

CONSTRUCTION OF FLORIDA EAST COAST RAILWAY.

BY ALLEN HALE.

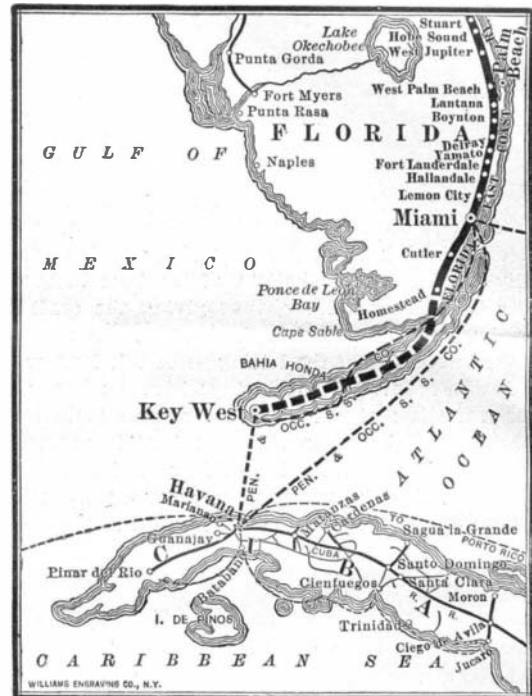
The extension of the Florida East Coast Railroad to the city of Key West, Fla., which was partially described in the SCIENTIFIC AMERICAN in 1905, has progressed to such a point that an idea can now be gained of the really remarkable engineering feats which are being carried out in the construction of what is really a railroad over the sea. This is not a figurative term by any means, for of the 156 miles of track which must be completed between Miami on the mainland and Key West, fully 75 miles will lie over the water, and a considerable portion over the sea itself.

The Florida keys may be called a series of stepping stones leading into the ocean. They extend between the Florida peninsula and Key West in the form of a curve, the channels separating the islands varying from a few hundred feet to several miles in width. Between the nearest key and the mainland is a stretch of salt water marsh, which must be spanned by trestling and other structures, as the formation will not admit the building of a solid roadbed. The first 29 miles of line south of Miami are along the mainland, where construction work is comparatively easy. The next 19 miles, however, are through a heavy mangrove swamp, with insufficient water to float dredges and not enough material within reach for wheelbarrow work; a condition which made it necessary to dig channels to accommodate the dredges used in building this section of the embankment. At Land's End, where the swamp begins, two dredges were first constructed, and an excavation made wide enough to contain a

Knight's Key channel, 7,300 feet; across Moser Key channel, 7,800 feet; and across Bahia Honda channel, 4,950 feet. The material of these islands is coralline limestone. In many places the embankment is 8 or 9 feet in height, which when the roadbed is ballasted with the same material, affords foundation for one of the finest and safest tracks in the world.

South of Bahia Honda the work is being done largely by land dredges or excavators. Three or four large land forces are assembled in this territory. At the present time there are ten excavators employed in the work, each excavator being expected to do the work of 50 or 100 men daily. In getting in on the line of actual work, many of these excavators had to dig their own way, and were from one to four months in reaching their respective stations.

The route over which the line is to be constructed consequently offers a variety of problems for the engineers to solve. As already stated, the great extent of marsh requires not only very large fills, but extensive trestling, and much of this work is almost as difficult and expensive as the viaducts which must be built between the keys. As is indicated, however, the engineers have taken advantage of powerful suction dredges, and in this way have accomplished results which would have been impossible to attain without the aid of such machinery. While the roadbed has been thrown up by means of these dredges through a portion of the Everglades, they have also been employed for filling on some of the low marshy islands. At some points a wooden framework has been made along the right of way. Through this has been ex-



