FLOATING DEPOT FOR COALING WARSHIPS.

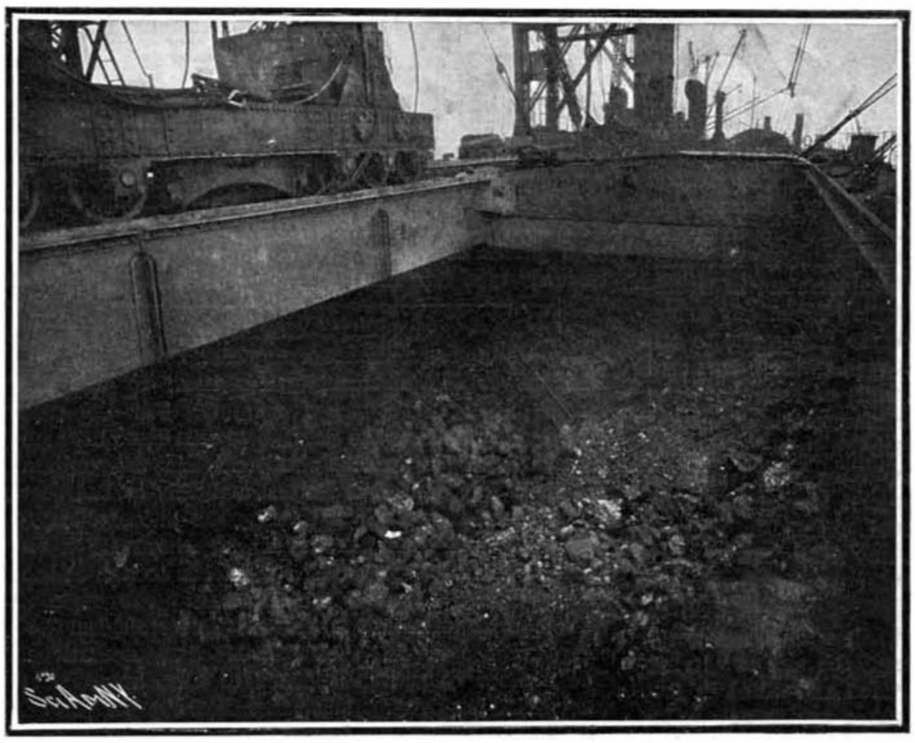
BY DAY ALLEN WILLEY.

The British Admiralty has placed in service a floating depot for coaling warships, which is notable by reason of its great capacity, novel design, and the mechanical methods used for loading and unloading purposes. The coal depot, which is known as No. 1, has been utilized in the harbor of Portsmouth, where it has been tested in a variety of ways with such successful results, that it is understood the government will place several other depots at naval stations elsewhere.

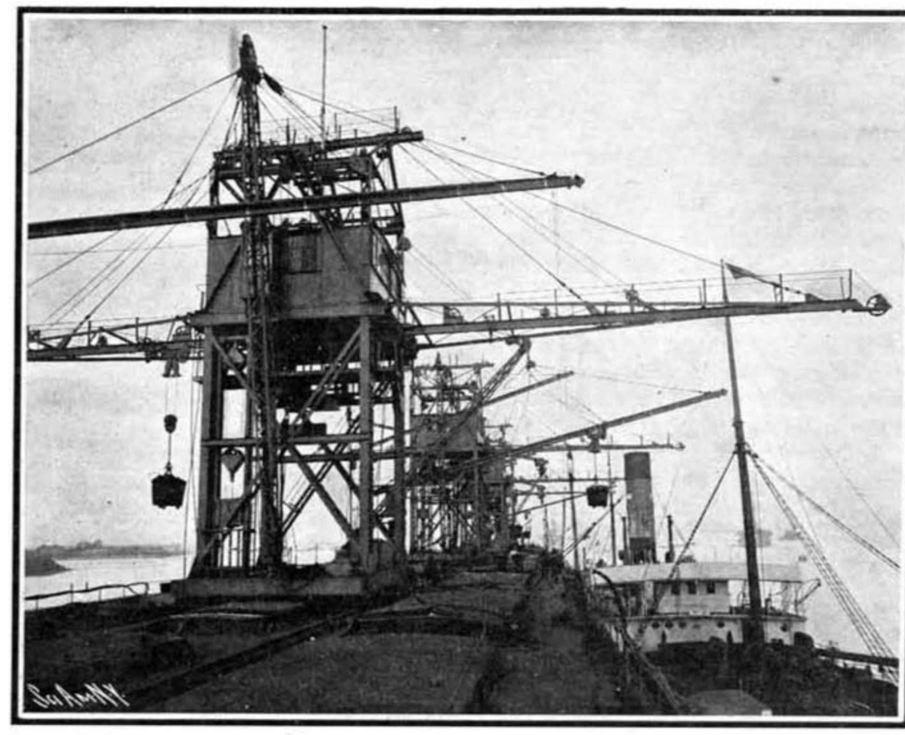
As the illustrations show, the craft is of large dimensions. It is constructed of heavy steel plates, the framework being sufficiently massive to withstand the strain of the load of fuel as well as the machinery with which it is equipped. In reality, it is a huge barge which can be towed from harbor to harbor, if necessary, or to any convenient point in a harbor, while its capacity—12,000 tons of fuel—permits it to coal a small fleet of warships before its compartments are emptied. The hold is divided into a series of compartments, or large bins, which are covered with movable hatches like the compartments in the hold of an ordinary ship. The bottom plates of the storage bunkers, however, are V-shaped, allowing their contents to be transferred by gravity to other portions of the depot and at the same time assorted into lump and slack coal if desired. The compartments are arranged in two parallel rows with open galleries between them extending from the bottom to the upper deck.

