The Inter-oceanic Canal.

A Thesis

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by

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The Interocaninc Canal.

The Interocaninc Canal is an old subject. It has been in the thoughts of men of science for centuries and has been a grand problem to those whose greatest ambition it is to break down all barriers of nature and thus aid in the supply of man's wants. It has been the dream of capitalists, The sport of politicians, and the fruitful cause of much international diplomacy. But the time seems almost at hand when the Isthmian Canal, having as yet only an ideal existence, shall be worked into a reality—a waterway that shall connect the two oceans. The activity of the past fifteen years, the time and money spent for the advancement of this enterprise, the renewed interest of
The commercial world are all a sufficient surety that the will and means will not be wanting to build an interoceanic canal, if it is shown to be within the reach of modern skill and ingenuity. Who will vouch for the possibility and be a leader to anxious followers in this great enterprise?

Since the time of its discovery the American isthmus has possessed a peculiar interest to commercial nations. It is an interest that has grown almost equally with the development of the New World. It began in the desire of the European nations for a quick and easy communication with the rich lands of the East Indies. The want is still felt and is applicable to all the shores of the Pacific ocean. A century was spent by the nations of western Europe in trying to find an open passage through the American continent. Since then until the beginning of this century
The need has found expression only in earnest but futile wishes for an artificial communication. But the last sixty years have produced a great change in the possibilities of the industrial arts, and the closing years of the century bid fair to witness the realization of these wishes and the introduction of a new impulse in international commerce.

The commercial importance of an artificial waterway between the two oceans is readily comprehended and estimated, but there is another attendant element of importance that must not be overlooked. It is the civilization of the Pacific countries. There may be some doubt as to the good that can be brought to the people of the Asiatic continent by an increased intercourse; but, to the countries now or ultimately to be inhabited by the descendants of European, the contact with the best civilizations of the world is very necessary. The people of the
west coast of South America are far behind those of the
North Atlantic shores, and though a mixed race of un-
certain ancestry, they have one of their principal drawbacks
in their isolated position. With better facilities of com-
munications, the use and demand of these facilities
will increase and the nations of the Pacific be brought
into closer union with the older civilizations. To the
world at large the cost importance of an interoceanic canal
is above cost. It is only the question of individual
or national profit that has held the project in check
for many years.

Much has been written on this subject; but
it is fragmentary in its nature and is scattered
through a large number of reports and periodicals.
Many articles quite full in the particulars have been
published by the advocates of the various schemes;
but as one as far as the writer knows, has written
upon or discussed the subject as a whole, and indepen-
dent of prejudices for particular routes. It is the ob-
ject of this article to collect the scattered facts and pre-
sent in as concise a form as possible an historical
outline of the development of the several projects for the
Isthmian Canal; and to give a description of each route
such as will serve to locate it and convey some idea
of its advantages or disadvantages. A discussion of the
relative merits and commercial importance of the va-
rious plans and a study of the national and political
questions that have been connected with them would
be proper themes for a continuation of this account.

In 1513, Vasco Nuñez de Balboa, standing upon a low
peak of the Cordilleras between Caledonia Bay and the
Gulf of San Miguel, beheld for the first the Pacific
ocean. A few days after Alonso Martin de Don Benito
discovered a pass through the mountains, and Balboa
by working his way wearily through the rich tropical
growth of that climate, waded into the water and took
possession of the new ocean in the name of the king
of Spain. Immediately was begun that long and fruit-
less search for el Secreto del Estrecho, the Secret of the
Strait. In the next year, 1514, the king of Spain gave
secret orders to Gonzales Davila and Juan de Solis to ex-
plore the isthmus for this purpose. In their search
they advanced as far north as the lakes of Nicaragua.
It was the same purpose that led Cortez into Mexico,
and the same that induced him, after the Conquest,
to explore both coasts and to present to the king a
map of the entire Gulf of Mexico.

For some time there was a supposition that an
open communication really existed by the way of lake
Nicaragua, the lake being connected with the two
oceans by two rivers. It was believed that all that
was necessary was a free and easy passage up the
San Juan river. Philip II instituted a survey to test the
evidence of this belief. The survey and its results
were kept a secret, an instance of the policy which
characterized Philip and many of his successors in
their dealings with the central American colonies.

In the early days no one felt the need or
knew the possibility of a water communication so
well as the Spanish monarchs. The subject of canals
was not new at that time and the explorers had
drawn attention to the various nebes and low passes.
Cortez was attracted by the possibilities of the isthmus
of Tehuantepec. Men of science soon became acquainted
with the conditions and were warm advocates for
the new enterprise. Yet almost nothing was done.
For centuries much of the commerce of Spain with
her Pacific colonies was carried in the rudest man-
nur across the narrow points in Mexico and Central America. The Spaniards followed the routes which had long been used by the native Indians. With very few efforts at improvement the colonists were compelled to work their way up the rivers and then carry their merchandise by mule paths over the rugged divides. Two of the postage routes were the Tehuan-tepee and the Panama.

World beneficial improvements were without the scope of Spanish ambition. Selfishness and greed for gold, conservation and religious proselytism were the governing principles of many of the kings. Gold was found on the isthmus at an early date, and the discoverers guarded jealously any inducements that would tend to draw large immigrations of people from other countries of Europe than Spain. The maps that had been made were locked up in the royal archives.
Efforts were even made to mislead foreigners as to the true physical nature of the isthmus. The colonists were suppressed. Then, in 1775, the citizens of Oaxaca presented to the Spanish government a memoir for improving the postage route across the isthmus at Tehuantepec, they were censured for their act and an act order issued forbidding the subject to be mentioned. It is certain however, that the Spanish government itself did not remain in ignorance of the geographic conditions of its Central American possessions. When the archives were opened to Humboldt at the beginning of this century, he found many maps valuable for their truth and extent.