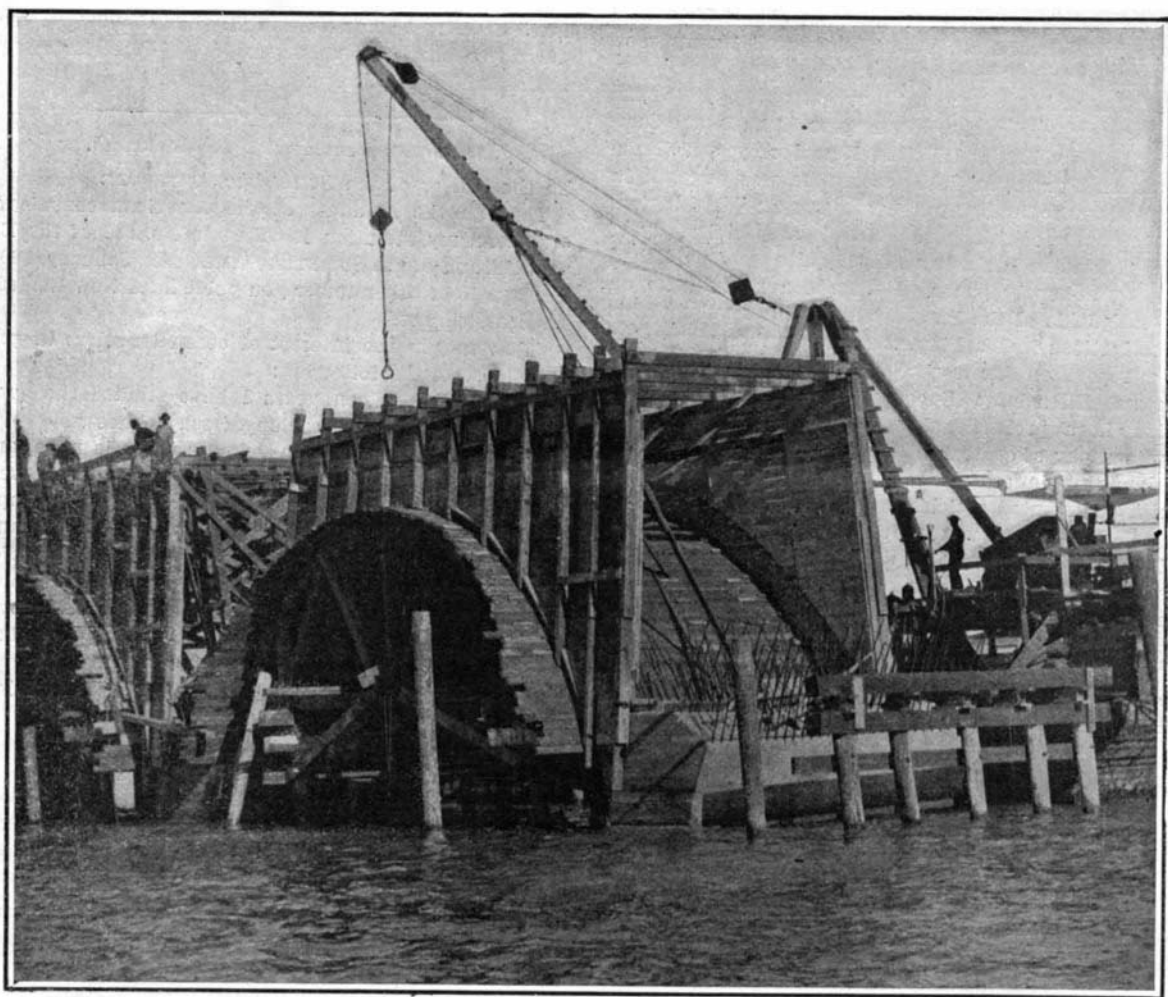
MAP OF FLORIDA EAST COAST RAILWAY.

From Jacksonville to Miami is 366 miles; from Homestead to Key West, 128 miles.

