

Engineering

The Panama Canal Locks

A Brief Description of the Machinery Operating Them

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One so constantly sees reference to the Panama Canal in the daily papers, and so much has been said and written about the Canal proper, and the engineering difficulties that have been met with, and each in its turn overcome, that one is apt to miss features of the construction, in every way as wonderful as the actual cutting of the Canal itself, that have been designed and carried steadily to near completion, without break or set back of any kind.

The arrangements made for the working of the machinery connected with the locks at Gatun, Pedro Miguel, and Miraflores, are a most interesting feature from an engineering point of view.

The electrical energy employed for this purpose is generated at a 7,500 k.v.a. hydro-electric station at Gatun Dam, with an emergency 4,500 k.v.a. Curtis steam turbine plant at Miraflores, and is transmitted across the isthmus by a 44,000 volt line connecting Christobal and Balboa with those two stations.

The extent and intricacy of the installations may be judged from the fact that at Gatun Locks there are 218 electric motors, at Pedro Miguel 122, and at Miraflores 160, a total of 500. These motors range in power from $\frac{1}{2}$ to 70 h.p. and their aggregate h.p. is no less than 12,020.

In addition to these, many other motors are employed for the sump pumps, spillway gates and other purposes.

The machinery provided for working the ships through the various locks consists in the first place of the lock gates. A pair of these is placed at each point where a change of water level occurs, dividing the locks into chambers 1000 ft. long.

In case of failure of the lock gates, at both the ocean, and lake ends of the locks are placed duplicate or guard gates, and in order to economise water when only small vessels are being passed through, each lock of 1,000 ft. is fitted with intermediate gates dividing the main lock chambers into two compartments.

At Gatun there are 40 motors of 25 h.p. each for moving the leaves of the gates, at Pedro Miguel 24, and at Miraflores 28, a total of 92 motors. When the gates are closed they are held in place by what is called a "mitre forcing machine" which requires no less than 46 motors of 7 h.p. each to operate at the three locks.

For regulating the flow of water in the culverts by which the locks are filled and emptied a large number of valves are employed, and with a view to prevent interruption of working, an elaborate system of duplications is installed. These valves are

known as rising stem gate valves, guard valves, auxiliary culvert valves, and cylindrical valves, and 266 motors of 7, 25, and 40 h.p. with an aggregate capacity of 6,014 h.p. are needed for their operation.

These figures are given here not only with a view to pointing out the enormous power necessary to operate the mechanical part of the Canal work, but to also draw attention to the very large number of units over which the work is distributed.

The subject of control of these units presented a very formidable difficulty.

Local control of the individual machines stationed along the locks, by men placed at local controls, would not only have necessitated a very large staff, but among such a number, it would have been difficult to secure efficient co-ordination.

Any mechanical system of control from a central point seemed impractical, owing to the great distances involved, for it must be remembered that the Gatun locks extend over a length of approximately 6,200 ft. or say one and one sixth miles. The centralized electrical system was finally decided on, as being the only one possible under the circumstances.

The whole of the operations necessary for the working of the locks, are effected from control boards situated in houses placed on the centre walls between the locks, and although these houses are built at the points which command the best view of the locks, it would be practically impossible for the operator to follow the movements of shipping—gates etc., by eyesight.

The control boards situated in the houses are fitted with indicating apparatus which reproduces any movement of the various appliances. They are of great size, in order that the detail may be presented to the operator on a fair scale, the board at Gatun control house being 64 ft. long, at Pedro Miguel 36 ft., and at Miraflores 52 ft.

The three together weigh some 39 tons, and their construction required the employment of about 6,000,000 ft. of control leads made up of 5 and 8 conductor cable, 732 indicator motors, and 464 control switches.

The operator can see at a glance exactly what is happening in any part of the locks under his control. The indicator for each of the lock gates consists of a pair of aluminium leaves, which travel horizontally just above the top of the board. The position of the fender chains that protect the lock doors, the position of the rising stem valves, fitted in the filling and emptying culverts, and the level of the water in the various locks are all clearly shown, every movement taking place in the actual working of the locks being automatically reproduced on the control board, as it happens.

So perfectly has this work of installing the tell tales on the control boards been carried out, that an accuracy of one-twentieth of a foot in the level of water in the various locks has been obtained.