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The Americans In Panama

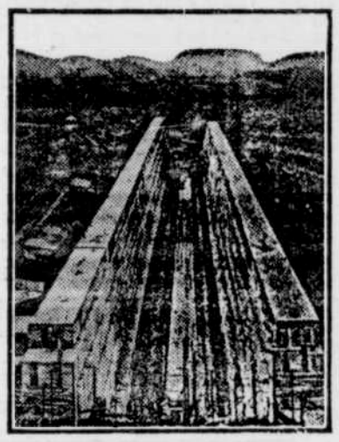
Story of the Panama Canal From Start to Finish.

By Wm. R. Scott.

(Continued from last week.)

operate turbine engines, which in turn will operate the electric machinery that will generate all the power and illuminating current needed from one end of the canal to the other But an additional power plant will be maintained at Miraflores for emergencies The power to operate the lock gates will come from the spillway plant.

The Gatun dam is so stupendous that it almost seems to be a continuation of the hills that inclose the lake It in fact does complete the natural mountain chains that form the barriers of the Chagres river. It is 105 feet high, or twenty feet above the ordinary level of the lake at eighty-five feet elevation The plan of construction has been to build parallel mounds for the mile and a half, 1,200 feet apart. Between these mounds, built of rock and earth, a core for the dam has been constructed by pumping mud and sand from the bed of Chagres river. About 20 per cent of the material pumped is solid matter, and when it has deposited the water is pumped off This operation has been repeated until an impervious heart has been made in the dam. Even if water from the lake penetrated the outside walls of rock and earth it would find this core water tight. The dam is nearly half a mile thick at the base, 398 feet thick where the water surface strikes it at eighty-five feet and is 100 feet wide at the top. The outer coverings of rock and earth on the dam close over the hydraulic core at the crest. For about 500 feet the dam will be subjected to the full pressure of eighty-five feet of water, at other points to a less severe pressure.



Guide Walls Pedro Miguel Lock.

Engineers consider the dam excessively safe, and the layman has no difficulty in appreciating its strength. About half of the material required, 22,504,000 cubic yards, has been brought from the Culebra cut. On July 1, 1913, the dam was more than 99 per cent completed, leaving less than 1 per cent to be done before the passage of the first ship.

On the Pacific side the first dam to be encountered is at Pedro Miguel and serves to hold the waters of Gatun lake at its southern end. It is 1,400 feet long and forty feet wide at the top. The maximum height of the water against this dam will be forty feet. The plan of construction is much the same as at Gatun, but only 1,000,000 cubic yards will be required.

After a ship is lowered thirty feet by the Pedro Miguel lock it finds itself in an artificial lake a mile and a half long. This lake is formed by two dams, the one to the west being 2,300 feet long and forty feet wide at the top, holding a maximum head of water of forty feet. It is constructed with a hydraulic core like the Gatun dam On the east a concrete dam 500 feet long and provided with a spillway, as at Gatun, and capable of discharging 7,500 cubic feet of water per second will hold the small lake in control The Cocoli river is the principal feeder of this lake.

Records kept by the French and by the Americans since 1904 show conclusively that enough water always will be available to keep the Gatun lake and the tiny Miraflores lake adequately supplied with water. No trouble at all can develop during the eight months of rainy season, and in the dry season of four months enough water will have been stored in the lake by means of the regulating works in the Gatun dam spillway to allow for all losses through evaporation, seepage, power consumption and loss through the locks. During the wet season the lake will be raised from elevation 85 for two feet to elevation 87 over an area of 164 square miles. This water could be used until the lake falls to about eighty-two feet, or five feet over the 164 square miles. In an average dry season this would permit fifty-eight complete transits of the canal every twenty-four hours if the full 1,000 foot capacity of the locks were used or more than the period would allow if vessels followed at intervals of one hour.

The Gatun lake is backed up among the hills by the dam until it reaches a width of more than twenty miles at the widest point and a length between Gatun and Pedro Miguel of thirty-two miles It will be broken by many small islands and stretches of high lands and is narrowest in the Culebra cut, where for nine miles the width is 300 feet. From Gatun to the entrance of the cut, a distance of twenty-three miles, lighthouses are stationed at commanding points to guide ships at night The channel throughout is at an average depth of forty-five feet. In order to raise the relocated Panama railroad above the level of the lake it was necessary to make fills to the extent of 16,425,292 cubic yards.

The navy department has selected a site near San Pablo, about twenty miles inland from the Atlantic and on the east side of Gatun lake, for a high power wireless station. It is to be at an elevation of 110 feet above the level of the lake and capable of sending a message for 3,000 miles, to Washington or to a similar station on the California coast

If the great Gatun dam should break the water in the lake might sweep devastatingly over the city of Colon, seven miles away, or pass through the old bed of the Chagres river harmlessly into the Caribbean sea. While the pressure on the dam will be terrific, no such catastrophe is considered probable The Gatun lake is the largest artificial body of water in the world. Wrecks or accidents in the lake or locks will be handled by monster 270 ton floating cranes.

CHAPTER XII.
The Culebra Cut.