As the photographs show, a modification of the fast plant, so commonly utilized in this country in transferring cargoes on the Great Lakes, is employed. The depot is equipped with four Temperley conveyors, each consisting of a steel tower mounted upon rails, so that it can be moved forward and back, and adjusted to a hatch of the depot or the ship which it is to serve. Each tower supports a series of lateral tramways consisting of steel girders, which can be raised and lowered to a suitable angle. Beneath each tramway travels the bucket, which can be operated from any point between the extremities of the tramway by means of an automatic guide. The power is supplied by an electric motor; but to assist in overcoming the load of the receptacle, the chain holding the bucket is attached to a wire cable and sheave. The trolley system is utilized in hauling the buckets back and forth, as well as in the up and down movements, and as the tramways extend from both sides of each tower, two vessels can be coaled at once or the depot filled from both sides. In addition to the tramway conveyors, however, the depot is also provided with a series of boom derricks—the arms being constructed of latticed steel work. These are auxiliary to the tramways, but are intended principally to serve the galleries to which we have referred. Frequently it is desirable for a warship to take on assorted fuel in bags. Nearly all of the manual labor required on board the depot is to fill the fuel bags with coal in the lump form. The lower portions of the bins open out into the galleries, and as fast as the bags are filled they are wheeled into these, when the fuel is lifted out by the derricks, swung over the side, and placed on board the receiving vessel. A half dozen or more bags can be transferred at once by means of the series of hooks which are attached to the boom cable, the hooks fitting into rope grips fastened to the fuel bags.

As may be inferred, the coaling depot contains an individual power plant, but all of the operations with the exception of filling the bags are performed by electric power. The current is generated by steam power, and transmitted by cable and wire system to the series of motors installed on the tramway towers. The boom derricks are also of motor design. The length of the depot allows the bunkers of a flotilla of gunboats to be filled at one time, while the reach of the tramway arms is such that two small vessels can lie abreast and be served by the mechanism. In the trials which have been made of the coal depot at Portsmouth, it has been hauled alongside of a dock, and a certain proportion of its cargo sacked and dumped on the dock in a given period of time. In another test the mechanism of the depot was employed to transfer its cargo to the dock, where the coal in bags was trundled on board a warship. As the photographs show, to keep pace with the charging capacity of the series of tramways, an entire ship's crew was required. Perhaps the most valuable feature of the depot, however, is that it is not only movable, but is available for serving vessels on either or both sides. It can also be utilized while loading cargo to coal the battleship or cruiser. While the bunkers of the war vessel are being filled on one side by the tramways and booms, the contents of the collier can be taken aboard by the mechanism on the opposite side. Indeed, the cargo of the collier can be transferred directly to the warship, the coal being taken across the deck of the depot by its conveying mechanism.



One of the Compartments in Which the Coal is Stored.

