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The Marriage of the Oceans

The wedding day has not yet been set, but in about five years—it may be a few months earlier or a few months later—the Canal Zone will be the scene of an impressive ceremony; the civilized world will look on with intense interest while a representative of the greatest republic of history speaks the words which will solemnize the union of the world's greatest oceans through the most stupendous engineering enterprise in the annals of time.

It is a pity that the work can not be completed by September 25, 1913—the four hundredth anniversary of the day when Balboa scaled Culebra hill and looked down upon the placid waters of the Pacific; but that is too much to expect, although under very favorable conditions, ships may cross the Isthmus by the four hundred and first anniversary.

After one has been here a few days and has felt the growing enthusiasm which the project arouses, he can understand how the idea of a canal at this point has for nearly four centuries haunted the minds of men.

As early as 1520 the king of Spain caused a survey of the Isthmus to be made with a view to the construction of a canal, but a successor to the throne became alarmed lest it might inure to the benefit of other nations and the enterprise was discouraged until the eighteenth century.

While Balboa, Pizarro and Gonzales were speculating about a canal at Panama or Darien, Cortez was looking for an international route farther north and reported favorably on the advantages of Tehauntepec.

Two and a half centuries later the Nicaraugua route was investigated and from that time until De Lesseps began digging in 1882, the plan of joining the oceans was urged with increasing force and frequency by the representatives of different nations. Survey followed survey, plan followed plan, and report followed report, Americans and French leading in the work of investigation.

The discovery of gold in California quickened interest in a route through or across the Isthmus and in 1855 an American company completed a railway from Colon to Panama, following the general line of the present canal. It is not surprising that this line was profitable, notwithstanding the difficulties attending its construction. It may moderate our indignation at the extortion sometimes practiced by railroads in the United States, to know that at one time the Panama road charged twenty-five dollars for carrying a passenger across the Isthmus, or about fifty cents per mile, and even went to the extreme of making a track-walker pay ten dollars for the privilege of going on foot!

The railroad now belongs to our government and is operated under the canal commission, first class passage being reduced to five cents per mile, and freight to about one dollar and fifty cents to three dollars and fifty cents per ton.

In considering the canal, the subject naturally divides itself into two parts—the physical canal that is, the actual work of construction, and the commercial canal, including the influence, direct or indirect, which it is likely to exert on trade and civilization. I shall observe this division and consider the construction of the canal in this article, leaving to the next the discussion of the project as a part of our nation's contribution to the world's welfare.

I find myself substituting the word "large" for the word "great" in describing the canal—it is really a simple enterprise, multiplied until it amazes one by its bigness. It involves the dredging of a channel through swamps and out into the oceans; the building of locks and dams and the cutting down of hills, but these things are not new.

We are deepening harbors all the time; here we extend the harbors some distance inland—but the principle is the same. We have built hundreds of locks and dams; these are the largest in the world, but a lock is a lock and a dam is a dam. We are excavating constantly; the Culebra cut is gigantic in dimensions but it differs from others only in the time necessary and the money required.

The dredging will take out eighty-five million cubic yards of earth, the twelve locks will contain four and a half million cubic yards of concrete and the steam shovels will remove seventy-eight million cubic yards from the cut, but it is purely a problem in mathematics. That it can be done and will be done, no one can doubt who will inspect the work.

Of the sixteen miles of canal between the locks and deep water more than half the distance has been dredged; of the dirt to be removed from the cut more than half is gone, the locks are well under way and the Gatun dam is rising.

The sea level canal is generally called the ideal canal and yet to be ideal a canal must fit into its surroundings and a sea level canal would not fit into the conditions here.

A visit which I made to the Saulte St. Marie in 1891 convinced me that a lock canal is entirely practicable and in congress I favored the Nicaraugua route, which contemplated the lifting of ships to a lake level of 110 feet. I was a little surprised, however, when I read that the minority of the International Board of Consulting Engineers (which reported in 1906) claimed for a lock canal at Panama greater capacity for traffic, greater safety to ships and more speedy transit, as well as economy in time and cost of construction.