POPULAR interest always has centered chiefly in the excavation phase of canal construction, losing sight of the fact that the locks, dams and breakwaters call for an expenditure of $85,643,000 The Culebra cut has been exploited more than any other feature of the canal, yet it was estimated to cost $80,481,000, or $5,000,000 less than the features just enumerated. Even the dredging of fifteen miles of sea level channel has received little publicity, and this was to cost no less than $30,906,000

The Culebra cut is nine miles long, with a curve for nearly every mile. At these curves the cut is widened to permit the ships to pass easily. Always the chief problem has been one of transportation, or how to keep empty cars in front of the steam shovels constantly, in a canyon only 300 feet wide In a working day of eight hours it has been found possible to keep the steam shovels working only about six hours because of this circumscribed field of operations.

Naturally the seventy-five miles of track in the Culebra cut must be shifted constantly as the excavation work carries the levels down. This kept the track shifters and hundreds of men at work day and night. During the maximum operations in the cut 6,000 men were employed in the day time, while at night 400 men worked to keep the steam shovels in repair, to replenish their coal bins, blast more material for the shovels and otherwise to get the cut in shape for the next day's activities.

About 100,000,000 cubic yards were to be removed to complete this part of the canal, or practically half the total excavation On July 1, 1913, the beginning of the last year of work, there were 5,000,000 yards left to be removed

For the whole length of the cut the average depth from the surface to the proposed bottom of the canal was about 120 feet, the highest point on the center line of the canal being at Culebra between Gold and Contractor's hills where excavation has gone down 272 feet After the soil had been removed for a short depth solid rock was struck and to Jan. 1, 1913, 54,504,150 pounds of dynamite were used in blasting, or the staggering total of 27,252 tons The lay mind thinks of a pound of dynamite as impressive, but its use in the canal work has been bewilderingly heavy.

Most of the explosive has been used in the Culebra cut. It is estimated that a pound of dynamite will break up 2.14 cubic yards of rock and earth, and as much as twenty-six tons have been set off in one blast in the canal. Stringent rules have prevailed to prevent accidents, and, while deaths from this cause have run into the hundreds, the handling of this amount of dynamite has been distinguished for the small number of fatalities The largest single shipment of dynamite to Panama was 846 tons, received on June 27, 1911, without an accident in loading or unloading from the steamer.

All through the day drills operated by compressed air bored into the rock in the cut for twenty-four feet. A small charge of powder was set off at the bottom of these holes to enlarge them for the real charge of as much as 200 pounds. Then after the men had quit for the noon hour or after 5 o'clock in the afternoon the charges were set off by electric current. Many persons have been killed by being struck by rocks hurled long distances in these blasts. The next morning the steam shovels found plenty of food for their hungry jaws, which bit off four or five cubic yards at a dip, swung around and dropped the six or seven tons upon the cars Frequently they lifted rocks so heavy that the cars were broken

From 150 to 175 trains a day loaded with excavated materials left the Culebra cut for the dumps. A great deal went to build the mighty Gatun dam; much has been used in reclaiming nearly 400 acres from the ocean at Balboa, the Pacific terminal; the new Panama railroad required millions of yards in making fills, and the breakwater at Balboa also took a considerable amount. What could not be usefully employed was wasted on dumps. The average haul from the cut has been twelve miles, but as much as thirty miles was traveled by some of the dirt trains. Twenty flat cars constituted a train, and one car could be loaded by a shovel in two and a half minutes, or with seven scoopfuls of earth and rock. When the trains got to the dumps an unloading plow was drawn by a steel cable over the flat cars, sweeping the material off the side which was open. Then spreaders were pushed over the track to shove the material to one side and down the embankment. Track shifters later came along and moved the track over to the edge of the fill. Between 1,000,000 and 1,500,000 yards went out of the Culebra cut every month since December, 1907.

The employees were carried from the various towns to their work in the cut or on the locks and dams by labor trains. These trains took them to their homes or the hotels for the noon meal, consuming from ten minutes to half an hour in the journey. But as the rest period at noon was for two hours in the canal zone ample time for eating was allowed.

In the month of March, 1909, more dirt was taken out than in the first twenty-two months of operations. The excavation in one month usually exceeded an amount equal to the pyramid of Cheops, which is 750 feet square and 451 feet high. The canal force of 1909, 1910 and 1911 would have dug and finished the Suez canal. March, 1911, retains the record for the greatest excavation in the cut, when 1,728,748 yards were removed, and this also is the record month for excavation for the whole canal, with a total removal of 3,327,443 yards. The average daily output of steam shovels rose from 500 yards in 1905, when only dirt was handled, to 1,500 yards in 1911, when rock predominated. The cost in the central division has ranged from 10 cents a yard to 91 cents a yard, with an average of 91 cents, from 1904 to 1909 and fell to 51 cents in 1911-12.

Rains interferred with the excavation work in the cut, reducing the output in the rainy season several hundred thousand yards a month. During the downpours operations were suspended, but the cut was dug at a slant on both sides of the mountain system, so that water was drained out of it by gravity, running out at both ends. Rivers which crossed the line of the canal were diverted by digging new channels for them.

(Continued next week)