of the supporting frame, to which they are united by three bolts, 5½ inches in diameter. The plate girders are 34 feet long and extending across the well-hole or shaft, which is 26 feet 6 inches square, have a bearing at each end of 3 feet 9 inches. The girders are 4 feet deep and are built of ½ inch web plate and 4 inches by 5 inches by ⅝ inches angle iron.

ly transmitted to the frame, being independent of the plates adjoining it.

The copper plates are rendered rigid by being stiffened with iron bars ¾ inch by 2 inches, bent to conform closely to the curves in the copper, to which they are fastened by copper bands whose ends are riveted to the casing, forming a close network of bracing, cover-

FIG. 4.—WOODEN SKELETON OF THE LEFT HAND OF THE STATUE OF LIBERTY.

At a depth of a little over 60 feet below, is arranged a second and similar system of girders, 41 feet long. These girders are of the same thickness of iron as those above, but are only 3 feet deep, and are arranged two in a set. The two systems of girders are joined by four sets of eye bars, consisting each of four bars 4 inches wide and 1½ inch thick, placed close to the side of the walls of the shaft, and are prolonged to join the main frame at the top of the first or second panels.

The supporting frame having been erected upon the pedestal, presented the appearance indicated in the

FIG. 6.

annexed engraving. The copper casing had then to be fixed in position. These copper plates are about ⅜ of an inch in thickness, and were marked with figures as a guide in the re-erection of the figure.

In fixing each section the piece required was protected by a wooden frame or covering and raised by means of a rope attached to a derrick and engine, to the platform built around the top of the pedestal. From thence it was carried to the place where it belonged as indicated by the marks upon it, and it was then riveted to the adjoining plate and to the braces connecting it to the main frame. The work is carried up in courses in such a manner that the weight of each section is direct-

ing and strengthening the whole statue. The inside view of the face in the drawing annexed shows the manner in which this is done, and the effect is to trans-

FIG. 7.

mit pressure of wind and other forces acting on the thin outer copper through the various struts and braces to the main frame, which is firmly fastened to the pedestal as already explained.

FIG. 5.—THE STATUE OF LIBERTY.—HAMMERING A PLATE OF COPPER INTO A PATTERN.

The riveting of the plates is of three kinds. Where the joint is to be concealed, the edges are brought together and covered on the under side by a strip of copper, through which pass two rows of rivets with their outer heads countersunk. In other cases one edge overlaps the other and a single line of rivets pass through the overlapping edges, the outer one of which is hammered down where the location renders it necessary. A staircase is provided leading to the head, with steps up the outstretched arm.

The principal dimensions are as follows:

	Feet.	Inches.
From bottom of plinth to top of torch.....	151	41
Heel to top of torch.....	111	
Height of head.....	13	6
Width of eye.....	2	4
Length of nose.....	3	9
Length of forefinger.....	7	11
Circumference of finger at second joint.....	4	9
From water level to top of pedestal.....	149	10
Water level to foot of pedestal....	60	10
Foot of pedestal to top of same....	89	
From high water to top of sea wall.....	10	
Top of sea wall to foot of fort wall.	2	6
Foot of fort wall to gravel level, at parapet of fort.....	23	6
Parapet to foot of pedestal.....	24	

The head will hold 40, and the torch 15 persons. The total weight of the statue is 440,920 pounds, of which 176,368 pounds are copper and 264,552 pounds iron.

The object of the statue as a beacon is effected by the electric lighting now in course of erection. The statue itself is to be brilliantly illuminated from base to summit by four large lamps placed in front of powerful reflectors behind the parapet. They will be arranged out of view, to throw light on every part of the figure, which will thus be visible on the darkest night. On the balcony surrounding the torch are placed at equal distances apart eight lamps of 6,000 candlepower each, with reflectors behind them.

The whole structure in its final appearance is eminently satisfactory.

Long may it stand as an emblem of Freedom and a monument of the good will and friendship existing between France and the United States of America!