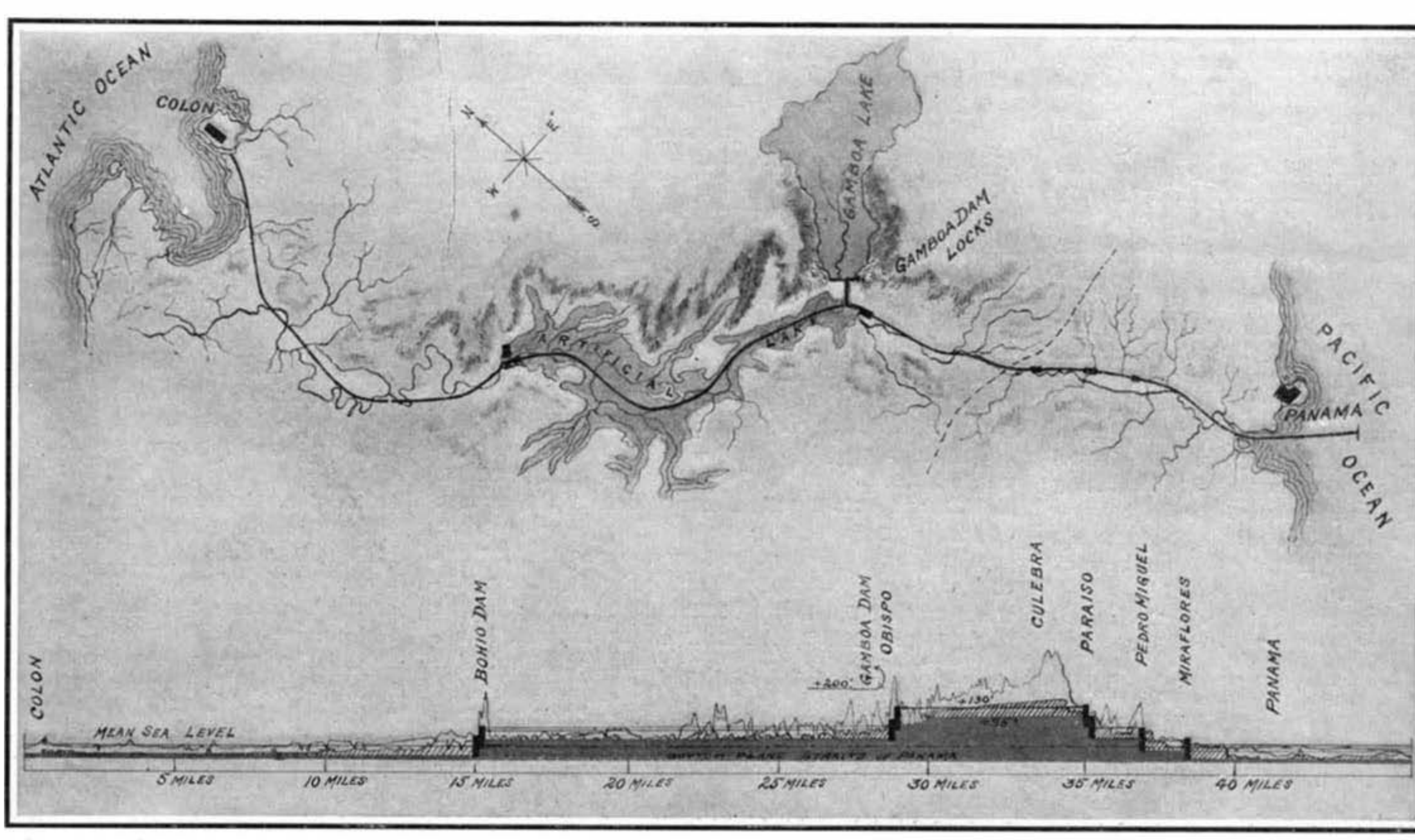


Deck View of the Floating Coal Depot.

FLOATING DEPOT FOR COALING WARSHIPS.

PROPOSED EXCAVATION OF THE PANAMA CANAL BY FLOATING DREDGES.

The plans for the rapid construction of a high-level canal, and its ultimate enlargement to a sea-level canal, which were presented in much detail by Mr. Bunau-Varilla before the Board of Consulting Engineers last September, is developed in general outline in the following article. Mr. Bunau-Varilla believes the best way to carry through successfully the great task which the United States government has set itself at the Isthmus is first, to build a high-level canal with locks, placing the summit level at an elevation of 130 feet, so as to secure a canal of the necessary depth and width with a minimum amount of excavation, and in the shortest possible time, which is estimated to be not over four years. When, at the expiration of that time, the canal is opened to traffic, the work of widening the waterway and cutting it down to sea level would proceed contemporaneously with the use of the canal for navigation. Mr. Bunau-Varilla explained to the Board of Engineers his special method of construction of the locks,



Map and Profile of Preliminary 130-Foot Level Canal at Panama, Proposed by Bunau-Varilla, Chief Engineer of the Former French Project.

