CONSTRUCTING THE CONCRETE LOCKS OF THE PANAMA CANAL.

BY H. PRIME KIEFFER.

The final plans for the locks of the Panama Canal have just been adopted, and the accompanying drawings will serve to illustrate the colossal proportions of these great engineering works. They are to be constructed wholly of that newest of building mediums—concrete; and it is extremely doubtful whether the great waterway would have been designed upon its present ambitious lines, had not concrete gained the powerful prestige as a building material which it now holds. A number of other giant structures, such as the Gatun spillway, and various dams, culverts, diversion tunnels, etc., are being carried out in this medium; but the most interesting of all will be the mammoth locks. They will be by far the largest and longest concrete structures of the kind in the world, and it is improbable that they ever will be exceeded.

The locks will be six in number, three at Gatun on the Atlantic side of the Isthmus; one at Pedro Miguel; and two at Miraflores, both of these latter points being on the Pacific side of the Isthmus. The channel from Gatun to Pedro Miguel will lie in Gatun Lake, at an elevation of 85 feet above sea level.

The adopted plans call for locks 1,000 feet long, 110 feet wide, and all in duplicate, that is to say, with two sets of locks side by side. The three locks at Gatun will be built as a continuous structure, and together with the piers at either end they will have a total length of 3,800 feet, all of massive and continuous concrete work. At Pedro Miguel the one lock with piers will have a length of about 1,800 feet, and at Miraflores the two locks and piers will be about 2,800 feet in length. The building of these locks will necessitate the use of about 8,000,000 cubic yards of concrete, which, if loaded on the 20-yard cars in use on the canal, would reach sixty times across the Isthmus; or it would make a string of such cars reaching from New York to Chicago, to New Orleans, and back to Chicago again. Cement alone to the amount of 900,000 tons will be employed.

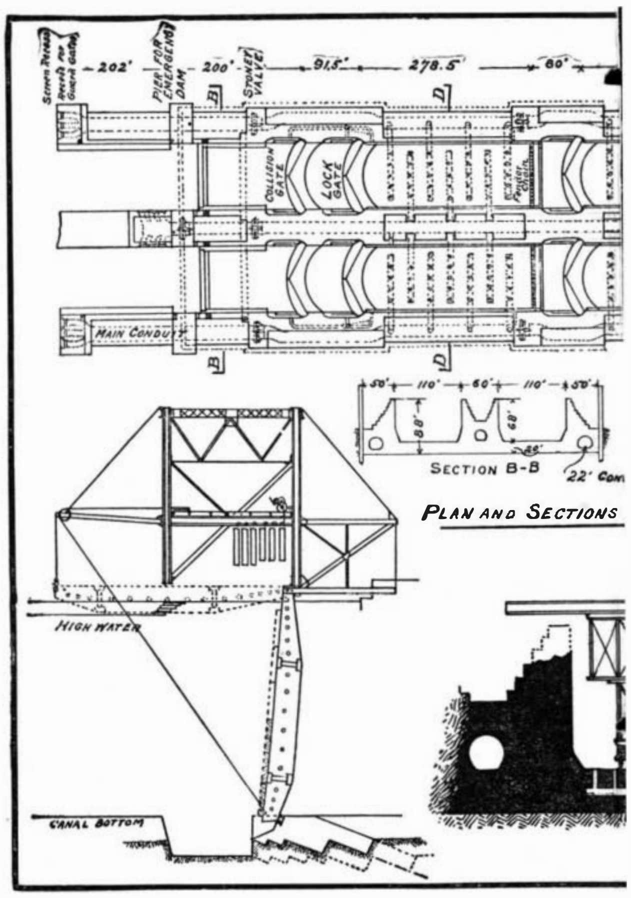
In addition to their size, the locks will present many interesting studies in their safeguarding features and in the mechanical and electrical devices for the opening of the gates, the rapid unwatering of the locks, towing of vessels, etc. These appliances, as well as the very locks themselves, have been designed with such care and skill, that the factor "human frailty" cannot possibly play the important rôle, which the enemies of the lock type would have us believe.

The locks will have plate-steel, hinged arch gates in duplicate, and these gates will be protected by massive fender chains stretched across the locks ahead of the gates, to take up the shock in case a vessel approached the gates too rapidly. Although these chains are not designed to absorb the total shock, they will check the vessel's speed, and thereby protect the gates. In addition to this precaution, the vessels will be required to come to anchor at the piers outside of the locks, and the towing ropes will there be made fast. Then, by the aid of mechanical "mules," located on top of the lock walls, the vessel will be towed through the locks at a uniform speed, and the vessel held in perfect control. This can be readily accomplished, as there will be no tides or storms with which to combat. The gates are of exceedingly massive construction, set in walls of solid concrete 40 to 60 feet in thickness.