NOTES ON THE PANAMA CANAL.

By CHARLES D. JAMESON, Member of the Boston Society of Civil Engineers. Read May 19, 1886.

THE idea of connecting the Atlantic and Pacific oceans by means of a ship canal across the isthmus between North and South America was almost contemporaneous with the discovery and conquest of the country by the Spaniards.

The first paper upon that subject was written in the year 1550, and in this paper the relative values of the Nicaragua and Panama routes were discussed.

The next notice we have of the idea was in 1779, and surveys were ordered by the Spanish Government in 1780. But owing to complications in Europe, these surveys were not made, and none of these earlier Spanish projects ever advanced far enough to have any reliable surveys or plans made.

When, in 1825, the most of Central America had thrown off the Spanish yoke, and had become small, independent republics, they, knowing so well the configuration of the coast and the feasibility and advantages of a ship canal, did all in their power to have the question well studied and brought before the notice of the world.

In 1825 the republic of Nicaragua asked the co-operation of the United States in the building of a ship canal connecting the Atlantic and Pacific oceans. But as the United States Government could at that time get hold of no reliable data connected with the subject, it was not deemed advisable to commit the Government to any such grand undertaking. The only result was that a new minister was sent to Nicaragua, with instructions to examine into the question fully and collect all possible data.

The first regular survey of a line across the Isthmus of Panama was made at the expense of the Government of New Grenada in 1828, from the mouth of the Chagres River to Panama. This place at that time was considered one of the most feasible places for cutting the isthmus, as it was one of the narrowest, and also there is a great depression in the main chain of mountains.

There was really very little reliable work done on the isthmus in the way of any surveys for a canal until 1870, and from then up to 1880 all the best work was done by the United States Government. The principal attention of this Government has always been turned toward the Nicaragua route, although there have been eleven different routes surveyed and plans and estimates made.

Owing to the fact that the Nicaragua route is in a more inhabited and healthy climate than any of the others, and also that the estimated cost of construction has always been less, this route has always been the one most advocated by our Government.

We will now look at the manner in which the French came to have the concession for, and the control of, the Panama canal.

While the United States Government was having careful surveys and estimates made of all these different lines, a lieutenant in the French navy named Lucien Napoleon Bonaparte Wyse, and Lieut. Armand Reclus, with a party of about twenty men, in 1876 commenced an examination of some of the lines which had been run across the isthmus. These exploring parties under Wyse and Reclus spent the better part of two years on the isthmus in examining into the different merits of the many lines which had been run, and also to decide as to the actual feasibility of building a canal at all.

The expenses of these exploring parties were defrayed by a private company in Paris. As soon as Lieutenant Wyse had procured all the information and data he required, or at any rate had used up all the time at his disposal, he pushed on at once to Bogota, the capital

the United States of Colombia, and on March 28, 1878, got his concession signed by the Government. By the terms of this concession he was granted the exclusive privilege of constructing a ship canal from Colon to Panama, for a period of ninety-nine years; the canal to be finished in 12 years after the organization of the company; and if any unforeseen obstacles are encountered, the limit of time for construction will be extended six years more. There can be no doubt but that the canal company have a right to this additional six years, as most of the obstacles which they have encountered appear to have been entirely unforeseen.

Lieutenant Wyse then went at once to New York, to see what arrangements could be made with the Panama railroad, as it was then evident that the best line between Colon and Panama must run near the line of the railway, or at least within their right of way, and that the co-operation of the railway company would be all-important to the construction of the canal.

Having made his arrangements in New York, he sailed at once for France. Now, this company of which Wyse was the head had a concession and all the rights necessary for the construction of an interoceanic canal across the Isthmus of Panama; and the only, and by far the most important, thing which they lacked was the necessary amount of money.