The first serious attempt to use the isthmus as a general trade route was made by the Scotch. In 1698 the Scotch merchants organized themselves into a trading company, and at the advice of Mr. Patterson, the lead-
ing financier of the time, they immediately undertook to plant a colony on the isthmus of Darien. Twelve hundred people were landed in the bay now called Caledonia, and the foundations of two new cities begun. This settlement met the same fate that many others of similar character had met before in those days. Lack of provisions, sickness and anarchy soon greatly reduced the colony and within a year the remnant embarked for home. Subsequently, two independent parties arrived with supplies. They were met by the hostility of the Spaniards, and though existing successfully for a time, were finally compelled to abandon the settlement. It is probable that Patterson gained his knowledge of the isthmus from the Buccaneers whom he is known to have visited in Jamaica. It was his plan to centralize the commerce of the world and connect the Caribbean sea and the Pacific by a water passage. The latter scheme was con-
considered visionary and treated as such by the most of Patter
son's contemporaries.

In 1779-1780, the district of Nicaragua, more especially the
river of San Juan and the lake were surveyed, secretly,
by the English officers, Colonel Hodgson and Lee. This was
preparatory to an invasion made by Capt. Nelson—afterward
Lord Nelson. The invasion was made in the hope to
get possession of the river and the lake, to capture the
cities of Granada and Leon, and if possible to establish
communication between the lake and the Pacific
ocean. This would be a means of dividing the possessions
and weakening the power of Spain. The plan originated
with Sir John Dalling. Nelson arrived at San Juan del Nica-
ragua or Greytown, at a time when the river was at its
lowest and had to transport his troops from the coast
to the lake in open boats. The passage was found
quite dangerous on account of the current and the rapids.
The ravages of fever and the want of proper provisions worked sad havoc among the troops, and from the want of force the undertaking was abandoned. It is thought by some writers that, to render another invasion impossible, the Spaniards placed obstacles in the river San Juan and thus greatly injured its bed.

The incursion of the English immediately called the attention of Charles III of Spain to the subject of a canal route through Nicaragua. He sent out a commission to examine this line. These commissioners together with the engineer Don Manuel Galisteo, made their survey in 1781 and reported unfavorably. The subject was soon dismissed from thought.

Alexander von Humboldt was early attracted by the idea of a canal through the American isthmus, and had his attention called to it at various times in a period of more than forty years. He had always
recommende[d] an hypsometric survey throughout the entire isthmus and more especially between Caledonia bay and the Gulf of San Miguel, and between the head waters of the Atrato river and Cupica bay. In 1828-29 at the request of Humboldt, Gen. Poliner, the patriot of the United States of Columbia, had the isthmus leveled between the mouth of the Chagres and the city of Panama by the Englishmen Lloyd and Falmare. This is the route that has since attracted so much attention. Humboldt was confident of the possibility of a canal and always expressed regret that no nation or company had seen fit to follow his suggestions and make complete and comprehensive survey.

A great number of lines have been proposed for the interoceanic canal. Conrad Malte Brun a French geographer of the first part of the century has enumerated nineteen. Of late many public spirited men have spent their time and fortunes in developing these
projects, each one having his own favorite scheme. Yet their surveys and plans were often and necessarily incomplete. Capitalists were skeptical. Companies were formed but were without money and without the general public approval. Numerous efforts were made to enlist the support of the governments of the United States, France or England. Nothing substantial was done, however, by any of these governments until about the year 1870. The United States then began a series of explorations and surveys of the most favorable route that had been advocated. These labors, extending through a period of six years, were reported upon and the reports submitted to a commission appointed by the President. This commission, appointed in 1872, and composed of Brig. Gen. A. A. Humphreys, Hon. C. P. Patterson, and Admiral D. Arner, reported in February 1879 in favor of the route known as the Nicaragua
The contents of this paper will be limited to a presentation of the principal schemes discussed by the Commission.

The routes to be considered and the only ones that have ever received much attention are the Tehuantepec, Nicaragua, Atroto, Napipi, San Blass, and Panama. The Tehuantepec line runs from the bay of Coatzacualco in the bay of Campheche to the harbor of Salina Cruz in the Gulf of Tehuantepec. The Nicaragua line runs from Greytown to Lake Nicaragua; across the lake; and then, by means of a low pass, through the narrow neck that separates the lake from the Pacific. The Atroto-Napipi line follows the river Atroto, which empties into the Gulf of Darien, as far as the mouth of its tributary the Napipi; thence up that river, through the mountains and terminating in Cujiva bay. The San Blass line runs from the bay of San Blass on the Atlantic side to the
river Chipe or Bayano which empties into the Gulf of Panama. The Panama canal line is essentially the same as that of the Panama railroad. The San Blas line lies some forty or fifty miles east of Panama.

The Tehantepec Route.

This route as before mentioned has been a thoroughfare for centuries. It lies in the states of Vera Cruz and Oaxaca in the narrowest part of Mexico. It is the most northerly of all the routes and has one of its chief attractions in its proximity to the U.S. ports and the consequent facilities for rapid domestic commerce and easy protection.