As a precaution against the carrying away of the lock gates by a similar accident to that which recently occurred at the Soo Canal, they are being built in pairs, with a water space of about 80 feet between them. The first gate will serve a similar purpose to that of the heavy guard chain above referred to. Should a vessel break through the guard chain, which would check its speed, it would bring up against the first set of gates, which are of such enormous strength that they would be certain to check the vessel's way. Should they be broken, the water would still be held by the second set of gates. As an additional precaution, however, and in the inconceivable event of both gates being broken down, at the Gatun end of the lock there will be built a huge structural steel, wicket, swinging dam, similar in principle to that which was used effectively in stopping the rush of water at the Soo Canal. The structure is nothing more nor less than a massive swinging bridge, similar to a railroad drawbridge. On the under side of the floor are attached about a dozen heavy steel girders, which are hinged at the edge of the bottom floor, which is downstream when the dam is swung across the canal entrance. The other ends of the girders are attached to hoisting and lowering cables, electrically operated. To close the waterway the dam is swung around across the entrance, the girders are lowered until their bottom ends rest upon bearings countersunk in the floor of the canal, and then a series of transverse steel plates, or "wickets," are lowered in succession across the face of the girders, gradually closing the channel from the bottom upward, until the passage is entirely shut off.

Another feature of the locks which, because of its great magnitude, is of unusual interest, is the system

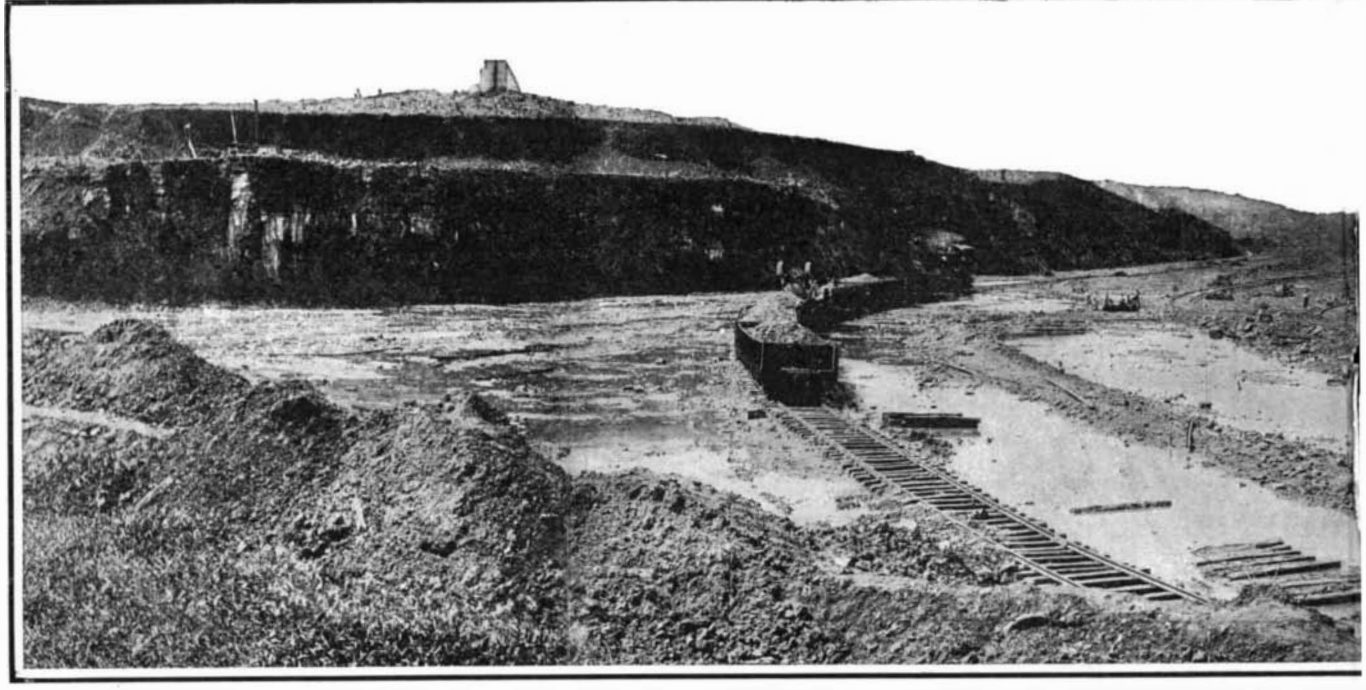
Portable grab-bucket crane unloading crushed rock from scows in the old French canal at the Gatun docks.



Cross-section of emergency dam in the closed position, with wicket girders down and sliding gates partly in the lowered position.