In order to form a company and raise the immense amount of money necessary for the undertaking, it needed, as the head and front of the enterprise, a man the simple name of whom could so inspire and rouse the people that, without knowing much more about the enterprise than the one fact that this man was at the head of it, would give them unbounded confidence

in its success and the enterprise unlimited credit. The only man who could fill these requirements was Ferdinand de Lesseps, who, with his fame founded upon the construction and success of the Suez Canal, could raise money to any amount for any enterprise to which he lent his name.

Le Comte de Lesseps was induced to become the head of the Wyse-Reclus canal project, and a scientific congress of all nations was called at Paris to decide as to which of the many lines run across the isthmus was the best. The decision of the congress was in favor of a sea level canal from Colon to Panama. This decision was rather a foregone conclusion, from the fact that the Colon and Panama route was the only one of which Wyse held the concession and of which De Lesseps was the head. Unless one has been in France, and particularly in Paris, one can form no idea of the amount of influence and blind enthusiasm the mere name and reputation of one man can arouse. De Lesseps made a success of the Suez Canal in the face of the strongest opposition, and to the ordinary French people he is little less than a god. The majority of them are satisfied with the fact that he says the Panama Canal will be a success, and up to the present time he has merely had to ask for money to get all and more than he asked for. In June of 1884, when he called for 80 millions, the morning when the books were opened to receive subscriptions, the streets were packed for blocks with people who took their luncheon and crowded and pushed all day to get a chance to let him have all their savings. The money which has thus far been spent upon the Panama Canal has not come from rich bankers and capitalists, but in small lots out of the pockets of women and orphans and the middle class of French people, who seem willing to pour into the capacious pockets of De Lesseps their last cent, and take his word for it that at some time in the future they will reap their reward. Perhaps they may. Where the remainder of the money needed to finish the Panama Canal is to come from is a query.

We will now leave Le Comte de Lesseps and his poor people in France and go to the Isthmus of Panama. The administration of the Canal Company upon the Isthmus is as follows: Director-General, Assistant Director-General, Chief Secretary, Chief Engineer, and a great number of other chiefs up to about 700. In fact, nine out of ten of the employes of the Canal Company are chiefs of something, and a man must indeed be down pretty low not to be able to write chief after his name. During the five years of construction upon the Isthmus there have been eight different administrations, no one of them lasting two years. Of course, this has been a source of great loss to the Canal Company, which can hardly be exaggerated.

The Panama Canal is to be a sea level canal from Colon on the Atlantic side to the mouth of the Rio Grande, on the Pacific side near Pauama. The total length will be 74 kilometers, or about 45 miles. At the Pacific end there will be a tide-gate by which to control the excess of tide of the Pacific Ocean over that of the Atlantic. The difference between high and low tide in the Atlantic at Colon is only about 12 inches, while in the Pacific it is 20 or more feet.

At the Panama end there will be a basin 1,600 meters long and 110 meters wide. At Traverulla, at about the center of the canal, there will be a large basin about 5 kilometers long, and at Colon there will be a basin well protected by a sea-wall—a basin 3 kilometers long and 1 kilometer wide.

The bottom of the canal will be 30 ft. below the water line, and will be from 100 to 200 ft. wide. The deepest cut upon the center line is at kil. 55 Culebra, where it is 330 ft. for a short distance. At this point the depth of cutting at the slope stakes runs up to 450 feet.

By means of the profile one can form some idea of the comparative quantities of each kind of material to be excavated. The whole line of the canal has been sounded to its full depth by means of the diamond drill, and the cores of the entire soundings extracted and classified.

The city of Colon (Aspinwall) is situated upon an island upon the Atlantic side of the Isthmus of Panama, and the whole of this island is owned and occupied by the Panama railway, who will not sell one foot of it. The city itself consists of only two streets running parallel to the water, and which, before the fire of March 31, 1885, were lined with stores, bars, and tenement houses.

they took a large swamp, which was usually under six feet of water, and filled it with broken stone and gravel to about six feet above high tide; on the top is put 18 inches of rotten coral to give it surface. This rotten coral packs down very firmly, and is entirely free from dirt and dust. This whole fill contains about 85 acres.