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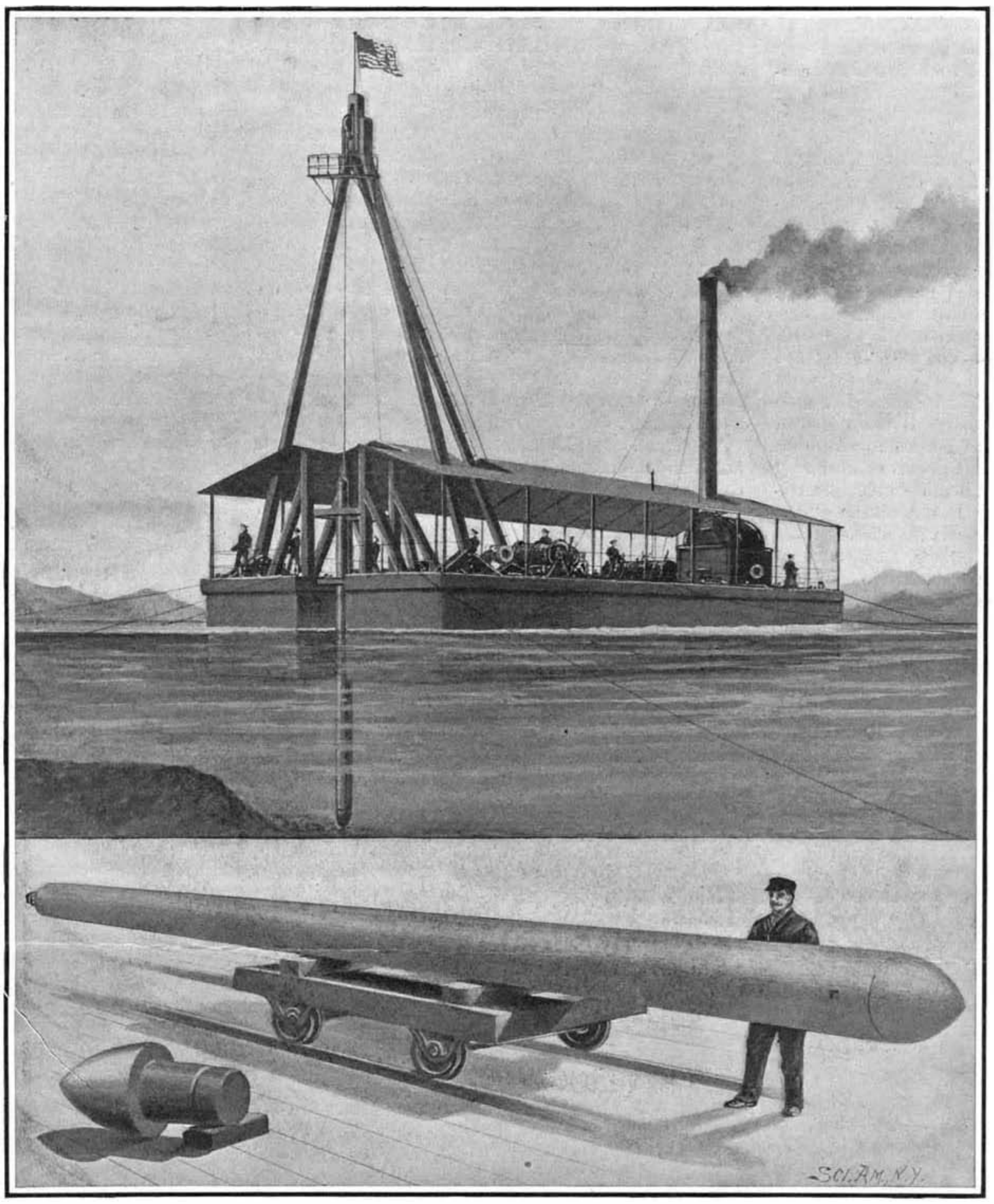
and his plans for widening and lowering the level of the canal by means of floating dredges. He believes that by the use of special under-water excavating plant, both the cost and the time of building a sea-level canal would be greatly reduced.

Method of Transforming from High Level to Sea Level.—The method of transforming the canal from high level to sea level without interfering with navigation is explained as follows: In the ordinary type of canal, the upper gate of a lock has a height equal to the depth of the canal, and it is supported on a massive vertical wall, which latter forms a base for the gate, and also acts as a retaining wall for the ground of the higher level. Evidently, in excavating the summit level down to the next level below it, it would be necessary to stop navigation while this foundation and retaining wall was removed, since the locks would be of necessity thrown temporarily out of service. To obviate this difficulty, Bunau-Varilla builds both the upper and the lower lock gate of exactly the same height, each of them being 80 feet in height (35 feet for the depth of the canal and 45 feet for the fall of the locks). It will be seen, upon referring to the accompanying sketch, that by this arrangement the 45 feet depth of material extending between the two summit-level gates, and reaching from the bottom of the summit level to the bottom of the next level below, a distance of 45 feet, can be excavated by floating dredges, without in any way interfering with the lock gates or with the navigation of the canal. Since all of the lock gates would be built of the same double height, it is evident that the successive levels could be dredged out down to the next level below, until the ultimate sea level had been reached. It is also evident that, after the earth and rock of each level has been excavated, the masonry of the locks could be blasted away, and the gates themselves could then be removed without difficulty.



This device is used for under-water excavation. The heavy chisel, weighing 15 tons, is shod with a hardened steel point. It is mounted on a twin scow and hoisted, and let fall, like a pile-driver hammer, by a hoisting engine. By its impact it fractures the rock bottom and breaks it into easily-dredged fragments. It is with machines of this type that Bunau-Varilla proposes to excavate the rock in the Panama Canal.

