This lake provides the head pond of the power works, and is arranged as a storage reservoir. Water is taken through a small intake with gates and screens and is carried through a tunnel 6'-6" diameter about 8,500'-0" long, on a slope of 0.12% to a small reservoir on the mountain side above the power station. This head house is provided with gates and screens and the water feeds into four penstocks each 40" diameter. Two of these tubes are now erected and con-

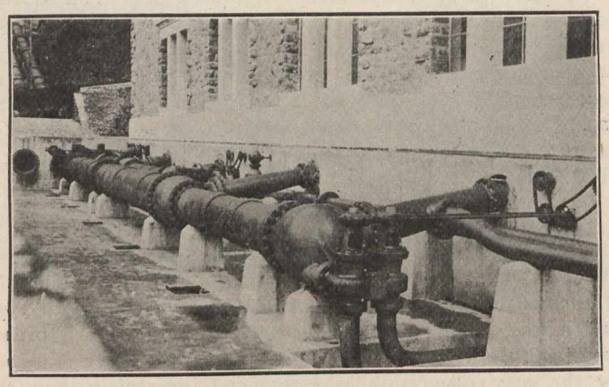

Fig. 11.—Engelberg: Penstock End and Its Distributor.

nected to water wheels. The total length of penstocks is 2,100'-0", giving a head of 1,030'-0", under which the wheels operate. The penstocks were constructed in 25'-0" lengths and bolted in place. They are each provided with five sliding expansion joints, with five heavy anchorages and are carried on concrete piers. At the lower end the sheets are 1" thick and at the upper 3/8". The distributors at the station branch each to 3 units, while the two exciter branches are connected to each tube; each has a butterfly valve, a guard plate, relief and emptying valve. Fig. No. 11 shows this arrangement.

The power station is a dignified castle-like structure built of limestone, in pleasing harmony with the massive cliffs and tree-clad mountains surrounding it. In the interior, the striking feature is the generous space provided for all apparatus. The generating room does not present the usual appearance of overcrowding, but with very ample floor space and lofty roof and windows. Even the power units look small if not lonely. The roominess of switch-board galleries and switching equipment chambers is quite as well marked as also is the great space allotted to the transformers, arresters, etc. The engineers look upon this as one of the modern features and in fact the writer saw no European plant with greater space given to this apparatus.

Four main power units are now installed, each having a capacity of 2,500-H.P. in the wheels and an output from the

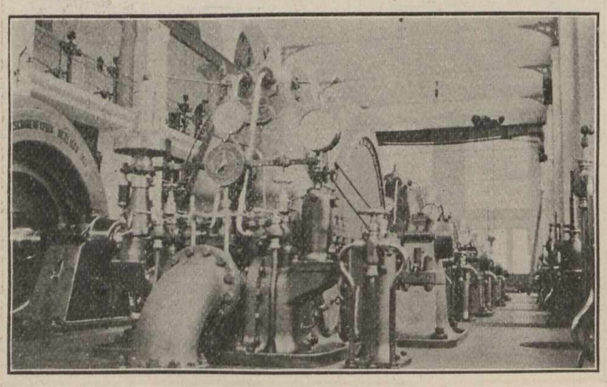

Fig. 12.—Engelberg: Interior of Station.

generators of 1,500-kw. Two exciter units are operated independently. Another separate unit of 600-H.P. furnishes power for the electric railway.

The water wheels, manufactured by Theodore Bell & Co., Kriens, are the Pelton impulse type with double buckets and side discharge. See Figures 12 and 13. They have one runner driven by a single nozzle having a throttling gate governed by a water pressure governor.

The alternators were built in 1904 at the Oerlikon works and are wound to 6,000 volts at 50 cycles at a speed of 300 revolutions per minute.

Local switching equipment controlling the power units is installed on the same floor as the generators. Shunt regulators for exciters and exciter rheostats are mounted on a mezzanine gallery. Transformers are on the ground floor and consist at present of two banks of three and three single phase with one reserve. Oil switches are provided on both low and high tension sides, the latter being at 27,000 volts. Bus bar compartments on ground and first floor are made thoroughly fire-proof, and in addition to spacious size are particularly well isolated between circuits. The lightning arresters are Siemens Double horn pattern arranged also with water resistance and choke coils connected in series. Distant control in convenient arrangement with centralization of instruments and recording apparatus is a marked feature.

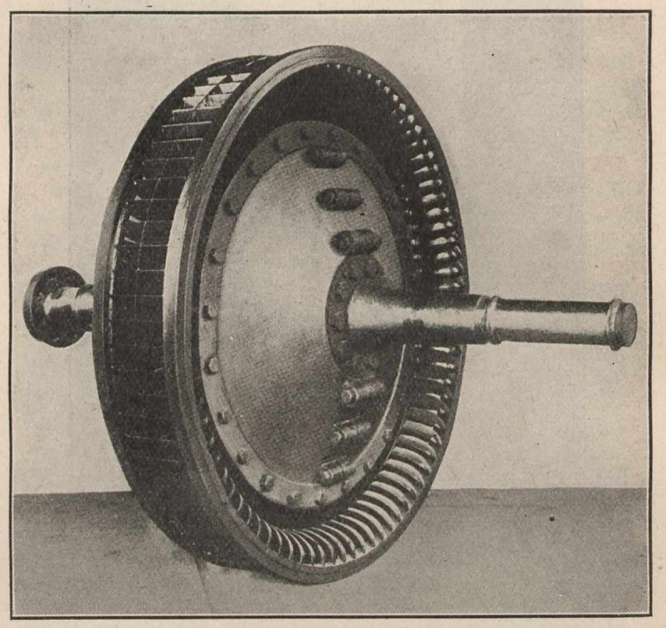

Fig. 13.—Engelberg: 2,500 H. P. Impulse Wheel.

In addition to the power supplied to Lucerne, about 400 kilowatts is used in the Engelberg Districts. Fortunately the peak load for Lucerne occurs in the summer period when there is ample water for the plant. The A. C. electric railway from Standstadt to Engelberg, about 15 miles in length, is newly constructed on the three-phase design and has proved a great success. A portion of the line, near the power station, is rack and pinion at 30% grade and is operated by electric locomotives. This road being one of the first to depart, in this respect, from the well-tried steam engine type.

ENGINEERING WORKS IN CRETE.

The present Government of Crete, purpose to develop the island gradually by the making of roads and bridges, and by the construction of harbor works, railways, and tramways, etc. Provision has already been made for the expenditure required to install a telephone system all over the island. No contracts have been let at present, but the firms who will be first on hand will have the best chance of obtaining the contracts for the other engineering works and supplies which are to follow the development of what is at present almost entirely a virgin field of industrial enterprise.

—Sheet-steel roofing may rust faster than iron because it holds the paint better, and yet steel in other forms, like tubing, may rust no faster than wrought iron. Different steels behave in different ways. Carelessly made steel, containing blow-holes, may rust faster than wrought iron, while carefully made steel free from blow-holes, may rust slowly.