In 1840 the Mexican government granted to Don José de Garay the privilege of opening a line of communica-
tion through this district. Señor Gaetano Moro was sent to the isthmus by De Garay to act as chief
engineer of a surveying expedition. Morro made a triangulation and geographical survey in 1843, and formulated his results in a plan for a canal. In this plan he proposed to follow the bed of the Coatzacoalcos for 60 miles, then, leaving the river, to follow the same valley as far as the pass of Tarifa, and then to reach the Pacific by a direct route. The summit is 650 ft above the sea level, but it was claimed by Morro that the water necessary to fill the upper portion of the canal could be obtained by diverting and turning aside the headwaters of the Chicapa and Ostuta, two streams which flow into the Pacific to the east of the proposed line. It has since been proved by the American expedition in 1870-71 that the water from these two rivers can not be used for such a summit. De Garay did nothing more than make this survey. After the Mexican war De Garay's grant became
The property of P. A. Harrons of New York. Upon application to Sec. Taylor for a Chief of Engineers, Brevet-Major J. S. Barnard was appointed to lead a new survey. The end in view, however, was the location of a line for a railroad rather than for a ship canal. Two years before gold had been found in California and the tide of emigration was strong in the direction of the Pacific coast. The journey overland through the great plains of the territories, or around Cape Horn was long and dangerous. Many travelers shortened the ocean passage by crossing the narrow necks in Mexico or Central America. Time was too precious to wait for the construction of a canal; and attention was turned, by the present need, to the feasibility of easier and more immediate means of communication. The line run by Major Barnard coincided in general location with that of Mow's canal. Nothing resulted from this survey.
In 1857 the line was again surveyed by W. H. Siddell, and the plans more carefully drawn. But, as in all such enterprises, the work of beginning large and years are gone before anything permanent is accomplished. When the civil war broke out the project was of necessity laid aside.

In 1870 the U.S. government sent an expedition of civil and military engineers to explore the region. The work was mainly a verification of the old surveys. Capt. A.W. Shufeldt was commander and C.A. Freudenthal chief engineer. The Americans were joined in the interior by a corps of Mexican engineers. President Juarez sent Colonel Montecino with a battalion of six hundred men to protect the party in the hostile districts. The expedition remained on the isthmus from Nov. 11, 1870 to April 27, 1871.

The route finally decided upon by Shufeldt and his engineers is, generally, the same as that of Senor Moro, except in the course of the water for the summit. The
line extends from the Bay of Coatzaacales up the river of
that name as far as the island of Tacamichapa. At
that point it leaves the river but follows the same
valley to the pass of Tarifa. On the Pacific slope it fol-
lows the valley of the Chicapa and terminates in the
harbor of Salina Cruz. (See map No. of the Report of U. S. Sur-
veying Expedition to Tehuantepec). A bar at the mouth
of the Coatzaacales would have to be cut through.
The river up to the island could be deepened to 20 feet
at a small expense. The roadstead of Salina Cruz offers the
best harbor facilities on the Pacific side.

The whole question, however, turns upon the practi-
cability of a water supply. It was quickly demonstrated
that the union of the Oxtuta and the Chicapa, as pro-
posed by Moro, was not possible for this purpose. The
Oxtuta being many feet below the summit. After a thor-
sough examination it was concluded to use the water of
the Rio Cortes, a tributary of the Coatzacoalcos. This would necessitate a dam and an aqueduct 27 miles long, of which there would be an aggregate of about 3 miles of tunnel. The supply was estimated as sufficient for a canal 22 ft. deep, 60 ft. wide at the bottom and 162 ft at the top. Commander Shufeldt says in his report that this size of canal would exclude one tenth of the commerce of the world. He states, however, as an opinion, that a surface of lock canal would exclude about this much at any rate.

The route is 144 miles long, while the summit of 680 ft will require about 140 locks. A maximum time for passage has been put at 12 days. North and South winds blow alternately during the year and may seriously affect the transit of vessels. Further, chief engineer, studied diligently the subject of earthquakes and came to the conclusion that the stability of the isthmus may be depended upon. The isthmus of Tehuantepec has one
advantage in the possession of building material. The district abounds with woods amply suitable for engineering purposes.

The country is in a hostile and ruined condition. The people, long oppressed by a foreign despotism, have made but little advance since their freedom. The civil wars and petty feuds that are constantly going on have kept them in a very low state. The native Indians have always resisted peaceful civilization and are a ready tool in the hands of the renegades and outlaws who infect such countries. It is evident that the laborers for any extensive public work would have to be brought from some other country. They would most probably be Negroes or Chinamen. In speaking of the source of labor Capt. R.W. Shufeldt says: "I have personal knowledge of the fact that, in the early days of our civil war, President Lincoln contemplated settling
the river bottoms of the isthmus with the Negroes from our Southern States, thus endeavoring to solve the problem of the blackman's status by means of forced emigration. I am also cognizant of the fact that the Mexican government favored such a project. Under the present condition of things the main body of laborers would come most likely from China.

The circumstances most unfavorable for this route and the one which will make it impracticable for an ocean ship canal are the length, the number of locks, the lack of water and poor harbors.

The Ship Railway—In this connection it may be well to speak of the ship railroad that has been proposed for the isthmus of Tehuantepec. This proposition, comparatively new to the public, has been advanced and ably supported by Capt. James B. Eade,
one of the foremost engineers of this country. Capt. Eads promises to build a railroad which will transport with a minimum of cost, time, and risk, the largest ocean vessels. The principle is not new. More than forty years ago canal boats were conveyed over the Alleghanies in Pennsylvania by means of the Portage railroad. It is the magnitude of the scheme that renders it novel and somewhat problematic.

