

## Mechanical Phase of Canal

Fred A. Calvin Tells of Elements That Enter Into the Great Panama Waterway

The Panama canal has succeeded. That is now to be taken for granted. Before so very long it will have brought together the two great sides of the world. To the commerce of the world the canal opens new fields, vast territory, closed before by the time and expense of the long voyage around the shoulder of a continent. The waters of the Pacific ocean lave the shores of the lands wherein dwell one-half the population of the world. To these people there will come through the canal the civilization of the modern times. Through the canal will sail the twin goddesses of health, Hygiene and Sanitation. Upon the disease-ridden east the prophylactic touch of Yankee methods of right living will descend as a benediction. It is our canal, too. It was made possible by American knowledge and American pluck and American ingenuity. Where the French and the English and the Spaniards, if we go back far into the history of the Panama country, failed, there have we worked a miracle, a wonder of science and intelligence, a boon to the whole world. There is in the Panama canal much ground for national pride. It is to be hoped that the administration of the canal shall find its measure in the remarkable standard of its building.

The article that is to follow was written by Fred A. Calvin, assistant editor of "The American Machinist." It treats in a comprehensive way the mechanical side of the digging of the world's greatest ditch.—Ed.

**M**ORE than any other undertaking in the world's history, perhaps, the Panama canal is due to the combined development of many elements of civilization. While the French engineers failed to complete the canal, we must remember that no one could have succeeded at that time, and we must give them credit for courage, engineering ability and a creditable achievement.

Without a Colonel Gorgas to first eliminate the mosquito and make the canal zone not only livable but comfortable and even attractive the canal would never have been built. Without the modern developments of excavating machinery and of concrete the great locks at Gatun, Pedro Miguel and Miraflores and the nine-mile cut at Culebra would never have been completed within a reasonable time. Without the repair shops at Cristobal, Gorgona, Empire and Balboa to keep the locomotives, steam shovels and other machinery in operation the rapid progress would have been impossible. And without the selection of proper material to stand the climate, not forgetting the too often overlooked item of belting, the cost in delays and in actual money might be difficult to compute.

The shops at Cristobal and Balboa handle the repairs for the dredges and other excavating machinery at the Atlantic and Pacific ends of the canal respectively. This includes the barges which carry the material away to be dumped, some being self-propelled and called by their French name "clapnets," as well as tugs, launches and any sort of sea-going craft which may be used.

The largest shops are at Gorgona, enlarged from the French shops at this place, and here all the locomotives and cars for the excavation work as well as for the Panama railroad are repaired. At times this shop has employed 1,800 men. It is difficult to see the necessity for such a large shop until we stop to consider that the Isthmian Canal Commission railroad, built solely in the Culebra cut and for hauling the dirt (or "spoil," as it is called) away from it, is about the size of the Boston & Albany railroad. There are over 300 locomotives and 4,000 cars, and most of the locomotives are big ones, weighing over 100 tons each. They are very unlike the usual contractors' locomotives we usually think of in connection with excavation work.

At Empire the steam shovels are repaired and the shops employ about 700 men at times. It takes a lot of shop work to keep the dirt flying, but they are kept at work with as little delay as possible by a thoroughly organized plan of action and a corps of inspectors and workmen.

The inspectors visit each shovel as it works away, and not only gets the reports of the shovel engineers, but look it over for weak spots and worn parts. Any needed repairs are reported to Empire by telephone so that repair parts and supplies can be prepared in advance.

After the dirt trains have stopped running at 5 p. m., the repair train starts out from the Empire shops and makes its rounds to the steam shovels which are in need of its services. This repair train consists of a heavy locomotive, a large wrecking crane, a box car, which is a fairly well equipped machine shop, and another box car filled with supplies and parts ordin-

arily used, such as bolts and nuts, packings, and similar pieces.

The train takes the small machine shop directly to the shovel to be repaired and in most cases does all that is needed without its leaving its position or losing a minute from the work, an excellent example of real efficiency. Sometimes a whole new arm or boom is swung into place by the wrecking crane and a trip to Empire with its attendant delay is avoided. And these arms or booms weigh several tons and are not easy to handle. But the aim of everything is to keep things moving and push the job through to completion.