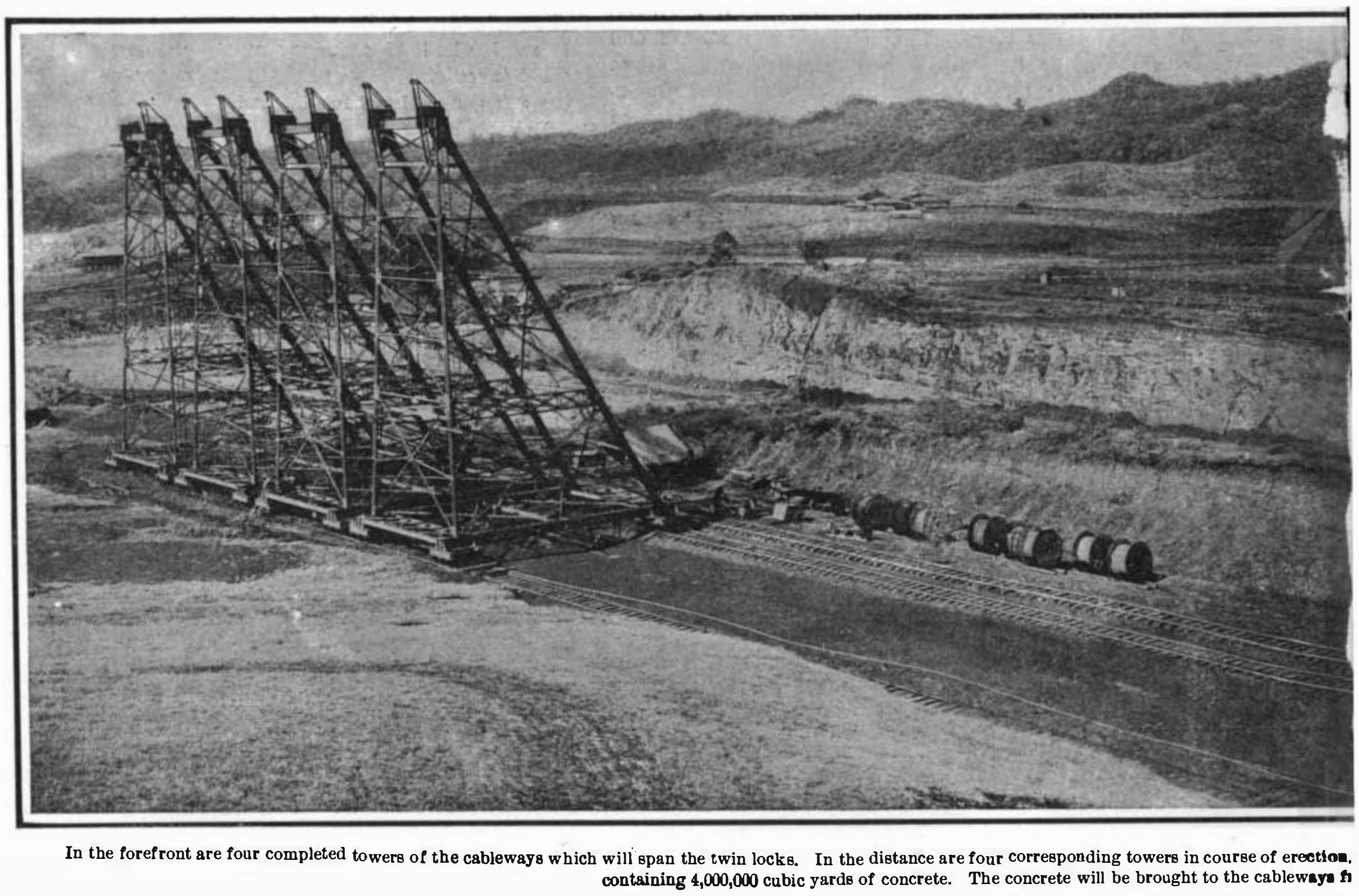
Diagram showing
are lifted fr

How the 4,000,000 cubic yards of concrete are bei



The Gatun dam is 115 feet high, 2,400 feet wide, and about 9,000 feet long. Near the center is a natural hill of rock, through which it was decided to build both on floor and sides. Concreting has