It may be needless to say that the building of the concrete viaducts has been one of the most interesting phases of the entire project, not only because of the size of the larger ones, but by reason of their location. It can be said that they are being constructed literally upon the open sea. In many places, where the water is deep enough to float a large-sized ocean steamship, and where the locality is exposed directly to the gales of the Atlantic, much of the work thus far completed has been performed by floating plants, where the concrete is mixed and placed in position by means of powerful boom derricks. In the shallower waters, molds for the foundation of the viaduct have been formed by driving piling which supported water-tight framework. The water was then pumped out, and the molds filled with concrete in the usual manner. In many places, however, the depth of the water has prevented this mode of operation, and it has been necessary to sink caissons or to construct coffer dams in which to place the material. As the photographs show, the concrete utilized is reinforced with metal rods, which extend from top to bottom of the mass, thus strengthening it considerably. The concrete arches are of course formed in molds of timber, but these are constructed on the mainland and towed into position by means of steamers. It may also be added that all the material, including the broken stone for the concrete, must be shipped by boat from Miami, near which town it is quarried. This is true of all fuel, supplies, and water for the men upon the work. In many places, in order to get supplies to the excavators, the supply boats have to travel eight or nine miles out of their way to reach a point not over a mile distant in a straight line.

Every drop of water used by the men and machinery has been, and must still painfully be, transported in tanks more than 100 miles. At one time it was thought to cut this distance down by hauling water from Manatee Creek, 50 miles distant. Accordingly a water station was put in, and an attempt made to haul water from that point. Along came a northwest wind one day and blew the water out of the bay, so that it was impossible for boats to get within two miles of the water station, and it was necessary to go back to Miami until the water regained its natural level. Three weeks later the wind came from the southeast, and piled the water up in the bay in such quantities as to drive them out again.

Engaged in the work have been 9 sternwheel boats, 3 tugs, over 100 lighters or barges, ranging from 100 feet in length to 120 feet and from 25 to 30 feet in



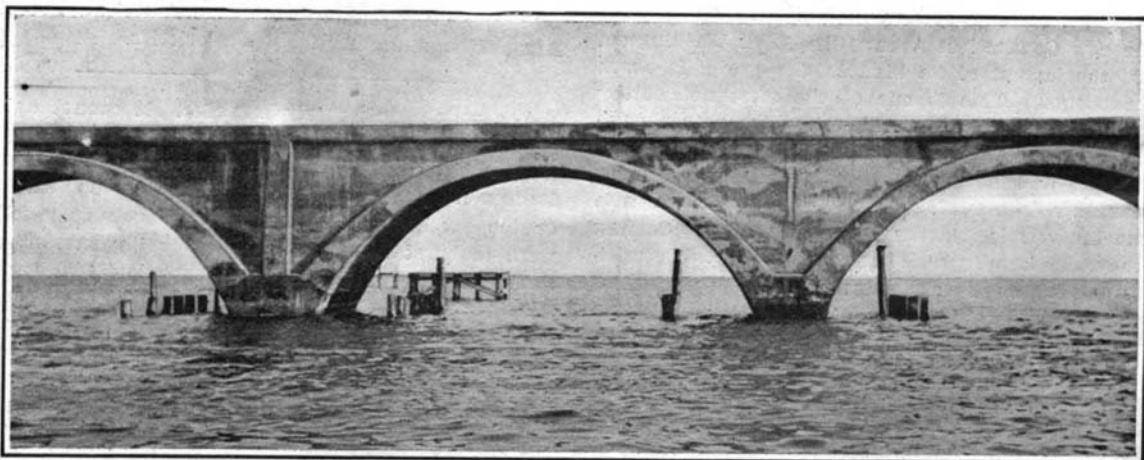
CONSTRUCTING THE CONCRETE VIADUCT THAT WILL SPAN THE OCEAN BETWEEN LONG AND GRASSEY KEYS.

Length, 10,156 feet. The viaduct will contain 186 arches of 50 feet span. Every fifth arch will have 60 feet span. Height 31 feet above high tide. This picture shows the arch and spandrel wall forms in place ready to receive the concrete.

dredge, with a depth of 2½ feet of water. Then these two dredges made their way down the two sides of the embankment, digging their own channels and using the material excavated for rearing the railroad embankment, but hampered and delayed at many points by the rock, which came so near the surface as to necessitate the construction of locks to float the dredges over them. Two additional pairs of dredges, making six in all, have been employed in this particular work, two of them starting at the southern end of the section and working north, while the other two worked up through Black Water Bay to Barnes Sound to about the middle point of this construction.

