,425	1,533	1,510	1,517	1,587	1,747

This increase is due to the increase in the number of large steamers trading between Europe and Asia. The same will be the case after the opening of the Central American Canal. Though the navigation of the neighboring seas by sailing-vessels is not so difficult as that of the Red Sea, steamers will more and more monopolize the trade.

It is hardly possible to say which country will be most benefited by the opening of a canal through Central America. For the United States it is of the greatest importance, as it will open a new and important route from the Atlantic to the Pacific ports, as well as to the west coast of South America and to the islands and west shore of the Pacific Ocean.

DR. FRANZ BOAS.

SEARCH FOR GEMS AND PRECIOUS STONES.

THE insatiate desire for ornaments and articles to decorate the person, and hence the race for the acquisition of wealth, gives employment to thousands of persons in different parts of the world, who are kept busily engaged in searching for gems and precious stones; and in this aspect Prof. P. L. Simmonds considers it in a recent number of the *Journal of the Society of Arts*. It is somewhat difficult to know where the line of demarcation as to 'gems and precious stones' is to be drawn, and what properly come within this category; for tastes differ materially, and fashions change from time to time. About one or two, however, there can be no doubt as to classification. Diamonds and pearls have always been highly esteemed and appreciated, and the demand for these is universal. But there are some stones and substances that have value chiefly in special localities: such, for instance, as jade among the Chinese and Pacific Islanders, from its hardness and rarity; amber among the Chinese, Turks, and Russians; and coral among the East Indians, Chinese, and Africans. The African race appreciate the artificial Venetian beads above any valuable gem, because they have long been familiar to them, and are the fashion.

Precious stones have been prized in all ages for their portability, and high intrinsic value in a small compass. In Christopher Marlowe's celebrated play, 'The Rich Jew of Malta,' the merchant is represented as having before him

> "Bags of fiery opals, sapphires, amethysts;
> Jacinths, hard topaz, grass green emeralds,
> Beauteous rubies, sparkling diamonds,
> And seld seen costly stones of so great price,
> As one of them, indifferently rated,
> And of a carat of this quality,
> May serve, in peril of calamity,
> To ransom great kings from captivity.
> This is the ware wherein consists my wealth!"

A glance over the various regions of the globe will show us men of all races, in large companies, delving in the ground or diving in the sea for this commercial wealth. Indeed, scarcely a sea or a river but has its fleet of boats at certain seasons laden with men eagerly searching for pearls, although it is chiefly in the tropics that these boats congregate. It may prove interesting to gather a few facts connected with this important quest, taking the searchers on land first, and then investigating the rich produce gathered from the sea.

In the Indian Empire there is a great commerce carried on in gems and precious stones, although no reliable data are available,