Upon one side of the fill there is nearly one mile of

There is no drainage of any description, and refuse of every kind is thrown into the streets, which, with the vacant lots, are gigantic cesspools. You hear a great deal about the deadly climate of the Isthmus, and beyond a doubt it is unhealthy. But if the people here in Boston lived in so much filth and drank as much brandy, the death-rate would be nearly as great. When the canal company wished to build their offices, store-houses, and dwelling-houses at that end of the canal, there was no land available where they could build a line of wharf which would be accessible to vessels of all kinds. So to the south of the island

stone wharf, with about 25 feet of water. Upon this fill are built all the dwelling-houses, offices, store-houses, etc., of the canal company.

That part where the dwelling-houses are built is laid off well in streets, and is well drained. There are sidewalks and cut stone gutters. All the buildings are built upon masonry pillars a few feet high, in order to allow the air to circulate freely under them.

The whole camp is in charge of a special police force, whose only duty is to keep it clean and orderly.

Owing to the fact that all the freighting is done by cars and locomotives, it is very seldom that the streets

of this encampment are desecrated by the presence of any beasts of burden, or that the streets are cut up by wagon wheels. Therefore, the camp can be and is kept most exquisitely neat and clean, and no expense is spared to accomplish this object.

Much of this care and expense, which is lavished not only upon the camp at Colon, but upon the camp of each section along the whole line of the canal, strikes the American who is new to the country and climate as a great waste of money. But after a little examination into the beneficial results arising from this same expense, any one will admit that it is perfectly justifiable. You all know by the newspapers what a tremendous death rate prevails in Aspinwall, but at the canal camp, which is merely one part of it, from June, 1884, to June, 1885, there were only four deaths, with a population of six hundred, and two of these were the direct result of intemperance. With all the sins of omission and commission of the canal company—and they are many—one must admit that in regard to the care taken of the health of their employes, in their commissary, sanitary, and medical departments, very little can be found lacking.

The large hospitals of the canal company were built, at an immense cost, at a few miles from Panama, and 200 feet above the sea. The position was most admirably chosen, as there is always a good sea breeze, and the drainage is perfect. The capacity of this main hospital is about 400 beds, and all the arrangements for the comfort and care of the invalids are made in the most perfect manner. There is a smaller hospital of 100 beds at Colon, and a fine sanitarium upon the island of Taboga, where the employes are sent for a change of air when necessary. All the employes of the canal company are admitted to these hospitals, and receive the best of care, food, and room, free of charge. The only thing needed is a doctor's certificate that he is sick. Any men working for contractors are admitted to the general wards for \$1 per day, which includes everything; and those who wish it can have a private room for \$1 extra. When the price of table board—and not very good board either—is from \$50 to \$100 per month all over the Isthmus, one can see that these hospitals are an immense expense to the canal company, and that they spare nothing which in any way tends toward the good health of their employes.

However well disposed one may feel toward the canal company, no one can deny that the management on the Isthmus has been very loose and very badly directed, and that a tremendous amount of money has been spent for which no result can be shown. The most noticeable thing about the employes of the canal (with one or two rare exceptions) is that none of them feel any interest in the success of the enterprise. Every man is working for himself, and seems to care very little what progress is made so long as he draws his salary regularly once a month. There is none of that holding a man down to his work, and either making him do it or getting some one in his place at once who will do it, that we see among the Americans.

Owing to the unhealthiness of the climate and the consequent uncertainty of life, the one idea on the Isthmus seems to be, get what you can, how you can, as quick as you can, and get out of the country. The main offices of the canal company are in Panama, in one large building which contains, during working hours, between four and five hundred employes. The salary of the director-general is \$100,000 per year and all his expenses, including house, horses, carriages, servants, etc.; in fact, everything he can possibly want.