Nearly thirty islands are to be used for short stretches of the construction, the longest being 16 miles, on Key Largo. More than 50 miles of rock and earth embankment will be built where the intervening water is shallow; but where the water is deeper and the openings are exposed to storms by breaks in the outer reef, concrete-arch viaduct construction will be used, consisting of 50-foot reinforced concrete, circular-arch spans and piers, with occasional spans of 60 feet. This will be the most difficult part of the work. The water is from 10 to 30 feet deep in most places, and the bottom is limestone. There are four of these arch viaducts, aggregating 5.78 miles in length. They extend from Long Key to Conch Key, 10,500 feet; across

tended pipe from the dredges, and this immense trough filled with the detritus consisting of sand, mud, and gravel taken by the dredge from the shore of the key or some other convenient point. The wooden framework holds the material in place roughly, forming the roadbed, which is surfaced with coral rock where possible.

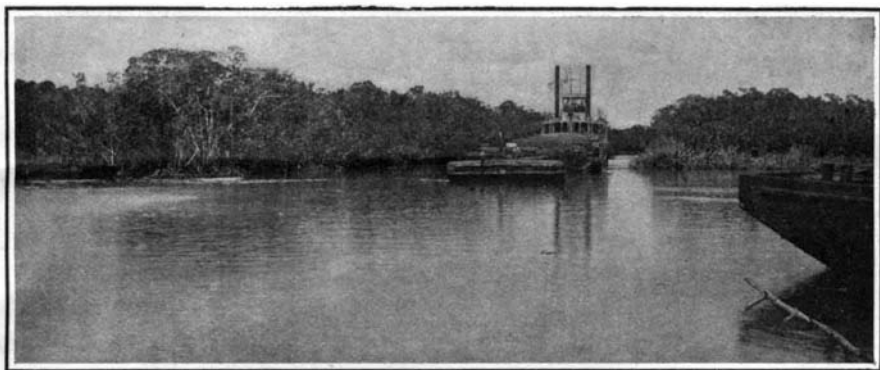


THE CONCRETE VIADUCT AT THE LONG KEY END. THESE CONCRETE BRIDGES ARE CONSTRUCTED LITERALLY OVER THE SEA.

with, 28 launches of various sizes, 6 or 8 pile drivers, 4 or 5 concrete mixing plants costing \$16,000 to \$17,000 each, 10 excavators, 3 derrick pump barges, 13 dredges, each varying in capacity from 10,000 to 200,000 cubic yards per month, machine shops, ways, locomotives,

The work is carried on entirely by the Florida East Coast Company itself, under the immediate direction of the vice-president, Mr. J. R. Parrott, who is its directing force, and Mr. J. C. Meredith, the constructing engineer. No contractors are employed. Under

new heavy hauling car lately built in France for the Minister of War by the Mors Company of Paris. It is a long platform car with an unusual wheel-spread, having an open driver's cabin placed just back of the radiator. The motor is of the upright 4-cylinder type,



AMONG THE FLORIDA KEYS. JEWFISH CREEK DREDGE ENGAGED IN EXCAVATING.



A ROCK FILL ALONG THE ROAD AT KEY LARGO. MORE THAN FIFTY MILES OF SUCH EMBANKMENTS MUST BE BUILT.