For the plan of construction see Sci. Am. Vol. 43.

Capt. Eads visited Mexico in 1887 and succeeded in obtaining from the Mexican government a concession remarkable for its liberality. A right of way one half mile wide is granted for any line that may be determined upon. A subsidy of one million acres of public lands is made. The land to be located on the isthmus and used in aid of the construction of a harbor on the Pacific shore. The projector is to be
entirely free in the plans and execution of the work. The maximum tolls allowable are $5 per cu.
metre of displacement and $15 per head for passengers. The grant lasts ninety-nine years, the work to begin
within two years and to be finished in twelve. At the expiration of the term of the grant the govern-
ment is to take the works and pay two thirds their value. The concession gives to Capt. Eade the
right to hypothecate the revenues of the road to any government which he may select to aid him in the
construction. Yet no hypothecation or conveyance of the grant, or of the works themselves, or of the land,
can be made to any foreign government without invalidating the concession.
Capt. Eade has this spring resigned his position on the Mississippi river Commission in order to
push forward with this new undertaking.
The Nicaragua Route.

This route has always received a large share of public attention and has been partly surveyed or reconnoitered at various times. The chief feature that has warranted the approbation and encouraged the labor of engineers as well as many others is the large lake situated in the interior of the isthmus. The moderate elevation and the usefulness of the lake as a considerable portion of the proposed passage, seems to be an advantage that gives this route the preference over all others. The lake is separated from the Pacific by a long narrow ridge of mountains through which there are a number of quite low passes. Many of the surveys that have been made were confined chiefly to this route. Yet that part of the line connecting the lake with the Atlantic presents difficulties that have been well considered in the last survey.
The following are some of the proposed lines of communication between Lake Nicaragua and the Pacific ocean. (See Map; page 2 vol. I of fiancee Nicaragua; also Map No. 1; Report of the U. S. Exploring Expedition to Nicaragua.)

First: The line via the Rio Sajiao on the lake to the Bay of Bolaños or Salinas on the Pacific. A reconnaissance was made by Dr. Andreae Oersted of Copenhagen, in 1848. The bay of Salinas is well adapted for commercial purposes. The state of Costa Rica claimed this part of Nicaragua at that time, and made a grant to an English company. Second: The line from the mouth of the Rio Sajioa on the lake to the Port of San Juan del Sur. It was surveyed in 1781 by Don Manuel Galisteo, and again in 1838 by Mr. John Bailey in the service of the government of Central America. Third: The line decided upon as a result of the American surveying expedition under Com'd. Hatfield.
The line runs from the mouth of the Rio Medio on the lake to the harbor of Brito.

It has also been proposed to reach the Pacific by first passing into Lake Managua. Three lines have been recommended. First: That running from the lake directly to the Port of Tamarindia, a distance of 16 miles. Second: The line running through the plain of Leon, forty-five miles to the river Telica which empties into the harbor of Realejo. Third: The line from the lake to the Gulf of Fonseca by the way of the estuary of the Estero Real. The distance to the estuary is twenty miles. The Gulf of Fonseca is next to the Gulf of San Francisco in its value as a harbor. A canal for this line was advocated by E.S. Squier, Charge D'Affaires to Nicaragua during President Taylor's administration.

Only one route has been offered for the com-
munication between the lakes and the Atlantic. This line follows for most of the distance the river San Juan, leaving it if at all only near its mouth.

The Central American Confederation, from the beginning of its independence, regarded the construction of a canal through Nicaragua as of primary importance. In 1825 the National Congress passed a decree authorizing "The opening of a canal fitted for the passage of the largest vessels." Six months were given for receiving proposals for construction. A contract was finally made with Charles Beriotti, the agent of Mr. Aaron H. Palmer of New York. A company was formed called the "Central American and United State Atlantic and Pacific Canal Company." Mr. Palmer presented a memorial to the U. S. Congress asking cooperation, but from a spirit of conservatism rather
than a lack of interest the government delayed action. After a vain attempt to secure the support of the English capitalists the contract was given up.

In 1828, the project received the indorsement of the king of the Netherlands. General Verweer was sent to the isthmus in 1829 to negotiate and arrange the plan. An agreement was ratified by the National Congress in Sept. 30, 1830; but before it could be sent to the Netherlands and there ratified, the dissolution of the kingdom took place and put an end to the undertaking. In 1832 an ineffectual attempt was made to reopen the subject with Holland.