With the exceptions of some six or eight persons holding the most important positions, and whose salaries range from \$10,000 to \$25,000 per year, the salaries paid by the canal company are not by any means high, considering the country and the prevailing rates of wages for the same class of services by the other companies, such as the Panama Railroad and the Pacific Mail Steamship Company.

The line of the canal is divided into sections of about six miles each. Each of these is in charge of an engineer. He has a first assistant, clerk, draughtsman, instrument men, time-keepers, store-keepers, doctors, etc. The salary of a chief of section is \$200 or \$250 per month and his board; assistant chiefs \$150, and instrument men and draughtsmen, from \$60 to \$100 per month. A chief of section was allowed \$2 per day for expenses, and below him about \$1.50 per day, varying, of course, with circumstances.

At the headquarters of each section there are comfortable and airy houses, sufficient for the accommodation of all the employes above the rank of laborer, and large barracks for the laborers. All these section camps are well policed, have a capable doctor and a small hospital. These section hospitals are merely to be used in case of accident or in very mild cases; in other cases, the patient is sent at once to either Panama or Colon.

To make it an object to the employes to stay on the Isthmus and continue in the employ of the canal company, the following inducement is offered: When any one has been in their employ two consecutive years, he is entitled to six months' vacation, with full pay, and his fare paid to any part of the world and return. Very few, however, have been entitled to this vacation, and it has been found that, of those few, the majority preferred to continue with their work, and have six months' extra pay and \$200 for expenses put to their credit.

Of course, the climate of the Isthmus, like all tropical climates near the sea-level, is most unhealthy. The prevalent diseases are dysentery, malarial fever, and yellow fever; and when one is taken down, the most powerful remedies must be used at once, or it will be too late. This climate, doing away with the fact of its unhealthiness, is one of the most beautiful in the world, but not the most invigorating. The nights are all cool enough to sleep well, and in the shade the heat is never oppressive in the day-time.

We will now take a look at the class of men who are doing all this work on the Isthmus.

Most of the higher positions are filled by Frenchmen, but the chief secretary, who is one of the hardest and best workers on the Isthmus, is an Englishman, Col. Chamberlain, of the English army.

The chiefs of sections are all French, and the clerks, under-secretaries, store-keepers, etc., are mostly Jamaica or Martinique negroes who have a fair common school education.

The laborers are in about the following proportions:

Greeks and Italians.....	0 10
English, Americans, and Swedes.....	0 06
Germans	0 04
Colombians.....	0 20
Jamaica and Martinique negroes	0 60
	1 00

Among these, the Greeks are by far the best and most intelligent workers, but much care must be taken not to work them in mixed gangs, but in gangs by themselves, as they are a vindictive, quarrelsome set, and very ready to use a knife. Being much addicted to drinking and gambling, they cannot be in any way depended upon.

The Swedes are about the best workers where only a moderate amount of intelligence is needed. They are very faithful, but also very stupid.

The English and Americans whom one sees on the Isthmus as laborers are the very scum of the earth. The most of them are runawaysailors who are tempted by the larger pay. As a general rule, the English and Americans of the laboring class upon the Isthmus are divided into two classes: either they are killing themselves with drink, and are therefore of no use, or else they are such fools as to be absolutely useless.

The native Colombians are of Indian blood, or Spanish and Indian mixed. They are a straight, well-built race, but owing to the climate and the very little need there is for work in order to live, they are a lazy, indolent set, who make the women do most of the work, and whose only desire seems to be plenty of sleep, bananas, cigarettes, and brandy. Consequently, they cannot in any way be depended upon by either the canal company or the contractors; and until the last year they have been so much taken up with revolutions that they have cared little whether they worked or not. The only kind of work for which they have shown any adaptability is the clearing of the "right of way," and most of this work has been done by them.

In this question of the supply of the manual labor needed, which, without doubt, is the gravest one the canal company have to face, the Jamaica negro seems to be the only answer, so far, that has any degree of stability to it. They form the main body of the laborers upon the Isthmus, not because they are even as good workers as many other nationalities, but because there are more of them. They are mostly imported directly from the islands at the rate of about 1,000 per month under contract for two months at \$1.50 per day.