A Lobnitz Rock-Cutter in Operation, and One of the 15-Ton Hammers.

Method of Excavation Without Interference With Navigation.—The preliminary 130-foot-level lock canal of Bunau-Varilla's proposition has a depth of 35 feet and a bottom width of 150 feet. His proposed sea-level canal is to have a depth of 45 feet and a bottom width of 300 feet, and his proposed "Straits of Panama" would be 500 feet wide on the bottom. In one of the accompanying diagrams is shown the method by which he proposes to carry on excavation after the opening of the canal, without interference with navigation. His first step would be to excavate the mass of material, representing that part of the sea-level canal prism lying above the 130-foot level, by the "dry process," that is to say, by means of steam shovels and trains of cars running over ordinary construction tracks. When this material had been taken out down to the surface level of plus 130, Bunau-Varilla would introduce his system of excavation by floating dredges. He would first cut a working canal parallel to the navigation channel, and extending through the full length of the summit level. In this he would place dredges and self-dumping scows. The softer material would be dredged directly from the bottom, and the harder material would be removed by mining and dredging, or by the use of what are known as the Lobnitz rock-cutters, in which the rock bottom is broken up by pounding it with heavy 15 or even 20 to 30-ton hammers, of the kind shown in the illustration.

The Lobnitz rock-cutter is a device which has been in successful operation on several important works, and notably in the Suez Canal, where the bottom rock was broken up into a condition suitable for dredging at the expense of twenty-five cents per cubic yard. Bunau-Varilla estimates that the hardest rock in the Panama excavation, if 25 to 30-ton hammers were used, could be broken up for from 75 cents to $1 per cubic yard, if using steam power. If electric power, generated by the Chagres River, is used, he believes that these figures can be reduced by one-half. The Lobnitz hammers are operated in much the same way as a floating pile-driver, the hammer being raised by steam hoist to a sufficient height to give the necessary blow, and then let fall. With 15-ton hammers ordinary rock is broken up, to about a depth of 3 feet, into fragments of a size suitable for dredging.

The new channel to the right of the navigation channel (see cross-section diagram) would be excavated to a depth of 50 feet from the navigation channel up to the slope of the sea-level prism, as shown by the dotted line. When this was done, the navigation tract would be shifted into the new channel, while the old channel, 35 feet in depth, was being excavated to the 50-foot level. The water would then be dropped 15 feet, and the navigation channel brought again to its original position on the left-hand side of the cut. By this arrangement the dredges, mining and stone-breaking apparatus, scows, tugs, etc., would be kept separate from the canal proper, and navigation from ocean to ocean could be carried on continuously until the whole prism was finally excavated down to about 45 feet below sea level.

Method of Disposal of the Excavated Material.—It is pretty well agreed that one of the most difficult problems at Panama will be the disposal of the enormous amount