At Empire, too, is the main air-compressing plant of the largest air-compressing system in the world. Three stations—Las Casendas, Empire and Rio Grande—pump into about 14 miles of 10-inch pipe line, which carries compressed air to drive the drills for preparing the rock for blasting.

Aside from the strictly repair work to the locomotives and cars the shops at Gorgona can be called the manufacturing shops of the zone. A good sized foundry equipment is provided for making iron, brass and steel castings for all purposes needed in the canal work. And while it is the intention to buy as much material as possible, it has been found necessary to make many repair parts which should have been made in the States on account of the short sighted policy of some manufacturers in charging exorbitant prices for repair parts. It has repeatedly been found cheaper to make a pattern and a casting and then machine the casting than to pay the price asked and wait for it to be made.

Nearly all the machinery which has gone to the Isthmus has been found to require strengthening to stand up under the severe work of the canal excavation. Crane arms have to be reinforced, car sides strengthened and other machinery parts increased in proportion. The old French rails have been largely used for such reinforcing and there seems to be no end of them. They make excellent I-beams for the sides of dump and other cars and are also used in reinforcing concrete structures in many places, even including the edges of curbing for street sidewalks. Bridges of short spans have also been built of these rails, and they have been put to more uses than can be mentioned offhand. Whoever bought them bought them with great liberality, to put the matter mildly.

Everything about the whole canal is on a big scale, even though the success of the largest may depend on the proper working out of the smaller details. The locks at Gatun will lift the vessels 85 feet from the sea level to that of the lake, which is formed by the huge Gatun dam. The lake will cover 164 square miles and flow the water from the locks at Gatun through the great Culebra cut and to the locks on the Pacific side at Pedro Miguel. The locks will accommodate vessels 1,000 feet long by 110 feet wide and drawing 45 feet of water. But as the average vessel in the tropical trade is under 600 feet long, auxiliary or intermediate gates are provided so that 40 per cent of the water for locking vessels can be saved unless the vessel exceeds 600 feet.

The Gatun locks are about 1 1/3 miles long, of solid concrete, and form the largest concrete structure in the world. They are double, to allow the passage of vessels in both directions

at the same time if necessary. Electric locomotives ahead, behind and on both sides will tow the vessels through the locks, both to save time and to prevent damage to the locks themselves.

The overflow of the Gatun dam will provide electric power for the locomotives and probably for all the uses of power along the Canal zone.

The lock gates are steel structures, each leaf weighing about 550 tons. They are about 77 feet high, 67 feet wide and 7 feet thick. There are 92 leaves, for there are 46 pairs of gates. An idea of their bulk may be had by noting that if they were laid flat, one on top of the other, the pile would be higher than the Singer tower. The riveting problem is also interesting. Counting 300 rivets as a good day's work for a single gang of riveters, it would take them a year to rivet up a single leaf, or 92 years to complete the lot.

The whole administration of the shop and storehouses is under the army in its various branches. The stores come under the quartermaster's department, and the storehouses are splendidly kept in every way. Employees all have a brass check or tag similar to a baggage tag bearing their number. This tag is the open sesame to all commission stores. Here the employees can buy anything at cost, usually much cheaper than the same thing can be secured in New York or any northern city.

At Cristobal are the main storehouses, the government ice factory, ice cream factory, bakery and laundry. Early every morning the supply train, usually of 21 cars, starts out to supply the smaller storehouses and distributing points along the Isthmus. And there are very few of the necessities and even luxuries which cannot be secured from the main stores and sent to you at short notice.

These seem strange when we think of canal digging, but show conclusively that it is the attention to details that brings success no matter how large the enterprise. Men would not stay until the surroundings were healthy and congenial. This meant comfortable quarters for their wives and children. This in turn necessitated the adoption of a complete school system, including a high school which ranks second to none as a preparatory school for college. It also meant recreation centers and Y. M. C. A. buildings for the men and women's clubs for the women. All strangely out of place and a seeming extravagance in a tropical climate and for a temporary job, but all absolutely necessary to the successful building of the canal in record time as has been done.

This same thing has been carried out in the details of shop management and the buying of proper materials to work with. We go into large or small machine shops and pay all our attention to the machines and never see the belts that drive them and without which they would be of almost no use. And the belt problem is one of the worst that comes up, especially in shops in tropical countries.