There are no Chinese employed as laborers on the canal, but at every encampment you will find them as small merchants, and in the city of Panama there are several large mercantile Chinese houses. During the construction of the Panama railway, and once since, that company and the Pacific Mail Steamship Company have imported large quantities of Chinese as stevedores and laborers, but each time they have been a failure, and the companies have had to fall back upon Jamaica negroes. The laborers work from 7 to 11 A.M. and from 2 to 6 P.M.

The clerks and office men work from 8 to 11 A.M. and from 2 to 5 P.M. No employe of the canal company ever by any accident overruns these hours. There is no night work done, and no Sunday work.

Most of the actual work which has been done upon the line of the canal has been done by contract, and in all of these contracts, with the exception of two, of which I will speak later, the tools and all the necessary machinery were furnished by the canal company. The contractor is obliged to give bonds for only 10 per cent. of the amount of his contract, and to pay 7 per cent. of the cost of the tools for their use.

During the last three years the great object of the administration on the Isthmus has been to make a showing in the amount of material excavated, and therefore any one who could give any bond at all, and would agree to commence work at once and push it, could make his own conditions with the canal company. For this reason all the large contracts which had been made up to one year ago were all in favor of the contractor, and any of them who lost any money on them must indeed have been stupid.

In these contracts, where the canal company furnished all the tools and machinery, any delay caused the contractor by the non-delivery of the tools on time is so much more time allowed to the contractor in which to finish his work; and any expense caused the contractor by the non-delivery of the tools, etc., such as large gangs of men, locomotives, and excavators standing idle, must all be paid for by the canal company. The service of the store-houses being organized in nothing but an immense amount of "red tape," a judicious contractor usually had a monthly estimate of damages due him two or three times as large as the amount due him for actual work done. In this way contracts could be taken at a very low figure, and still prove a source of profit to the contractor.

To illustrate this point more fully, I will give you the actual figures on one of the largest contracts which has been let on the Isthmus. The contract price per cubic meter for material excavated we will call 3 cts. At the end of one year's work, taking the total amount of money which had been paid this firm for work done and demurrage on the machines when standing idle at expense of the canal company, and dividing this amount by the actual number of cubic meters excavated, the cost to the canal company per cubic meter was 17 cts., in the place of 3 cts., as per contract.

This is rather an extreme case, but those are the actual proportions. You can, therefore, see at once the fallacy of any estimate of the cost of completion based upon the contract price, and it is upon these prices that the estimates of cost have been based by the canal authorities.

All the large contracts are divided into sub-contracts where possible. No contractor, when it can possibly be avoided, ever works any men by the day, but all by task work. But the large gangs of laborers who work directly for the canal company are working by the day. That is, putting in so many hours per day on the work for which they are paid.

Common labor receives from \$1.50 to \$3 per day, and skilled labor, as machinists and boiler-makers, \$5 to \$10 per day.

All the laborers receive their pay every two weeks. Office men receive theirs once a month, and contractors receive theirs once a month or as per terms of their contract.

The main store-houses of the canal are at Colon, but at each section camp there is a large one well stocked, and also some large ones in Panama. These store-houses are packed with everything one can imagine, and most of the articles in the most ridiculous quantities. For example, they unloaded and packed away in Colon, in one place at the same time, 600 anchors all of the same size and make.

Each of these store-houses is in charge of a chief and a number of assistants, who report to the chief-general of the store-houses and material. But if you wish for anything in a hurry, the only way to get it is to hunt round till you find which store-house it is in, and then, getting an order from the director-general of the canal for it, go and get it yourself.

MACHINERY.

For all the train work which is done on the main line of the Panama Railroad, American locomotives and American or English drivers are used entirely, but for all canal work in their own yards and cuttings, a small French or Belgian locomotive is used.