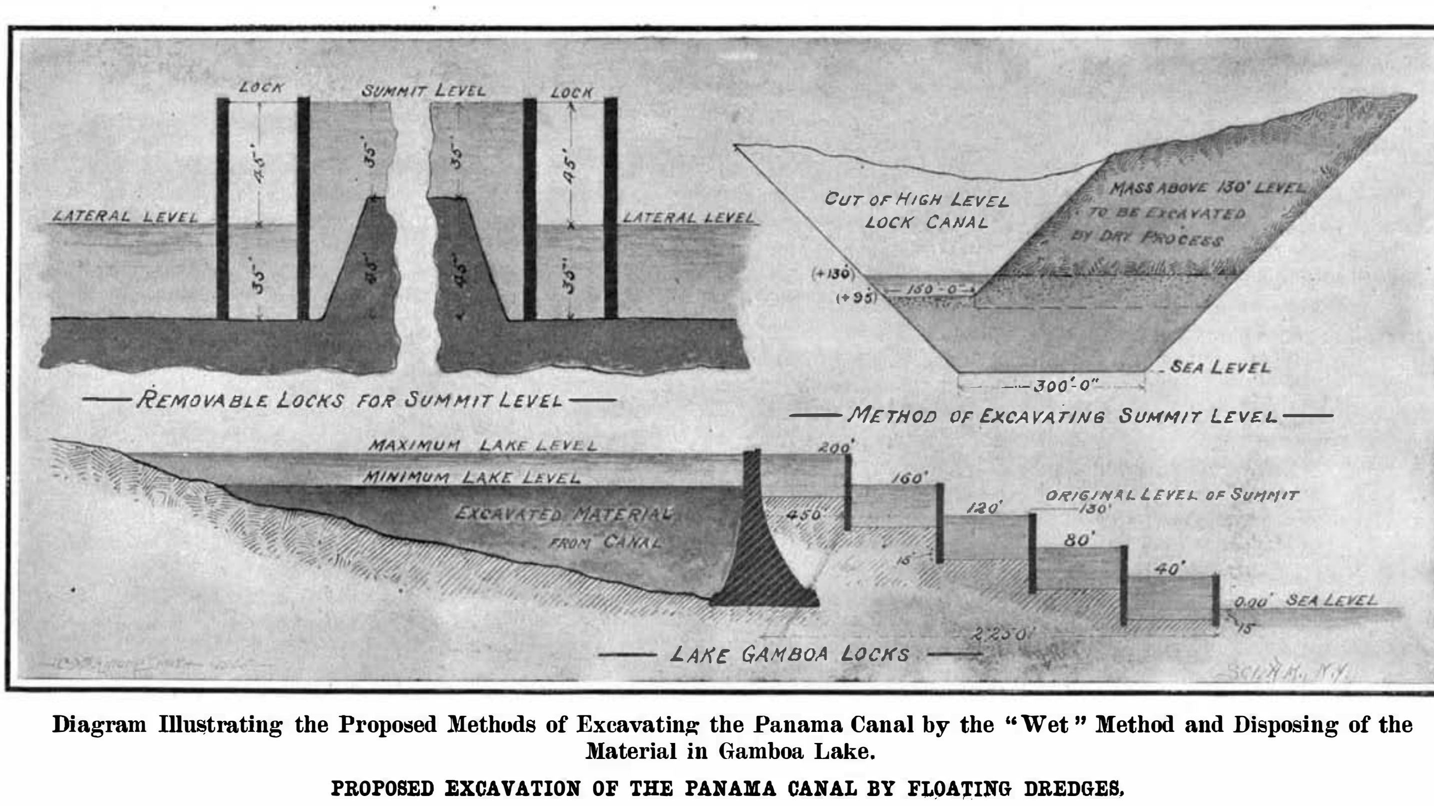


Diagram Illustrating the Proposed Methods of Excavating the Panama Canal by the "Wet" Method and Disposing of the Material in Gamboa Lake.

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of excavated material, most of which will come from the Culebra cut. Bunau-Varilla claims that he can cut the Gordian knot by dumping the greater part of it into the Gamboa lake. Now Gamboa lake, as will be seen from the accompanying map, is to be formed by the construction of a huge dam, whose crest will be 200 feet above the sea level, and which will extend entirely across the Chagres Valley at the point where the river Chagres first intercepts the line of the canal. All of the various schemes for the control of the heavy and sudden floods of the Chagres contemplate the construction of a reservoir, whose waters shall be held normally at such a level that there will at all times remain sufficient unoccupied space back of the dam wall to contain and hold all the waters of a Chagres flood. The minimum normal stage of the water in Lake Gamboa is plus 160, and there is sufficient capacity between that level and plus 200 to contain the river floods. Bunau-Varilla argues that, this being the case, the interior of the dam below the 160-foot level might be turned to good account by using it as a dumping ground for the excavated material. Accordingly, he would connect the waters of the lake with those of the summit level by a double flight of five locks. The material excavated by the dredges would be dumped into scows, which would be towed along the excavated canal in the channel opened parallel with the navigation channel, and after ascending the flight of locks, would be towed into Gamboa lake and unload themselves by opening their bottom gates. Bunau-Varilla estimates that eight dredges, working at the summit level, would in seven years dispose of the 110,000,000 cubic yards that would have to be excavated between the Obispo and Paraiso lock. There would be two chains of five locks, one for ascending and the other for descending. They would be able to take in one lockage four scows, 200 feet long, 40 feet wide, and drawing 14 feet of water. As each scow could carry 750 cubic yards, each lockage would lift 3,000 cubic yards, which would correspond to the passage into Gamboa lake of 96,000 cubic yards every twenty-four hours, or 30,000,000 cubic yards a year. Basing his figures on an estimated cost of excavation for hard rock of 65 cents per yard, for soft rock of 35 cents, and for earth of 20 cents per yard, he gets a total cost for excavating a 500-foot wide canal of $232,500,000. To this he adds for the cost of harbors, dams, electric power, etc, $17,500,000, and twenty per cent for emergencies. He finally arrives at a total cost of $300,000,000 for his "Straits of Panama," which would take twenty-four years to construct, including four years for the building of the preliminary 130-foot-level lock canal. The comparatively low estimated cost of the canal is explained by the fact that the excavation is done by the under-water method instead of the dry method, and that the power would be furnished by the impounded waters of the Chagres River, whose energy would be electrically transmitted throughout the whole length of the canal.

We offer no criticisms on the above remarkable scheme, which would probably have had a better chance of recommending itself to the Advisory Board, did its successful execution not depend so absolutely upon methods of excavation and disposal that have yet to be tested upon a grand scale.