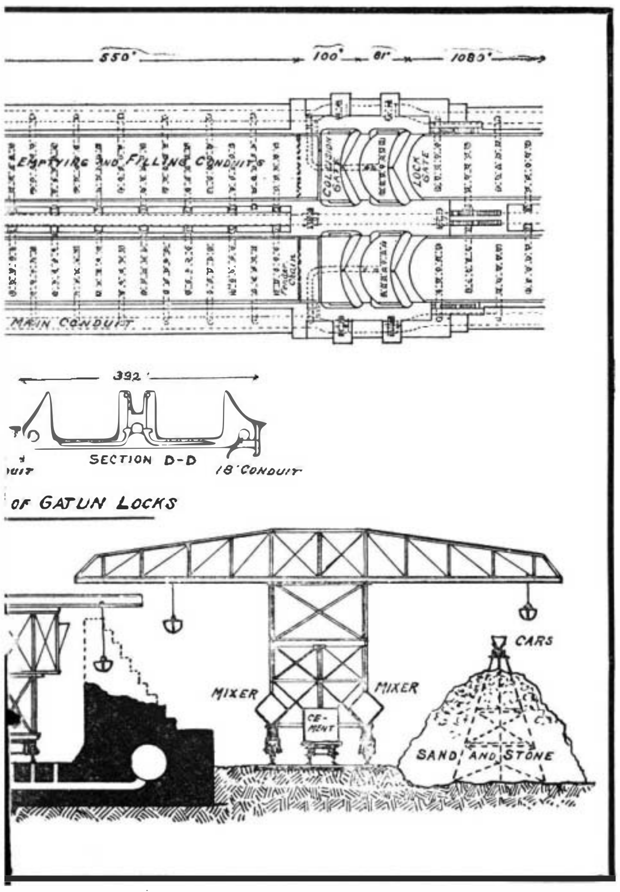
Excavation for spillway



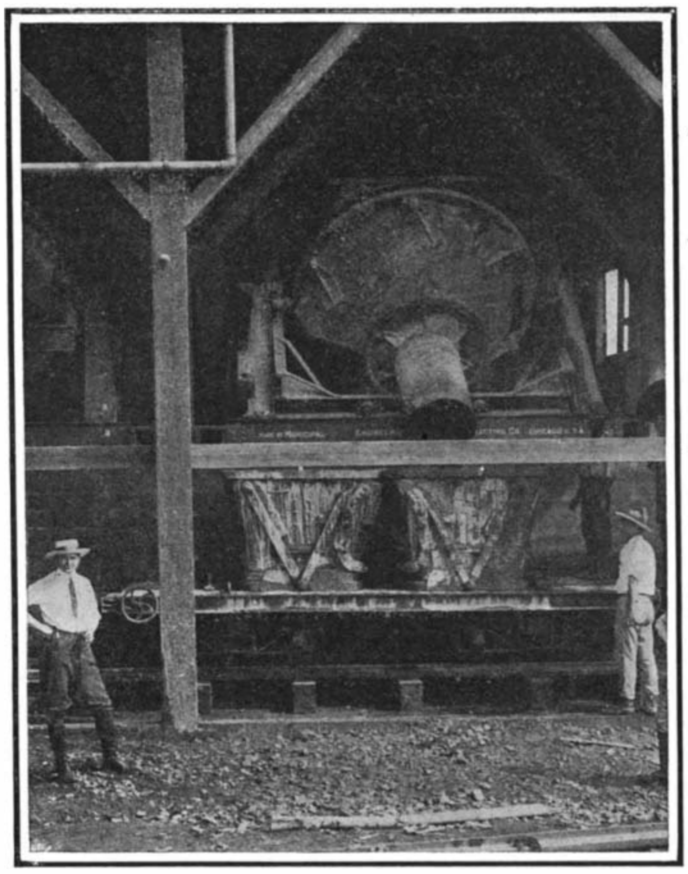
In the forefront are four completed towers of the cableways which will span the twin locks. In the distance are four corresponding towers in course of erection, containing 4,000,000 cubic yards of concrete. The concrete will be brought to the cableways fr

Excavation for the Gatun locks, showing the lo

CONSTRUCTING THE CONCRETE

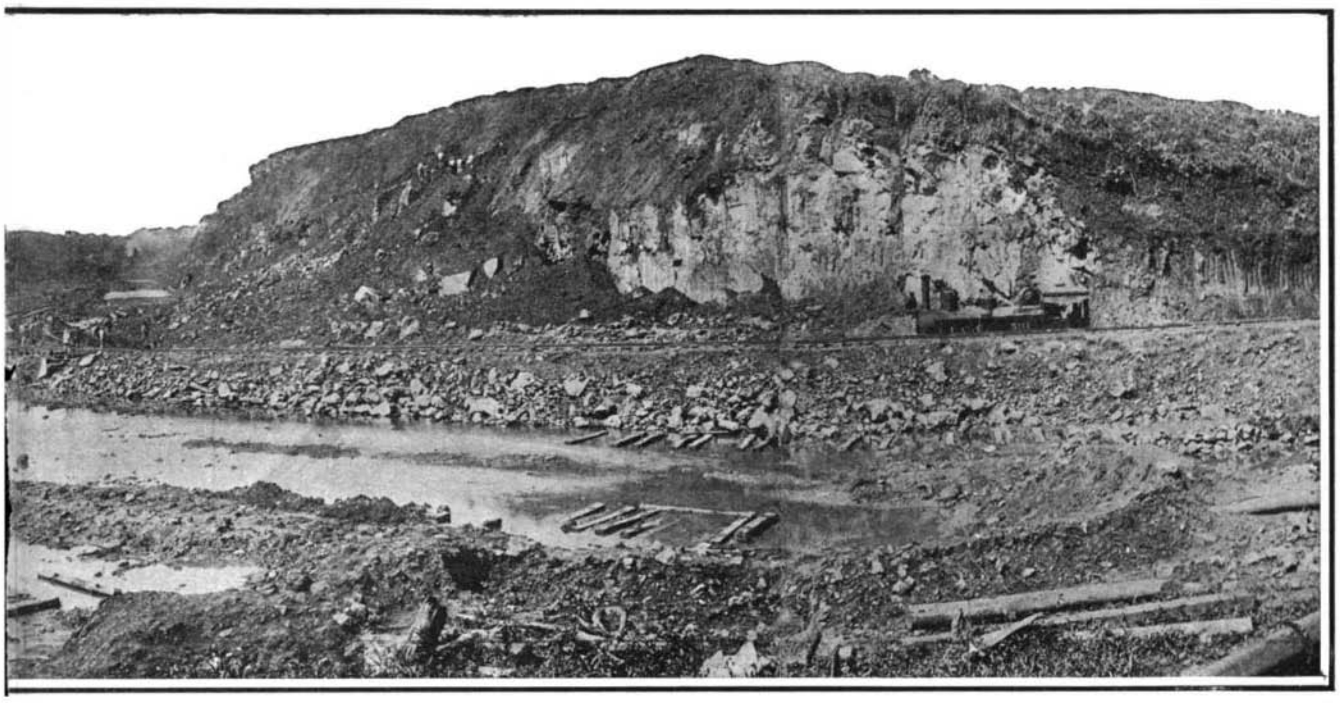


method of building the locks at Pacific end of canal. Sand and stone
m the stock pile to the mixers, and from the mixers the concrete
is carried to the lock site by the two cantilever cranes.