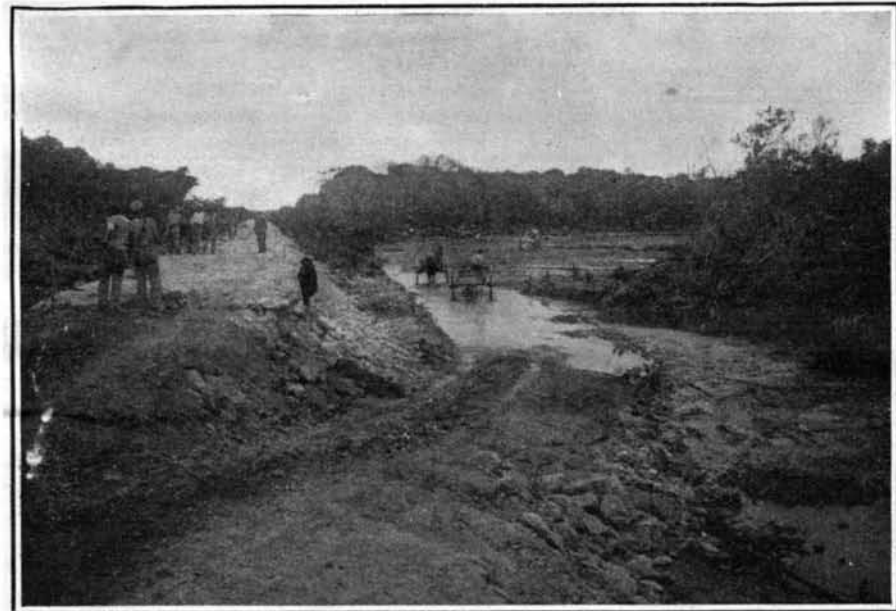
and a quantity of minor machinery and equipment, which altogether has cost the company more than \$450,000.

While this remarkable railroad on the sea will be one of the most expensive projects of its kind ever completed, it will result in the development of Key West into one of the chief seaports of the United States. The plans of the railroad company provide for the formation of a harbor which will contain no less than 170 acres. It will include the building of extensive docks and terminals, from which an ocean-going ferry will transport cars directly to Havana.

the constructing engineer are the assistant and second assistant engineers, a general foreman in charge of all the work under the chief assistant and superintendent of dredges, a master mechanic, foreman of carpenters, chief of drafting department, chief office assistant, auditor, superintendent of commissary, chief storekeepers, paymasters, superintendent of marine department, engineer of marine department, and engineers and foremen in charge of each specific piece of work. At present about 3,000 men are engaged in the work, but as many as 4,000 have been employed at one time.

While a considerable mileage of track has already

and is rated at 24 horse-power. Chain gear is used upon the rear wheels. The hauling car can take a net load of 8,000 pounds or more. It is designed to be used for the rapid supply of fortresses, and in case of mobilization it will be of great value, especially in transportation of water, as it can carry four great metallic casks which will replace the usual tanks, as the latter are difficult to handle. The Lorraine-Dietrich Company, of Paris, have also brought out a new car for the army. This is a touring car, and is remarkable for the fact that it has six wheels. A much greater length can be given to the car. It has four



THE MATERIAL OF THE KEYS IS CORALINE LIMESTONE, WHICH MAKES AN EXCELLENT BALLAST.

In this picture, the men are shown getting out the rock for the embankment at the left.



RANK VEGETATION GROWS ALONG THE RIGHT OF WAY.

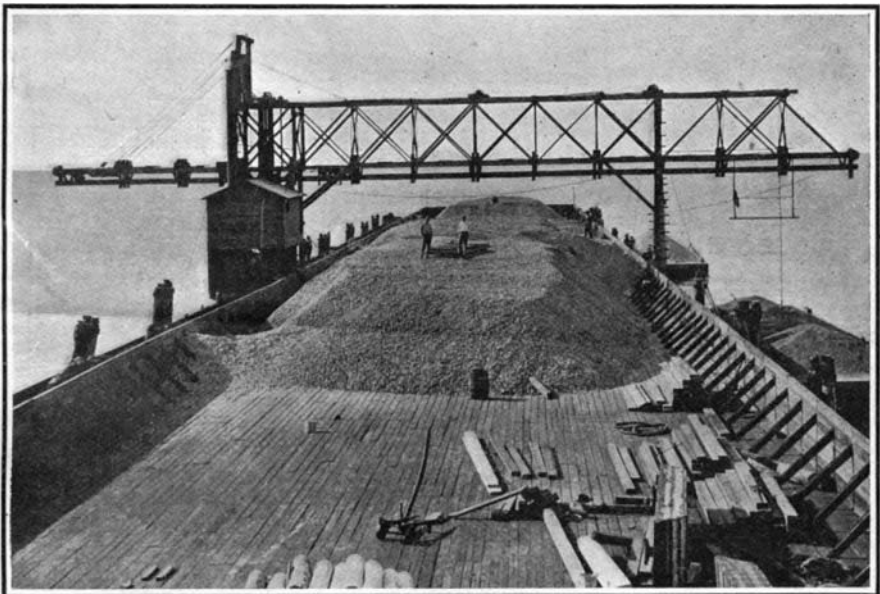
Not a little difficulty is experienced in clearing a path.