The dump cars used in the excavation are of English, American and French make. In opening all the works, small hand cars are used until there is a sufficient face on the work to admit the use of the steam excavator or the steam shovel.

The steam shovel used the most and the one which gives the best satisfaction is the Osgood & McNaughton, Albany, N. Y.

One of the best working excavators used is of French make. It consists of an endless chain of buckets, which works either at right angles to the track upon which the excavator stands or in the same direction. The ladder around which the buckets revolve can be raised or lowered at the bottom so as to feed the buckets, and the excavated material is dumped into a hopper about 20 feet high, from which it falls into a dump car which runs upon a parallel track. The motive power is connected to the buckets by means of a flat chain running over a toothed wheel.

The company have on hand pumps of almost every description and size, and miles of large, heavy piping, which they propose to use in the following manner. Of course, one of the gravest questions to be answered in connection with the construction of the canal is, What is the cheapest and best way to dispose of the material which will come out of the large cuts in the interior? There is very little chance for spoil banks without crossing the mountains into the next valley, and the length of haul stretching out into miles. Now the design, and to a certain extent the practice, is to dump all this material into large tanks placed in convenient positions and partly filled with water. These tanks contain agitators which reduce the whole to a semi-fluid state, and then the large force pumps force it all through these miles of pipes to the most convenient dumping ground. At every section camp where any work of construction is going on, there is a machine shop of greater or less extent. The main machine shops are at Gorgona, and are well fitted up in every detail. One reads a great deal in American newspapers about the immense quantities of machinery which have been allowed to rust away to ruin. This most certainly is an exaggeration. Of course, some machinery imported has been ruined by rust, but only a very small per cent. The rest of it is all taken good care of, and kept in working condition.

FLOATING MATERIAL.

This includes in Colon a rowboat with an awning and from one to eight oarsmen for each chief, assistant chief, head clerk, clerk, etc. As a man's position is, so is the number of his boatmen.

There are two small steam launches and eighteen towboats, all of them very small except six. All these boats are of metal, and English build. There are six large steam hopper barges (clapet), also English build. These barges and towboats are mostly manned by Greeks, who are the best sailors and pilots to be found in that part of the world.

All the dredges used on the Atlantic end of the canal work a number of buckets upon an endless chain. There are three classes of these dredges:

- 1st. Small French dredge.
- 2d. English marine dredge.
- 3d. American dredge, Hercules type.

The French dredge is a small dredge, with the bucket ladder projecting in front so that it can dig its way into banks, and thus float itself. One drawback to it is that it has to be held to its work and moved bodily from side to side and ahead by means of chains and anchors run out ahead and on each side. The buckets empty into a hopper 25 feet from the water, and the material falls at once into a scow moored alongside for the purpose, and which, when full, must be removed by a towboat and another put in its place. The capacity of these dredges is about 800 cubic meters in good material per day. The English marine dredge is built all of steel, and can dig 40 feet deep. They cost the canal company \$200,000 each. They have only two of them, one at Colon and one at Panama. They both came from England under steam alone.

They can only be used in deepening channels, etc., as they only work under themselves, and must always have enough water to float them. They also discharge all the dredged material into scows or clapets. The power in both the marine dredge and the small French dredge is carried from the main engine to the shaft, which works the buckets by means of a flat chain running over toothed wheels.

The capacity of the marine dredge is about 1,000 cubic meters per day.

The American dredges are built and owned by the "American Contracting and Dredging Company," of New York, and I will here say that this company and the Franco-American Trading Company, which as yet has done no work to speak of, are the only contractors on the Isthmus who furnish their own machines, and also that up to date the American Contracting and Dredging Company are the only contractors who have made any headway in their work, or have complied with their contract as to time. At the rate at which they are now working, there is no doubt but that all their contract will be finished well within the required time.

The main differences between the American dredges and those already named is: 1st. Their immense size, the tower upon them being 75 feet high. They were built expressly for the Panama Canal, and dig 50 meters