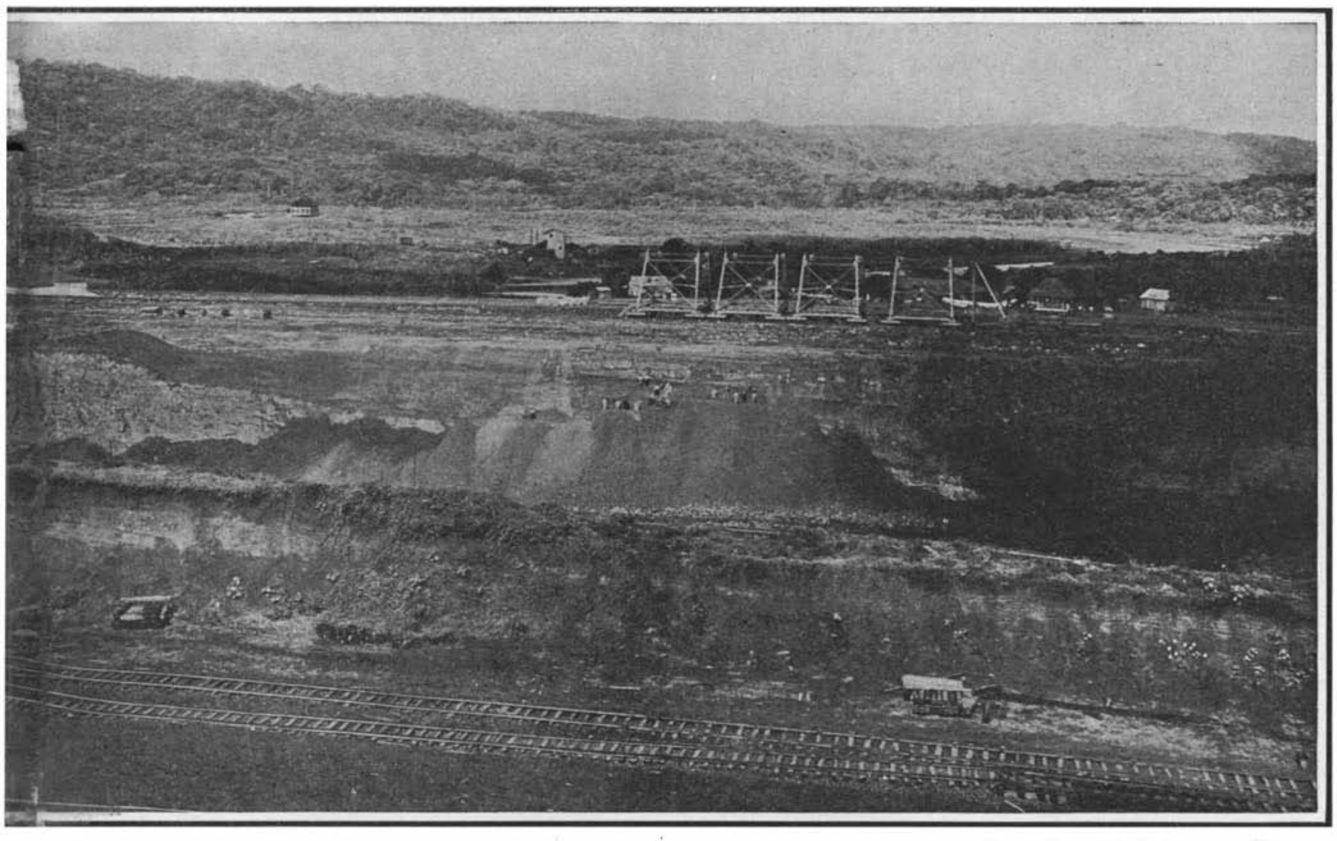
One of the concrete mixers dumping its load into steel cars for transportation to the overhead cableway that spans the Gatun locks.

g mixed and built into place at the Gatun locks.



he spillway. The above photograph is taken looking through the completed spillway excavation, which will be lined with a heavy covering of concrete
[redacted]nenced and is now well under way.

n center of Gatun dam.



[redacted]een and running from right to left is the excavation for the locks, which will be 380 feet wide and 3,800 feet long. They will consist of a huge monolith
[redacted] mixers in electrically-operated cars, picked up by the cableway, and deposited in place.

[redacted]teel towers for the construction cableways.

[redacted]KS OF THE PANAMA CANAL.

of conduits by which the locks will be filled and unwatered. Below the floor of the locks, and arranged transversely to their axes, is a series of large conduits, fed by numerous openings through the floor. These conduits lead into larger conduits built in the walls of the lock, which range in diameter from 18 to 22 feet. In the latter are set the huge gates by which the flow of the water into or out of the lock is manipulated. There are over one hundred ducts opening into each lock; and, because of their number and uniform distribution, there will be no disturbing currents in the water, and the filling and emptying will be done with unusual rapidity.

MATERIAL-HANDLING PLANTS FOR THE LOCKS.