Inspection convinces me that all these claims are well founded. In a given time more traffic can pass through the lock canal (and with greater safety) than could pass through a sea level canal of twice the cost.

The Chagres river, which would be an almost insuperable obstacle to a sea level canal, lends itself to the lock canal—in fact it is indispensable to it, and the lake which it forms, saves many miles of excavation.

The canal has been described so often that its dimensions are probably known to the reader, but I will give them here at the risk of repetition.

The total length of the canal is fifty miles. From the Atlantic ocean to the Gatun locks, a distance of seven miles, a channel five hundred feet wide is being dredged. This channel is forty-one feet deep at mean tide, or forty and one-fourth feet at low tide—the tide varying but eighteen inches on the Atlantic side.

At Gatun a dam is being thrown across the Chagres river which will raise the water to a height of eighty-five feet above sea level. This dam is the only feature of the canal which rivals the Culebra cut in interest. Advantage is taken of two hills, one at the east side through which the locks are built and one in the center through which the spill-way passes. The dam itself will be seven thousand five hundred feet long, and will have a width of twenty-three hundred and fifty feet at the base. It rises to a height of one hundred and fifteen feet above the sea or to a height of thirty feet above the level of the lake. The crest of the dam is one hundred feet wide and the maximum pressure is eighty-five feet, that pressure being confined to six hundred feet of the dam.

Work on the dam is progressing rapidly. Two stone dams, each several hundred feet wide were extended across the east half of the valley to the spill-way hill, and the space between these dams is being filled with what is called a "puddle core"—that is, sand and clay are being pumped in. This core is held in place by the stone dams and will, it is believed, furnish an impervious wall.

The Gatun locks will require two and a quarter million cubic yards of concrete, one-ninth of which is in place. Twenty-two hundred yards were added on January 7—the record day thus far. The locks are filled and emptied from the bottom and, as they are made in pairs, one set can be used if the other is out of order, and when both are in order, ships can pass through both ways at the same time.

The gates, which are of steel and hollow, are seven feet thick, sixty-five feet wide and from forty-five to seventy-nine feet in height. Besides the end gates each lock is equipped with intermediate gates which economize the use of water in the case of smaller vessels. There is also an emergency dam of steel for use in case of accident to the locks.

A central wall, sixty feet thick, separates the two sets of locks and this, extending about sixteen hundred feet beyond the locks at each end, serves as a guide wall for ships entering the locks. The locks will be operated by electricity and the same power will be used to tow the vessels through the locks.

The spill-way is a concrete canal three hundred feet wide and varying from thirty-five to twenty-feet deep. This spill-way runs through a cut made in solid rock. The hill, both in size and location, is admirably adapted to the purpose. The surplus waters of the Chagres will reach the ocean through this spill-way and will, on their way, generate all the electricity needed on the Canal Zone.

The concrete dam at the spill-way will be surmounted by steel gates which will control the lake level and give protection against all possible floods. The Gatun dam will, when completed, create a lake with a surface area of one hundred and sixty-four square miles.

The canal runs for about twenty-three miles through this lake and has a bottom width of one thousand feet for sixteen miles, a width of eight hundred feet for four miles and a width of five hundred feet for three miles. The canal varies from eighty to forty feet in depth along this section and requires but eleven million yards of excavation, of which only four million yards remain to be taken out.

This lake also furnishes an anchorage basin of fourteen hundred acres and the fresh water will rid the ships of barnacles and other sea growth.

This lake, formed by the Chagres river, answers several purposes; it supplies all the water needed for the locks and for the generation of electric power; it saves an enormous amount of digging and, most important of all, converts the Chagres from a menace into an invaluable ally. At present its floods are the terror of the Canal Zone, but when it pours its raging torrents into a great lake, it will be harmless. At its maximum it can not raise the level of the lake more than two feet and the lake level can be lowered to receive the floods when the rainy season begins.

The Culebra cut presents the most difficult problem—at least the problem which has been most discussed. For more than nine miles the canal runs through a range of hills where the excavating exceeds one hundred feet in depth and is, at the highest point, five hundred and thirty-four feet deep. The bottom width of the canal throughout this section is three hundred feet, extended to five hundred feet at curves. The French began their work on the canal at

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