In 1838, Mr. John Bailey, under the direction of General Morazan, President of the Central American government, began a survey of the proposed route; but before the work could be completed the plans for a canal were again nullified by a dissolution of
When the Nicaragua canal scheme again comes into prominence, it is in connection with the U.S. government. The diplomatic negotiations and the treaties arising from this subject form an interesting chapter in the history of the foreign relations of the country. In 1848 the British, under the pretext of protecting a native king of the Mosquito shore, took possession of the town of San Juan de Nicaragua or Greytown. This is the only possible eastern terminus of the canal, and the movement of the British was interpreted, by the State of Nicaragua, as the first step to gain dominion over this route. The subsequent actions of the British agents in that state and the Envoys to the U.S. confirm this interpretation. The Director of Nicaragua appealed to the U.S. for interference. At the beginning of Taylor's administration, E. G. Squier was sent out as Charge
D'affaires with full power to negotiate in regard to the Canal. When Mr. Squier arrived in Nicaragua he found awaiting him there the representatives of Mr. Cornelius Vanderbilt and others who desired a canal grant. The people had become suspicious of all canal proposals, as being insincere; yet with the assurance that the M. I. would guarantee a proper charter, they readily entered into a contract with the American capitalist, making a concession more liberal in its stipulations than any they had made before. The new company was called the "American Atlantic and Pacific Ship Canal Company." Its charter, together with the Treaty of Commerce and Friendship, which was negotiated at the same time, was ratified by the Legislative Chambers on the 23rd of Sept. 1849. The Treaty was dispatched to Washington, and, being approved by the President and his Cabinet,
brought before the Senate. But there it did not receive immediate attention. The British Envoy did everything in his power to defeat its passage or change some of its articles. The clause in opposition to English wishes was that in which the U. S. agreed to recognize the sovereignty of Nicaragua and its right of property in any canal that should be built through that state. It is not, at present, known to the writer if this Treaty was ever ratified.

Though the U. S. Government made no haste to make good the faith of Nicaragua, yet the invasion of the English into that country was followed almost immediately by a treaty with England—a treaty that has caused not a little trouble and questioning since its ratification. It is known as the Clayton-Bulwer Treaty, or, Clayton-Bulwer Convention. The United States and England agreed to recognize the sovereignty of Central
America, and the neutrality of any canal route, and to protect any company that should undertake its construction from "injust detention, seizure or violence." The treaty is differently interpreted by the two nations and may eventually cause some trouble.

The Ship Canal Company sent out a party of engineers in July and August of 1850. It never did more than to establish a transportation route and create a line of steamships which plied between Nicaragua and the United States ports in both oceans. A small steamboat was used on Lake Nicaragua.

In 1867, the United States closed a treaty with Nicaragua, similar in its stipulations to the one brought before the Senate in 1850. Five years later under the accumulated pressure of public approval, the government instituted an official survey of the several canal routes. The expedition under the Control of Commander Hatfield
accomplished its object during the years 1873 and 1874. A. G. Menocal was chief engineer. The old lines were all examined in respect to those features which were considered the most essential, and then a thorough survey made of the line found to be the most practicable.

The lines by the way of lake Managua, though in many ways commendable, are yet not advisable because of the lack of sufficient water. The lake 156 ft above the sea is connected with lake Nicaragua by a shallow estuary of the latter and a river some four miles long. But the water shed of the upper lake is so small that this river is left dry a good portion of the year. In the dry season then the withdrawal of water to supply the canals would quickly reduce its efficient depth.

The choice of a line was finally limited to one
of two running from the harbor of Brito. Hydrographic surveys of the harbor and the lake were made, and plans designed for the improvement of the river San Juan. The entire route may be conveniently discussed under the heads of its three distinct divisions: the western division, between the Pacific and lake; the middle division, comprising the lake navigation; and the eastern division, utilizing the river San Juan. (See map No. 1 of U.S. Exploring Expedition)

The western division—The lines from Brito terminate on the lake at the mouths of the Rio del Medio and Rio Lajaes. The two lines coincide on the west side of the divide below the level of the lake. The Lajaes line runs through a pass only 54 feet above the lake. This, known as the pass of the Lajaes Portal, is the lowest pass of the American isthmus. The pass of the Del Medio line is 134 feet
above the lake. This finally was judged the preferable route, though requiring a much deeper cut to bring the canal to the level of the lake. It is the shorter by 2 miles, being only 16 miles long; it will need fewer curves and can use a longer radius; it will meet a less number of obstacles in the shape of deep ravines and periodic mountain torrents. Estimates were made for a canal 26 ft deep, 150 ft wide in earth and 186 ft in rock.

The middle division—Lake Nicaragua is about 110 miles long, 30 miles wide, and 107 ft. above the sea. It has a watershed of over 12,000 square miles. It is quite shallow especially around the shores. On the west side the bottom is of rock, and estimates were made for 10800 cu. yds. of excavation. On the east side near the exit of the lake the bottom is composed of a stiff mud. A channel for two or three
mile would have to be opened by dredging. The
consistency of the mud is such that it is thought
there will be no trouble in keeping the channel
clear. There would be some 56 miles of lake navigation.

The eastern division: This division is by no
means the least difficult portion of the route. The
river San Juan is shallow and interrupted at four
points by dangerous rapids. The method proposed
for improving the river is to build dams at these
places. Each dam will back the water to the one
above and thus increase the depth. It is thought
that the depth of the lake might be increased in
the same manner. Short lengths of canal with
locks would be used to pass around the dam.
Sixty-three miles of the river would be used. It
is believed that this upper portion of the river is
not subject to such floods as most rivers in a tropi-
ideal climate, because the lake acts as a reservoir to equalize the flow. Below the San Carlos the canal would follow the left bank of the river about 27 miles and then run in a straight line a distance of 15 miles to the harbor of Graytown. The object of leaving the San Juan is to avoid the torrential and muddy water of the San Carlos. At any rate a new and uncertain channel would have to be dredged.

A want of good harbor is a trouble, common to all the best projects for the American isthmus. A large harbor on the Pacific shore is considered unnecessary on account of the proximity of the lake. The harbor of Graytown was once in a better condition than it is now. The deposit of the river and the action of the sea currents have been steadily filling it up. It is proposed to intercept the sand by a jetty or breakwater, and then to clear a channel on the lee side.
The entire line is 182 miles long. It has a summit of 107 ft. and will require 20 locks. Four and one half days is given as the maximum time for the transit of a vessel. The material for construction may be found near at hand. Labor would have to be imported. Some of the disadvantages are length, poor harbors, and dangerous lake navigation.