Naturally, the plant employed in the construction of such large structures, involving the laying of 8,000,000 cubic yards of concrete, is extraordinary in size and calls for much ingenuity of design. There are in the United States and in Germany some very large, interesting, and economical plants for the mixing, transportation, and placing of concrete, but the one now about completed at Gatun will surpass in magnitude anything ever attempted. The plant at Gatun will be used for all three of the locks, as they are to be built practically as one monolithic structure. The lock at Pedro Miguel and the two at Miraflores will, for several reasons, demand entirely different material-handling plants.

At Gatun about 4,000,000 cubic yards of concrete will be employed. The crushed stone, the sand, and the cement for this concrete will be handled in the following manner: The crushed stone will come from Porto Bello, a small hamlet about 20 miles east of Colon along the Atlantic coast. The rock will be taken from the quarry by steam shovels, and sent by gravity to the giant crushers, and thence by gravity to the barges in the harbor. From this point it will be carried to Cristobal, at the Atlantic entrance to the canal, and thence, *via* the old French channel, to the docks at Gatun. Here it will be unloaded into storage bins by giant grab buckets, operated from cableways suspended between two sets of towers on either side of the channel.

The sand will come from Nombre de Dios, about 40 miles along the coast from Colon. It will be taken from the sand pits by clamshell buckets, loaded into steel barges, and taken to Gatun, where it will be unloaded by a process similar to that of unloading the crushed rock. The cement is now being shipped from New York. At Colon the cement will be transferred to barges and taken *via* the old French channel to Gatun and unloaded to the storage yards. The rock and sand storage piles have a capacity of about 300,000 cubic yards, while the cement yard accommodates about 100,000 barrels. From these storage buildings, the rock, sand, and cement will be delivered through valves to charging cars running underneath. These cars, which are electrically operated, carry the materials to the concrete-mixing machines located nearer the locks' site and discharge it direct to the machines. About eight of these machines will be employed on the Gatun locks. After the concrete is mixed, it will be dumped into buckets set on flat cars, and the cars will be run to position under the great cableways spanning the locks' site, and from these cableways the buckets filled with concrete will be swung to position on the locks under construction.

The concrete-handling plants at Pedro Miguel and at Miraflores will be essentially different from the one at Gatun. It is desired to prosecute work simultaneously at all the locks, and therefore the great cableways and other plant at Gatun could not be used on the Pacific side. The plant at Gatun will be economical, because the three locks there are all continuous. It would not be economical to build other similar separate plants at both Pedro Miguel and Miraflores. In addition to this fact, the ground surrounding the locks at these two latter points is very unstable, and it would be unwise to place the great towers there. In their stead, therefore, there will be used a system of cantilever and berm cranes. These cranes will take the materials from storage and from cars and, after mixing, will deliver the concrete to place in the lock forms. It will be recalled that the materials at Gatun will be delivered by water, while at Pedro Miguel and Miraflores they will come by rail. As there is but one lock at the former point, the plant there will be taken, upon completion of the lock, to Miraflores, to assist in the work on the two locks at that point.

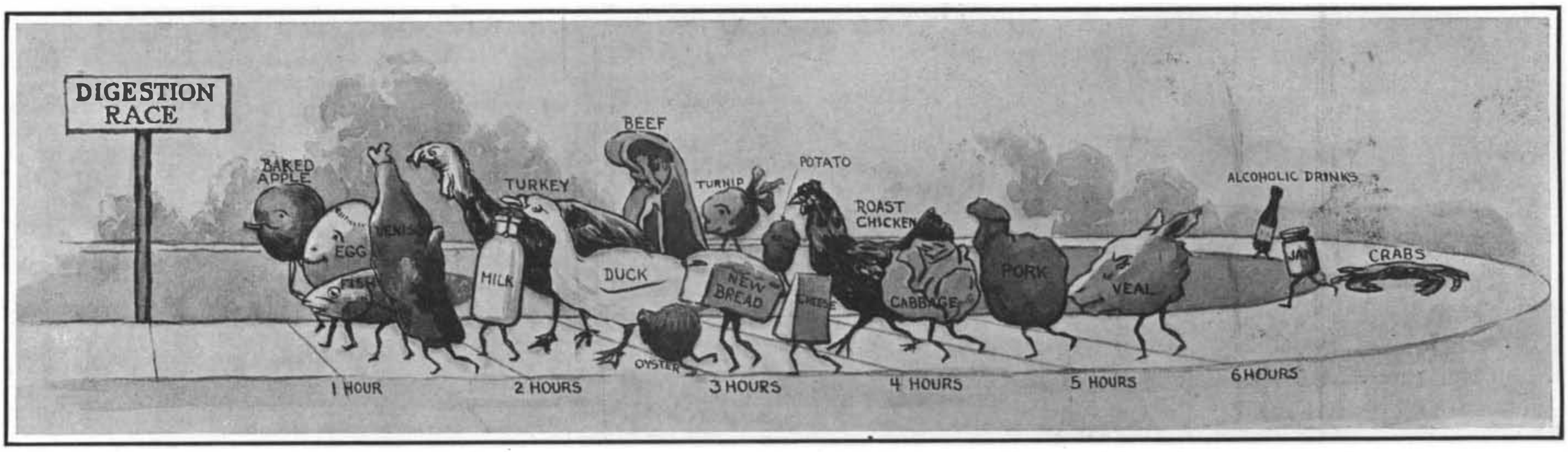
The cantilever cranes are set on towers, which rest on trucks running on tracks parallel to the lock walls. These cranes will travel the full length of the locks and, of course, parallel to them. They are situated outside of the locks. They will gather the material from the storage piles and, with the aid of grab buckets, drop it into the concrete-mixing machines situated in the towers. The inner arms of the cranes will then be used to transfer the concrete to the outside lock walls and to the smaller or berm cranes, which will in turn place it in position on the foundation and center wall between the locks, at points inaccessible to the cantilever cranes. The guaranteed capacity of the plant on the Miraflores locks is about 2,500 cubic yards of concrete per day. That of the cranes at Pedro Miguel is about one-half this, as the structure will be only half as large as the ones at Miraflores. All of the cranes, cableways, mixers, etc., will be electrically operated, and the power plants for furnishing the current are now about completed.