The present plans include the construction at Key West of one large drydock and ten wharves, each 800 feet long and 100 feet wide, with basins 200 feet wide between, in which the depth of the water will be from 20 to 40 feet. The piers will afford berths for forty vessels averaging 400 feet long. As the distance from Key West to Havana is but 90 miles, the transportation of freight and passenger cars by means of powerful steam ferries is entirely practicable, and it is expected that the trip can be made in about four hours across the Gulf of Mexico.

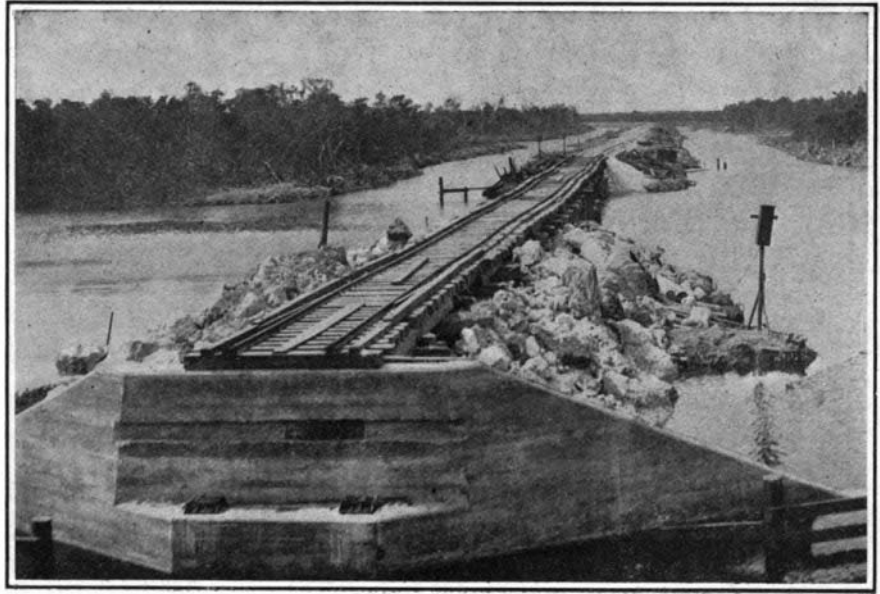
been laid upon the keys as well as the extension through the Everglades, the concrete viaduct will probably not be entirely completed before 1908. It is calculated to have the extension in operation, however, by transferring passengers and freight across the wider channels between the keys, so that travelers may be utilizing this route to Key West and Havana within the next year.

Among the new automobiles for army use which have appeared on the Continent we may mention the

seats of two places each, and besides the efficiency of the system is much greater, both as regards the relation of motor and weight as well as the question of keeping in order and personnel for a given load. It runs more smoothly than an ordinary car, and this allows a solid rubber tire to be used. A regiment of military chauffeurs has been organized in the Austrian army, following the example of Germany. The men wear a special uniform. The new regiment will take part in the annual army exercises which are soon to be held in Austria.



THE WHARF AT KNIGHT'S KEY.



VERY LARGE FILLS AND EXTENSIVE TRESTLING ARE REQUIRED.