A RATIONAL METHOD OF COOLING GAS-ENGINE CYLINDERS.

BY S. M. HOWELL.

It is a matter of common observation in gas-engine practice, that an air-cooled cylinder will develop somewhat more power than could be secured from a water-jacketed motor of equal size, and under otherwise equivalent conditions. In other words, the engine without water cooling is the superior in point of economical performance. This experience agrees perfectly with the well-known simple theory upon which the production of power is dependent in all forms of the internal-combustion motor. The gas engine is a heat motor, pure and simple, producing power solely by the development and conservation of a high degree of heat. The working fluid is a mixture of air and certain inflammable gases, and the whole is violently expanded by the instantaneous burning of the contained gas and the intense heat thus generated. It must follow, therefore, that a water jacket or any device which operates to dissipate the heat of combustion, prior to the moment of the exhaust, will also lower the pressure and curtail the power of the engine in a corresponding degree. In the case of the water-jacketed engine, the cylinder walls have a comparatively low temperature, and rapidly abstract heat from the burning charge, thereby reducing the pressure and diminishing the power of the stroke. But the so-called air-cooled engine, having a much higher temperature, will therefore develop a higher pressure, and for a time at least, or until the cylinder becomes excessively hot, will produce more power. The amount of heat lost through the walls of a gas-engine cylinder by the use of a water jacket varies with the conditions. A high piston speed and high compression are factors which have a marked effect in reducing this loss; for the reason that in such cases the cylinder is smaller than would otherwise be required to develop the same power. This reduces the extent of water-cooled surface with which the ignited gases are in contact, and also, by reason of the quicker stroke, shortens the time of such contact.

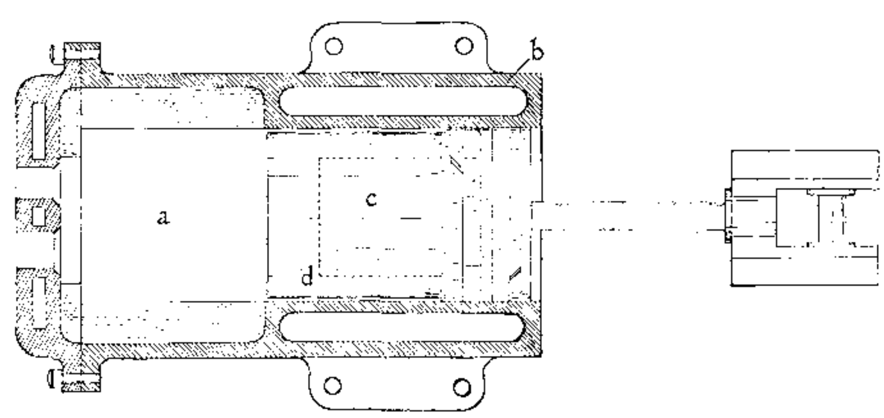
The amount of heat absorbed by a water jacket may readily be determined in any given case by a simple calorimetric test of the water used, taking note of its volume, and its temperature as it enters and as it leaves the jacket. But I have observed, in making experiments of this kind, that the figured result does not always account for the deficiency which exists in the power of the engine, as compared with the heat which should theoretically be developed, and that too after making fair allowance for all other apparent losses. In explanation of this, it may be urged that the full temperature and the total amount of heat generated by the complete burning of the fuel, is not, in the case of a gas-engine cylinder, fully developed. The combustion is more or less imperfect by reason of contact with an extended metallic surface at a comparatively low temperature. If this is true, then we have also an indirect loss caused by incomplete combustion, and chargeable to the use of water cooling.

The hydro-carbon liquids or gases, which are the usual fuel of gas engines, consist essentially of hydrogen and carbon. The hydrogen is readily inflammable, and under ordinary circumstances is capable of but one reaction, resulting in the formation of the vapor of water. The elastic force of this vapor, powerfully compressed within the confines of the cylinder by the heat of combustion, forms a large part of the working fluid by the pressure of which the piston is driven. The trouble would seem to arise from a deficiency in the burning of the carbon element. Carbon in burning may form either of two combinations—carbon dioxide or carbon monoxide. The former is always the result under fairly favorable conditions, but in some cases, notably those in which the flame is confined within narrow limits and in close contact with metallic surfaces, the heat is so rapidly withdrawn that the temperature falls, and the process degenerates into incomplete union with the oxygen of the air, and the formation of carbon monoxide, the difference being that the amount of heat liberated by this degenerate reaction is less than one-third that which would result from perfect combustion of the carbon and the formation of carbon dioxide. A familiar instance of this defective form of combustion is seen in the attempt to pass a gas flame through a sheet of gauze or cloth made of fine metallic wires, or to conduct a flame through small metal tubes. In these cases, the cross-sectional area of the passages is very small, and the extent of cold metal comparatively large, with the result that the temperature falls below the kindling point, and the flame is extinguished or reduced to the monoxide reaction described above. That these instances have a parallel in the conditions which exist in gas engine practice, seems probable. It is obvious, however, that such an effect must be more marked in the case of small engines than in those having large cylinders, and could be determined in any case by a careful analysis of the exhaust.