The forms for the concrete walls are to be of steel, and will all be interchangeable, which will allow them to be used on successive stages of the work. The circular forms for the water conduits, machinery chambers, etc., will all be of the rapid collapsible sheet-steel type.

FOODS AND DIGESTION.

The subject of food and its digestion is one of the most important with which the human family is concerned, and yet, strange to say, there is very little known about the comparative digestibility of foods by the average person.

To present certain facts relative to digestion, we have prepared an engraving which shows the relative digestibility of foods of various kinds. It will be seen that the baked apple and the raw egg are near the winning post, the egg being tied by the fish. Then follows venison, all these being digested within an hour. Then come milk, turkey, duck, and oysters. New bread and cheese follow in the same class with the above, the time required to digest them being about three hours. Then come turnips, potatoes, roast chicken, and cabbage. We are fast getting into the period of indigestibility, which is beautifully summed up in pork and veal, which require, under the most favorable conditions, five hours to digest. In the sixth hour and "beyond" class, we find jam, crabs, and alcoholic beverages of various descriptions. Certain other articles of food are about as bad as crabs and jam, notably eels, which are notoriously indigestible, requiring six hours, also stone fruits, which require the same period.



THE RACE OF FOODS FOR FIRST PLACE IN THE DIGESTION RACE.

It will be seen by our engraving that, as a rule, cooking facilitates digestion, partly by softening the food, and partly by inducing chemical changes, which would otherwise have to be induced by functional activities. Fat retards digestion, as it has to undergo a long process of emulsifying before being absorbed. This accounts for the indigestibility of pork.

Under normal conditions it is well that the digestive process should not be prolonged beyond four and one-half hours. For invalids and others with weak stomachs, the time should be much less. As a result of repeated experiments, the following digestive time table will be found of considerable interest:

Food.	How Prepared.	Time.	
		Hours.	Minutes.
Apples, sweet	Raw	1	30
" green	Stewed	1	35
Asparagus	Boiled	1	30
Barley Soup	——	1	30
Barley	Boiled	2	00
Beans	Boiled	2	30
"	Puree	1	30
Beef, lean	Roasted	3	00
" tender	Stewed	2	45
Beefsteak	Grilled	3	00
Beef, fresh salted	Boiled	2	45
" old salted	Boiled	6	00
Beets	Boiled	3	45
Brains	Boiled	1	35
Bread, fresh	Baked	3	30
Butter	Melted	3	30
Bread and Butter (with coffee)	——	3	45
Cabbage	Pickled	4	30
Celery	Boiled	1	30
Chicken	Boiled	2	00
"	Fricasseed	2	45
"	Roast	4	00
Cheese, old	——	3	30
Custard	Boiled	2	45
Duck	Roasted	2	00
Eel	Roasted	6	00
Eggs, fresh	Raw	2	00
"	Soft boiled	3	00
"	Hard boiled	4	00
"	Whipped (raw)	1	30
"	Scrambled	3	00
Fish (other than fat varieties)	Boiled	1	30
" " " "	Fried	3	00
Fowls	Boiled	4	00
"	Roasted	4	00
Game (most kinds)	Roasted	4	15
Goose	Roasted	2	30
Hashed meat	Warmed	2	30
Liver (calves)	Fried or sauteed	2	30
" (ox)	" "	3	00
Lamb	Grilled	2	30
Lentils	Boiled	2	30
Milk	Raw	2	15
"	Boiled	2	00
Mutton	Boiled & Broiled	3	00
" lean	Roasted	3	15
Nuts	——	5	00
Oysters	Raw	2	55
"	Stewed	3	30
Onions	Stewed	3	30
Peas	Boiled	2	30
Pig, sucking	Roasted	2	30
Pork, fat	Roasted	5	15
" salt	Boiled	3	15
Potatoes	Fried or baked	2	30
Rice	Boiled	1	00
Salad	Raw	3	15
Sausage	Grilled	3	30
"	Smoked	5	00
Suet	Boiled	5	30
Sago	Boiled	1	35
Soles	Fried	3	00
Spinach	Stewed	1	30
Salmon, fresh	Boiled	1	30
" smoked	Boiled	4	00
Stone Fruit	Raw	6	00
Tapioca	Boiled	2	00
Tripe	Boiled	1	00
Trout	Boiled	1	30
Turkey	Roasted	2	30
"	Boiled	2	15
Turnips	Boiled	3	30
Veal	Roast or Grilled	5	00
Venison	Grilled	1	00

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Spontaneous Combustion of Textile Fibers.