The ideas of heat in the Canal zone are apt to be exaggerated, as the temperature rarely goes over 93 degrees and sunstrokes are unknown. But heat is not the only factor in these climates.

Imagine sitting down at the table on a damp, rainy day and pressing with your knife on the salt in the salt cellar and see moisture stand in drops on the knife. Salt shakers are out of the question, and envelopes are made without gum to prevent their being accidentally sealed when not wanted. This gives you some idea of the dampness in the atmosphere.

It is not so hot as you expect, but you perspire at the slightest provocation and sometimes without any provocation at all. Your clothes may be damp in the morning, almost wet, in fact, unless you put them in the tight wardrobes usually provided. And your boots insist on getting mouldy unless they are wiped dry when put away, and even this is not a sure preventive.

And then imagine what a belt is up against. It must be dependable day after day. The season may be dry or wet, the atmosphere saturated or dried out by the close proximity to a boiler or other heating apparatus, but the belt must go on doing its duty or the machines cannot run and the shovels and locomotives cannot be repaired. Then, too, there is oil around the machinery to contend with, all of which makes the conditions especially trying.

Ordinary belting stretches with the moisture contracts when it dries out a bit, opens at the laps and has to be cut constantly to keep the length so it will pull the machine. Two or three ply belting is very apt to part com-

pany and be of little value as a driver of machinery of any kind.

Here again careful attention to detail saved the day and made steady and continuous work possible in the shops. What is known as the Duxbak belting solved the problem and wiped out all the delays due to poor belts which had previously been experienced. Over 15,000 feet of this belting, some of it under the most trying conditions, has given the best results in every case. None of the adverse conditions affected the belting in any way and loss of time from this cause was eliminated in all the shops.

And while belting may seem like a small item in the building of the great canal, it is not difficult to imagine the long delay and the increased expense if the shovels and locomotives had been compelled to lie idle day after day while ordinary belting was giving out, making it impossible to run the machines.

## Domestic Economy

Cabbages should be placed in barrels, the roots uppermost.

A soft rag moistened with lemon juice and then dipped in silver whitening will be found excellent for cleaning piano keys.

Lamps will not smoke if with a sharp pair of scissors the wick is trimmed the shape of the burner and a small V is cut from the center.

Palms and other foliage plants can be kept clean of scale and other insects by washing the leaves with soapy water and rinsing immediately thereafter.

Never envy the people seeing a show from a box. They get a fine view of the actors' makeup and can see what's going on in the wings. That's about all, too.

When silk is spotted with grease rub it with French chalk or magnesia, then hold the spotted portion near the fire. The chalk will absorb the grease and can be brushed off, taking the grease with it.

To get a good light from an oil lamp the wicks must be changed when they become clogged. Soaking wicks in vinegar 24 hours before putting them in the lamps aids in getting a clear flame.

When baking cookies use a large dripping pan. Turn it bottom side up and place the cookies on the bottom of the pan. They bake quicker and do not burn as easily as when put into the pan.

Paint splashes on a door may be removed by soaking them for a short time in benzine or turpentine, then rubbing them with emery paper or a little pulverized pumice stone, applied with a damp cloth.

The old-fashioned emery cushion is a most useful possession to the needle

woman, especially when working in hot weather. Passing a needle through an emery cushion two or three times polishes it, and makes it pass through materials smoothly.

Aluminum thread is the newest thing for chouching handbags, and it has the advantage of not tarnishing. The effect is soft and lustrous and it is just the thing to go with the grays that have so important a place in this season's costumes.

A small square cushion which would be especially nice for a guestroom is covered with blue silk, and over this a filet lace cover of white is drawn. This dainty bit of blue and white is then supplied with blue and white headed pins, neatly arranged, all ready for the guests' use.

The chenille embroideries are another novelty of the season. Dull colors are used for the portion of the design carried out in the chenille, while petals are frequently composed of pieces of satin applied on, and outlined with a dull gold cord tacked on. Velvet is used as a foundation.

White frocks and blouses or underclothing that have a bad color should be first soaked in cold water to which a little ammonia has been added and then given a lemon bleach; that is, a large lemon should be cut into slices, rind and all boiled up in the boiling pan or small copper. When at full boiling point put in the linens and muslins and boil for 20 minutes.

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By EVANSON



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