In regard to other methods of cylinder cooling, little need be said. Aside from the various methods of air cooling, the injection of water directly into the cylinder seems to be the only alternative. But this method, unless very sparingly applied, is worse than the use of an external jacket. It was one of the first cooling systems tried in the early days of the gas engine; and although modern designers sometimes attempt to revive it, it has usually proven unsatisfactory. This is evidently for the reason that the water in direct contact with the burning charge must greatly modify its temperature, while the cylinder walls would be only indirectly affected, and might still be insufficiently cooled. Then, too, the introduction of too large an amount of water into the cylinder of a gas engine, resulting of course in the immediate production of a body of steam, antagonizes combustion, and renders the ignition more difficult, and in the case of a four-cycle engine, has a tendency to destroy the vacuum produced by the retreat of the piston, filling the cylinder with steam on the suction stroke, and thus interfering with the inspiration of the charge. And still it is true that a small quantity of water, if properly regulated, may be injected into the cylinder of an air-cooled motor with much advantage. In this case it moderates the excessive heat of the contact surfaces, and assists lubrication by saponifying the oil and loosening any carbon deposit, which may otherwise adhere to the cylinder walls.

But after demonstrating the disadvantages of water cooling, the fact still remains that red-hot metal surfaces can not be continuously worked under heavy pressure in air-tight contact. Some means must be adopted whereby the destructive effects of heat on the cylinder and piston may be obviated. Thus it seems that in the present state of the art, the efforts of the gas engine designer are opposed by a conflict of natural conditions, and that he must so construct his engine that durability will be secured at the sacrifice of economy. But let us see if there is not a remedy.

In the figure which accompanies this article there is shown the high-pressure cylinder and piston of a compound gas engine, built upon a system which has for its object the utilization of the greatest possible amount of available heat in a cheap liquid fuel, viz., crude or partly refined mineral oil. It may be noticed that this cylinder consists of two parts, viz., the combustion chamber *a*, the internal walls of which are protected from the heat by a lining of refractory material, indicated by the dotted surfaces; *b* is the cylinder proper, wherein the piston and rings work in air-tight contact. This part of the cylinder is water-jacketed in the usual manner. The admission and exhaust valves are located in the head of the combustion chamber, this member being also partly jacketed to protect the valves. The piston *c* is the elongated type, that is, of somewhat more than the usual length, and having the rings near the forward or open end, the other end being covered by a thick cap *d*, of the above-mentioned refractory material. The elongation or extended part of the piston, with its refractory cap, is slightly smaller than the bore of the combustion chamber lining. This allows the elongated part to reciprocate within the combustion chamber, and to effect the necessary displacement without actual contact. Leakage past the piston is stopped by the rings at the opposite end which works within the cool part of the cylinder proper. The exhaust passes into a second and larger cylinder on the same shaft, where it delivers its remaining power in the well-known manner common to all compound engines. The cycle may be either two or four, but in either case, pure air alone will be admitted on the charging stroke. This air is compressed on the return stroke to a very high degree—300 to 500 pounds per square inch. The oil begins to enter (forced in by a pump) at the commencement of the power stroke, and without the use of any igniting device whatever, is instantly fired by the heat of compression, maintaining the required pressure throughout the stroke, in the manner of those engines which operate upon the well-known continuous combustion system.



A NOVEL WATER-JACKETED, HIGH-PRESSURE CYLINDER FOR A COMPOUND GAS ENGINE.

A gas engine constructed upon these lines would possess the following advantages: It would be perfectly adapted to the use of the cheapest liquid fuel known. The injurious effects of heat upon the working faces of cylinder and piston would be avoided. The losses incident to the use of the water jacket would be totally eliminated. The conflicting requirements encountered in the present methods of design would be obviated. The engine would be as durable as any other, and its thermal efficiency would be the highest possible in a heat motor.

Concerning the advantage of compounding, it should be observed that the exhaust from an engine operating upon the above system has a very high pressure (100 pounds per square inch) and the gain by this means would therefore be considerable.

Regarding the character of this proposition for a new gas engine, it is virtually a composition of at least three expired patents, and its value therefore does not consist in the novelty of its elements, but in the peculiarity of their combination. Certain other known devices might also be involved in its final construction, but this would depend upon the mechanical details of the arrangement by which the oil was delivered to the cylinder, rather than on the operative principle of the engine.

The temperature of the linings and piston cap—owing to the constant inspiration of fresh air through the inlet valve—would never exceed a dull red heat, and