As before noted the U. S. Commission reported in favor of the Nicaragua route. A company has been in existence for the purpose of advancing the interest of this canal, but it seems to have lacked a confident and controlling spirit, and nothing has, as yet, been accomplished.
The Strato-Napipi.

This route was the outcome of the so-called Darien Surveying Expedition which was sent out in 1870. Thos. O. Selfridge who commanded the expedition made a close survey or reconnaissance of the various routes which had been proposed for the isthmus of Darien. Those that have of late attracted the most attention are the Strato-Napipi and San Blas. These lines are all within the jurisdiction of the United States of Colombia.

In 1846 the first treaty on the subject of interoceanic canals was made with the Colombian government. In the 35th article of this treaty the government of New Granada (now Colombia) grants to the U. S. or its citizen a free passage over any route then in existence or afterward to be constructed. And in return for these privileges the U. S. guarantee the perfect
neutrality of the isthmus, and the sovereignty and right of property which New Granada has over any canal that may be built in its territory. The treaty is still in force.

The following are some of the routes proposed. (See Map no. 1 of the U.S. Darien Expedition.) First, the Darien route proper. The line of this route runs from Caledonia bay westward to the vicinity of the junction of the Suaebti and Chenaquaza, rivers which finally empty into Darien harbor in the Gulf of San Miguel, thence to the junction of the Sara and Savanna and then down the latter to the Pacific. Second, the Morti route. This line starts from Saccardi harbor in Caledonia bay, follows the river of that name, crosses the divide to the Morti river, and then proceeds down that river and westward in a direct line to the Savanna river which it follows to
The Pacific. Third, the Tuyra and Cacarica route. This follows the Rio Atta and its tributary the Cacarica, penetrates the ridge and then follows the Rio Tuyra to the Pacific. Fourth, the Funando route, utilizing the Rio Atta and its tributary the Funando, and terminating on the Pacific in Humboldt bay. Fifth, the "Du Puydt" route. The eastern terminus of this line lies in the valley of the Tanela river which discharges near the mouth of the Atta. Sixth, the Atta-Napifi route, follow the Atta and Rio Napifi and terminating at the mouth of the Limon river in Cacarica bay.

Though some of these lines have long been thought of, two of which were recommended to be surveyed by Humboldt, yet very few accurate surveys have been made. The explorers whose names are connected with the Tuyra-Cacarica route are Helvet, Labelme, and
Borregosa. Kellist made a hasty reconnaissance of the line and then prepared a paper, which he read before the Bedin Society of Geography. In 1865 Mons. Lacharme, a South American engineer, made a survey of the valley of the Tuyra at the request of Señor Borrego. Borrego subsequently visited the isthmus himself. Upon the basis of the reports of these two men a French company was organized to forward the work toward building a canal. Gen. Heine, then an attaché of the American legation, was sent out as inspector. Nothing came of these efforts, and the later surveys have shown the statements and conclusions of these explorers to be erroneous. In the same year 1865 De Brydts surveyed the Tana river. A company was formed in the U. S. of Colombia with the object to push forward De Brydts' project. Nothing was done however, and this survey has also been proved erroneous.
For a great deal of our interest in the Darien route we are indebted to Frederick M. Kelley of New York, who has spent a life and fortune in developing projects for an interoceanic communication. About 1850 Benj. Blagg, a merchant of New York visited Darien in search for gold; but finding this unprofitable he turned his attention to canals and succeeded in obtaining from the U.S. of Colombia a concession for the construction of such a work. Returning to N.Y. he sold his concession to Fred. M. Kelley.

Kelley and his associates immediately sent out an expedition under J. C. Frantwine. In the following three or four years quite a number of parties were sent out. From the results of these surveys Kelley devised a scheme to turn a part of the upper strato through the Tumando into the Pacific, by deepening the Tumando and using a tunnel about three miles long.
In order to carry on his work Kelley endeavored to obtain the guarantee and support of some government. He laid the plan before the cabinet of Pres. Pierce; but with little avail. He then went to Europe, and after a long and discouraging delay succeeded in seeing the French emperor. The emperor favored the plan and promised to pay for an international survey. With this promise Kelley returned to the U. S., but the new administration would not of Pres. Buchanan would not unite with the English and French; it being in opposition to a well known doctrine of American policy. The government finally offered to make the survey independent, and placed Brig. Gen. Mieghler (then lieutenant) and Lieutenant Craven at the head of an expedition for that purpose. Returning in May 1858 Mieghler reported in favor of the Tumando route while Craven reported adverse.
This was the last advance made. The war broke out, Kelley's plans were lost sight of and finally given up. This route presented great difficulties in the construction of a tunnel, the deepening of the Torando, and in the effect on the lower strata produced by turning the water of the Torando and upper strata into the Pacific.

Some years later with the revival of interest, these "Darien" routes did not fail to receive their share of attention. In 1869 Commander Thos. O. Selfridge received from the government orders to command an expedition to Darien. The first duty was to examine the old routes. In many cases as already mentioned they were found to be impracticable. The original explorers had either greatly underestimated the summit level of their passes or else exaggerated the source of water supply. After a thorough consideration of the latter essential Commander Selfridge decided upon the Strato Napopi. This was in 1871.
In 1873 he made another survey and changed the line of connection between the Napipi and the Pacific. This is called the Doguado line. (See Map No. 6 of Report of U.S. Expedition.

