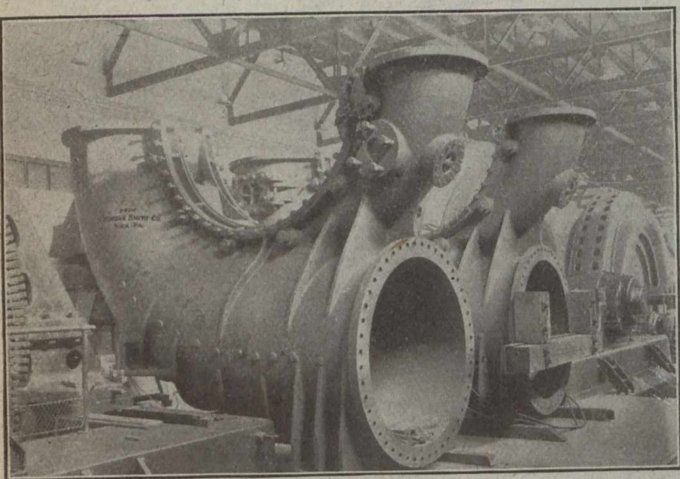
wall continues on an incline up the side of the cliff, connecting with the International Railway at the top. This opening is provided with stop logs that can be dropped in place by the power house crane in case of high water.

The rear wall, which is located next to the cliff, was designed as a straight gravity section and with a profile similar to the back wall in the existing power house. This rear wall is somewhat cut up by cable recesses and in order to compensate for the concrete taken out by these openings a certain amount of reinforcing was used.

The power house roof consists of a 6-inch reinforced slab designed to carry a live load of 150 pounds per sq. foot.



Bottom Sections of Spiral Casings of Turbines Nos. 15 and 16

This loading was used so as to take care of any accumulation of ice on the roof or falling rock fragments from the cliff due to weathering of the cliff.

Ample drainage is provided for all parts of the power house structure. The drains along the front part of the roof are carried down through the concrete of the front wall, and discharge into the draft tubes, while the drains in the back part of the roof run down through the rear wall concrete and discharge in the rear wall drain, which is two feet wide and five feet high, and runs along adjacent to the back of the rear wall at elevation 377.5, and discharges at the north end of the building. In case the north end of the drain blocks, an overflow is provided into the rear wall drain for units Nos. 13 and 14. The system of drainage used was to run all the drains from the various sumps and pits, along with the floor drains, into a common sump which runs the full width of the building between units Nos. 15 and 16. At the end of the sump nearest the rear wall a sump well is provided for the suction pipes of two 10-inch centrifugal pumps which are used to drain the sump. These pumps are placed at elevation 360, directly above the sump well. Each pump is driven by a direct connected 35 h.p., 25 cycle, 220-volt motor, and has a capacity of approximately 1,500 gallons per minute. One pump is figured to take care of the drainage, while the second one is a spare.

Comparison of Hydraulic Characteristics

Air for cooling the generators is supplied by centrifugal fans located in the power house near the front wall, under the railway track, and at elevation 558. The air supply is obtained from outside the building through ducts leading from the lower part of the front window down the inside of the front wall to the air chamber beside the fans. Provision has been made at the inlet end of the air ducts for taking the air, if desired, from the power house instead of from outside during the extremely cold weather.

The hydraulics of the plant are of more than ordinary interest due to the fact that each of the three pipe lines and surge tanks that have been installed differ considerably. For this reason an excellent opportunity is presented of making a comparison of their respective hydraulic characteristics and capacities.

No. 1 tank has very little capacity and is of the simple tank type. Its only function is to limit the surge pressure on conduit No. 1 during load changes, and provides entrance to a spillway for discharge of water at times of load rejection.

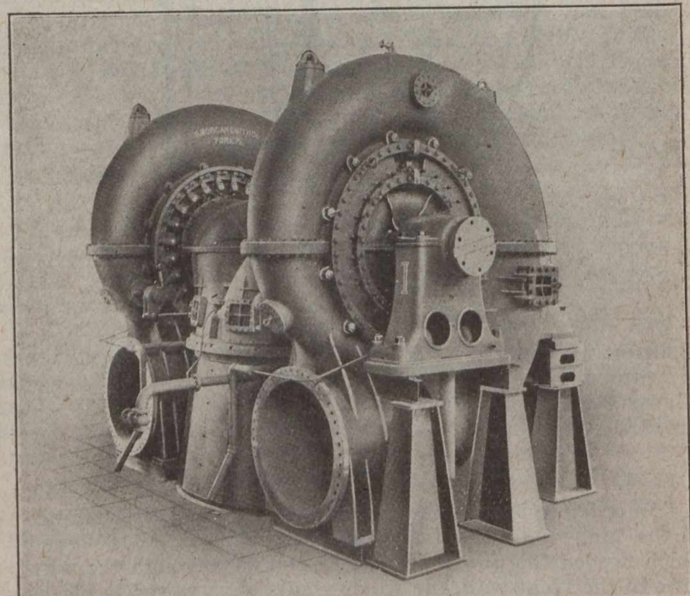
No. 2 surge tank, of the Johnson differential type, was the first tank of this character ever built. This tank serves the double purpose of relieving pressure surges and furnishing or storing water during load changes while the velocity in conduit No. 2 is being accelerated or decelerated. It is also equipped with a spillway as an additional safeguard, to prevent spilling over the top at times of abnormal surge, and to limit the height which would have been required without this provision.

No. 3 surge tank is of the same type as No. 2, but has no spillway. Its design is such that full load rejection under the most abnormal conditions will not cause overflow.

During 1913 a series of tests were made to determine the hydraulic characteristics and carrying capacities of conduits Nos. 1 and 2, also of penstocks Nos. 1 to 14, inclusive. The results of these tests indicate some very striking facts regarding the relatively greater carrying capacity of concrete pipe as compared with riveted steel and also the exceedingly smooth surface that can be obtained with concrete if proper and careful construction methods are used.

Concrete Shows Highest Coefficient

The capacity of No. 3 conduit, which is of wood stave construction, is 2,750 cu. feet per second, giving a velocity of 19.2 feet per second in the pipe on the basis of a coefficient of roughness "C"=135 in the Williams and Hazen formula. Under such conditions, there will be a total loss in the conduit, from gate house to penstock, of 32 feet, which includes entry losses, friction loss and velocity head. This figure was arrived by assuming low water elevation in forebay at 554, and the minimum elevation of the gradient at penstock No. 15 at 522, which is eight feet above the top of the conduit. From past experience with conduits Nos. 1 and 2, it was found advisable not to go below elevation 522 in order to prevent the gradient being drawn down below the top of the pipe under operating conditions. Under the above conditions the capacity of the pipe will be approximately 45,000 turbine



Shop Assembly of Turbines Nos. 15 and 16

horse power. With a coefficient of roughness C=150 in Williams and Hazen, which value is within the limits of possibility, and the same total loss of 32 feet, the discharge capacity would be 2,930 cu. feet per second with a velocity of 20.5 feet per second in the pipe. This quantity of water in turn would give approximately 48,000 turbine horse power. In comparing the coefficients of roughness of the concrete and steel pipes, as obtained by test, and the assumed coefficient