Unspun and uncarded textile fibers collected in large masses have caused many conflagrations through spontaneous combustion. It appears to be established that clean fibers do not ignite spontaneously and that the combustion is due to the impurities, which consist chiefly of oils used in the preparation of the fibers and of the natural grease of unwashed or insufficiently washed wool. The refusal of a shipping company to transport shoddy in a ship's hold has led a German investigator to make comparative studies of the shoddy and the fibers which were accepted for shipment, in regard to the nature of their impurities and the degree of spontaneous heating to which they are subject. The admitted fibers included unwashed wool containing 6 to 21 per cent of grease, washed wool containing about 3 per cent of grease, wool cardings and combings containing 2 to 3 per cent of added oil, and raw cotton containing about ½ per cent of grease. The shoddy contained from 1 to 5 per cent of oil. The experiments were conducted by compressing with the hands about 2 ounces of the fiber into a ball, surrounding the bulb of a thermometer, placing the ball in a wool oven heated to 230 deg. F., and reading the thermometer at intervals until the temperature ceased to rise. The first series of experiments were made with cotton, with which increasing quantities of oil were incorporated in successive experiments. A curious and inexplicable fact was observed. The cotton to which no oil was added, and which contained only 1/6 per cent of fatty matter, showed at the end of two hours an elevation of temperature of 16 deg. F. above the constant temperature of the oven.

Very dirty unwashed wool, which lost 64 per cent of its weight in washing, showed a superheating of 21½ deg. F. in five hours. Wool washed in three baths of boiling petroleum naphtha for three hours, superheated 11 deg. F. in three hours, and the same wool, after the addition of 10 per cent of olein, superheated 21½ deg. F in three hours. Five specimens of wool shoddy, containing a maximum of 5 per cent of olein and a maximum of 10 per cent of cotton, showed elevations of temperature varying from zero to 18 deg. F. in three hours or more. The conclusion is that spontaneous combustion cannot occur in fibers containing less than 10 per cent of fatty matter, and that such fibers may safely be stowed in the hold of a ship.

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The Chemist in the Soap Factory.

In view of the lively competition which prevails in the soap industry it is necessary to exercise constant control, by chemical analysis, over everything, from the raw material to the finished soap and by-products. In the analysis of raw material great care should be taken to obtain fairly representative specimens. In analyzing animal fats it is only necessary to determine the proportions of water, ash, dirt (matter insoluble in ether), free fatty acids, and unsaponifiable matter. From these data the yield of glycerin and fatty acids can be calculated. In vegetable fats it is necessary to determine the proportions of water, dirt, unsaponifiable matter, the iodine ratio, and in some cases the saponification ratio and the amount of free fatty acids. It is often necessary, also, to apply iodine, saponification, titration, and color tests to the fatty acids after separation.

As the proportions of the different fatty acids in a mixture can be determined only approximately (to 5 or 10 per cent) by these methods, it would be very desirable to have all the constants, especially those of the most largely used fats and oils, accurately remeasured. Another desideratum is an agreement among soapmakers to employ similar methods, in order to prevent controversy in buying and selling.

The alkalies employed must be analyzed quantitatively for caustic and carbonated alkali and sometimes for the proportions of soda and potash. The purity of the acids and other chemicals used in bleaching and clarifying should also be tested.

The actual soapmaking should be left to the practical soapmaker, but the chemist should always determine the excess of alkali or of fatty acid in the finished product, in order that the manufacturer may give guarantees of quality.

Finally, the residual liquors must be analyzed for glycerin, salt, impurities, and alkali.

Another extensive field of work is open to the chemist in devising and testing new processes and products, and improvements in manufacture.

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The Beginning of Iron.

It is commonly believed that the use of iron commenced in either Africa or Asia, but Ridgeway, in his recently published work, "The Beginning of Iron," states that the latest investigations prove that iron was not worked in Egypt until the ninth century before the Christian era or in Libya until 450 B. C., that the Semites adopted its use still later, and that it has been known in Uganda only within the last five or six centuries. In China iron is first mentioned in 400 B. C. Bronze weapons were employed in China until 100 A. D., and in Japan until 700 A. D. According to Ridgeway, the metallurgy of iron must have originated in central Europe, especially in Noricum, which approximately represented modern Austria and Bavaria. Only at Hallstatt and in Bosnia and Transylvania, from which countries the Achaians and Dorians are supposed to have migrated to Greece, are found evidences of a gradual introduction of iron, at first as an ornament applied to the bronze which it ultimately displaced. Everywhere else, iron was introduced suddenly—a fact which implies a foreign origin. Of course, Ridgeway does not assert that iron was unknown outside of central Europe. On the contrary, he states that meteoric iron was known in Egypt in remote antiquity, but that it was worked as flints were worked, by cutting or chipping, and was not smelted. In other words, it was the metallurgy, not the knowledge, of iron that originated in central Europe.