The Atapu-Napipi line follows the Atapu river for a distance of 150 miles to the mouth of the Napipi and then, following the valley of this river to the principal divide, passes through the mountains by a tunnel 7000 feet long and terminates at the mouth of the Limon river in the bay of Cupico. It is thought that the Atapu could be rendered navigable at a moderate cost. The summit level is 130 ft and would require 22 locks. The tunnel would have a center depth of 120 feet. The question of tunnels is briefly discussed under the head of the San Blas route. By improvements, moderately good harbors may be obtained. The Doguado line penetrates the mountains by a tunnel 3 miles long, and ends in the bay of Chiri Chiri. It has a summit of 120 ft requiring about 330 locks. Estimates
were made for a tunnel 112 ft. high. The water for the head of this canal would have to be drawn from one of the tributaries of the Napipi, necessitating an aqueduct tunnel 3 miles long. It was still further proposed to modify this last line by reducing the summit to of the level of the water in the Strato at the mouth of the Napipi. This reduction could be accomplished by increasing the length of the tunnel and deepening the beds of the Doguado and Napipi rivers. Only 3 locks would then be needed.

The canal prospects may be characterized best by representing their disadvantages rather than by trying to judge and name distinct points of advantage. The Strato-Napipi route is situated at the very southern end of the isthmus and has the inconvenience of length, tunnel construction, and a long line of river improvement. Vessels in their transit would find a serious obstacle in the periodic floods that come down the Strato. This route is common
with many others has an disadvantage in the probable effect of the calms and hurricanes known to occur on the Central American coast.

No forward step has been taken for the construction of an actual canal on this route.

The San Blas Route

The San Blas route is the shortest of all that have been proposed, being only 87 miles in length. It is in fact the shortest route possible. The line extends from the Bay of San Blas on the Atlantic to the river Chepo or Bayano which empties into the Gulf of Panama. Ten miles of this river would be used so that the canal proper would have a length of only 27 miles. (See Map No. 1 of Report of U. S. Expedition to Darien)

In 1863 the interest of F. M. Kelley, of Atro-Truanda fame, was revived in connection with this plan. Kelley entered
into contract with Cyrus Butler and Luke T. Merrill, and in the fall of the same year had a barometric line run by Capt. Norman Rude. In 1864 A. MacDougall led a party to the isthmus and surveyed from the Chepo over the mountains toward San Blas. On the basis of this survey Kelley developed a plan for a sea level canal with a tunnel 7 miles long. Kelley and his associates applied to the government of Colombia for a concession, but failed to get it because of some misunderstanding on the part of that state.

As before mentioned this route was examined by Thos. O. Selfridge. Commander Selfridge gave his attention to three portions of the line which Kelley had neglected, especially the eastern slope. He determined that the tunnel would have to be 10 miles long. He also projected a canal for the same route with 31 locks and a tunnel 7 miles in length.

A sea level canal is the principal plan and the one that
has received the most attention. Yet in either case there is one peculiar and overwhelming obstacle. The tunnelling of a chain of mountains for the passage of large ocean vessels seems to be a task that few engineers wish to undertake. But with modern appliances and modern ingenuity for developing new methods it would seem as though this project were not impossible. It is really the magnitude and cost of the undertaking that intimidates the ambitious engineer. Subterranean water, loose strata of rock, and earthquakes are the great sources of trouble to be met in a tunnel of this size and at this place.

The material for construction and the labor would have to be imported. The route is far from otherwise, by short length, sea level and good harbors. The canal at present has only an ideal existence.

* The following dimensions have been proposed for the tunnel, depth of water 25 ft., width at bottom 75 ft., at top 100 ft. Perpendicular rise above water 48 ft. Entire depth 115 ft.
The Panama Route.

The route is so familiar to the minds of everyone that there will be no need for a general description. In the last two or three years the attention of the commercial and engineering world has been concentrated on this part of the isthmus. This is the only one of all the designed canals to which the work of actual construction has ever been brought. A company of French capitalists and engineers are now actively busy in the effort to realize the existence of an interoceanic canal.

As early as 1835 the M. S. took an interest in this line. Charles Biddle, appointed by Peter Jackson to look into the subject, visited the isthmus and returned an adverse report.

Nor joly de Sablé, a rich planter of the west India island, Guadeloupe, first turned his attention to the canal project about this time. Having made several personal
examination of the isthmus, he secured the services of
the French engineer Messrs. Garell and Courtenes, and
made a triangulation survey in 1843. It was proposed
to build first a railroad and then use it as an aid
in the construction of a canal. De Sabla visited France
and formed a syndicate of 13 capitalists. A grant was ob-
tained from the Colombian government and the plans
were nearly matured when the revolution of '48 came
upon the French. Sabla's undertaking was checked
and before tranquility could be restored the time of the
grant expired, and a new grant was made to a company of
American citizens.

The American company had no intention beyond the
construction of a railroad. The road was begun in 1850
and finished in 1855.

After this there seemed to be no special call for a
survey until 1875. In that year at the request of the amer-
and engineer A. S. Menocal were sent to make an actual location. The plan developed by these gentlemen was for a locked canal. The line follows the Rio Chagres on the Atlantic slope and the Rio Grande on the Pacific slope. The water for the summit would have to be drawn, by an aqueduct, from the upper Chagres. It was admitted, however, that this supply could not always be depended upon.

Since the times of the government surveys events have taken place that have greatly increased the interest in the route by the way of Panama. It is pretty well decided among engineers that the only canal, which can be used practically and advantageously by all classes of ocean vessels, must be one at the sea level. The Suez canal is notably a sea level canal, and its founder and engineer Count Ferdinand de Lessep is ambitious to perform a similar work for
America. He has conceived its possibility and is working slowly though steadily toward its realization. De Lesseps is a diplomatist as well as an engineer. He knew that he would have the support of the French, but he needed something more before he could begin actual work. At the International Congress of Geography held in Paris in 1875 the subject was incidentally considered. It was then proposed to hold in Paris at some future time an International Congress of civil engineers to discuss and decide upon some route for an interoceanic canal. This Congress was not called until 1879.

In the mean time De Lesseps was not idle. At his instigation the French naval officer Lieutenant A. H. B. Upry and M. Reclus made a reconnaissance of the Isthmus 'Strait' and San Blas routes. Their report was adverse. The main object of their visit to the isthmus was to obtain a grant for the construction of a canal on any part of the isthmus.
The same gentlemen were soon sent back under the auspices of a "Society of Exploration" to explore the Panama route. They developed two plans, one for a locked and the other for a sea level canal. Both plans were submitted to the Congress.

The Congress met on the 15th of May 1879, and held a session of 4 days. (For an account of the proceedings see the Annual Cyclopedia for 1879). Count de Lesseps was elected president. The Americans were represented by Admiral D. R. Rumen, Commander Thos. O. Selfridge, and Civil Engineer A. B. Menocal. The Congress was composed however principally of Frenchmen and the adherents of De Lesseps. During, or before the session, De Lesseps declared that he would have nothing to do with any canal with locks. After much discussion in which the reports of the M. S. Survey were the most trustworthy evidence presented, the choice was brought to a vote. When all, who had advocated a canal scheme, were excluded from voting, the decision was ren-
dered by a large majority in favor of the Panama canal without locks. This decision is what De Lesseps needed. A company was formed and the work begun.

The Panama route as now being worked by the French company has essentially the same line as the railroad. This road has been in operation for 28 years, and the general topography is pretty well known. The lowest pass, the pass of Culebra, has a summit level of 287 ft.

The line extends from the town of Colon (Aspinwall) on the Bay of Pedro through some marshes to the village of Gatun on the river Chagres.* It then follows the valley of this river as far as the village of Matachin, crossing the river several times. At the last named place the valley of the Chagres turns almost at right angles, so that the line leaves the Chagres and follows its tributary the Obispo which comes down from the pass of

Culebra: Beyond the pass it follows the Rio Grande and terminates in the Bay of Panama south of the city. At the Pacific Terminus it is proposed to use one lock to guard the canal from the high tides of the Pacific, the difference in the range of the tides of the Atlantic and the Pacific at this point being between 12 and 18 feet.

The greatest obstacle to the Panama Canal is the waters of the upper Chagres. The bed of the river at the point where the canal is to leave its course is about 45 feet above the sea level. It was first proposed to take the water into the canal by cutting down the bed of the river for a little way back from the border line. But the foregoing that at some times of the year would pour into the canal would be a serious hindrance to safe navigation and a constant source of destruction. After some deliberation the Canal Congress recommended the plan to turn the upper Chagres through a new channel.
into the Atlantic ocean. To accomplish this a dam is to be put across the river above Matachin at a point where it flows between two mountains. The excavation from the pass of Cutlera is to be used in building this canal dam. Its height is 130 ft and width at base 3300 ft. The reservoir thus formed will cover over 400,000 acres. Owing to the depth of the soil it has been decided not to try to get a rock foundation for the dam. It seems hardly necessary for so large a dam.

The approximate dimensions are as follows: Length 41/2 miles, depth 28 ft, width 65 ft. slope 2:1 to 1 until 11 ft above the water and then 1:1 to the top of the rock. The total amount of excavation has been estimated as near 100,000,000 cubic yards.

The harbor facilities are poor and it will require 180,000 cubic yards of excavation to render the bays practically useful. Numerous wild estimates have been made as to the probable cost of the canal. The French estimate at $100,000,000.
The work of construction is actively going on at the present time. A large part of the excavation has been let to contractors, and this part of the work is already begun. The company has cleared the line, collected a large quantity of material, built houses, sheds, warehouses, hospitals, etc., and has also purchased the Panama rail road. A few years more will decide the question of the Panama route as being fit for an interoceanic ship canal.

Conclusion

There are so many conditions to be considered and so many points on which engineers differ as to the practicability of any route, that it is not an easy matter or possible to draw an absolutely fair conclusion upon the superiority of any route. But from a brief comparison of the more distinct disadvantages of each route, leaving out the question
of earthquakes, winds, and ocean currents, we may arrive at the following conclusions: The Tehuantepec route is impracticable on account of its length and number of locks. The Strato-Napier and San Blas routes are fairly impracticable because of the necessity for tunnels. The choice may be considered as limited to the Nicaragua and Panama routes. The Nicaragua is objectionable because of the great necessity for river improvements, the doubtful possibility of safe lake navigation and the want of good harbors. The Panama route is objectionable because of poor harbors and the momentous question of the disposal of the waters of the upper Chagres. The Panama route has the advantage of the Nicaragua in being short and planned for the sea level. We may conclude, if it is possible to obviate all the injurious effects of tropical flood waters, that the Panama canal, built at the sea level, is the most practicable of any that have yet been proposed.