the writer's visit, May 1906, temporary extensions of wood had been made pending permanent construction.

The power units indicate an interesting evolution so common in present day practice in power stations the world over. The first hydraulic installation had four 500 H.P. units of single nozzle Pelton type impulse wheels by Escher Wyss & Co. Then one 1,200 H.P. unit of the same type was added. Then came a 1,000 H.P. vertical reciprocating

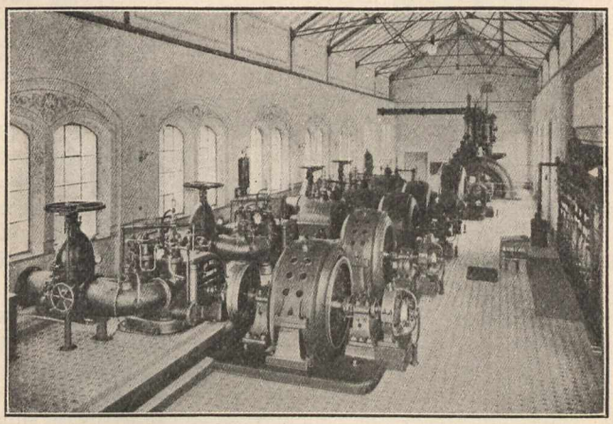

Fig. 3.—Kubel: Interior of Station.

steam engine unit to act as a reserve, due to fear of water shortage. After this more water was secured, a second penstock connected up and a second 1,200 H.P. impulse unit was installed. Early in the present year a third 1,200 H. P. unit, by Theodore Bell & Company was added, but of the Francis reaction type. The change from impulse to reaction is due to the fact that the latter has now attained a stage in design so as to be adapted for heads approaching 300'-0".

The impulse wheels of 500 H.P. have a single tangential nozzle on each of two runners in the same case, while those of 1,200 H.P. have three nozzles on each, or six to the unit. The former revolve at 375 and the latter 300 R.P.M. Referring to Fig. 4, it will be seen that the water is controlled by tips linked to the governor by rocker arms, and that the jets are deflected when not in use. The outside diameter of these runners is 50" and the unit, when loaded, consumes about 40 cubic feet of water per second. Although impulse wheels they are set 20 feet above tail water having draft tubes which are fitted with air valves to admit sufficient air to prevent the water level rising as high as the wheels. The governors are operated hydraulically by means of pressure from the supply pipe with which the governor cylinders are connected by piping. Admission of water to the latter is regulated by a fly ball governor and delay piston.

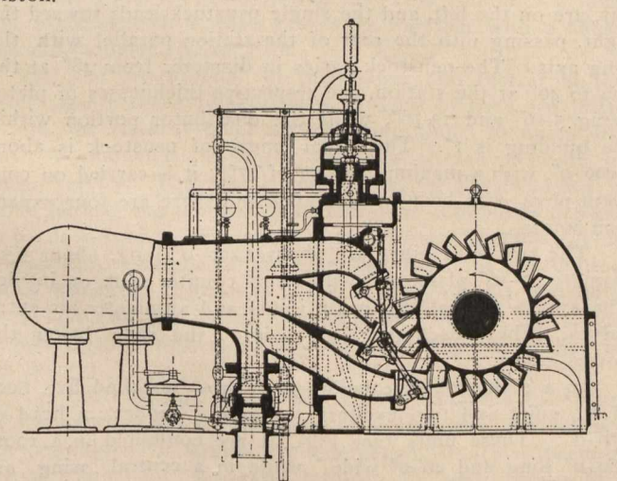

Fig. 4.—Kubel: Section Through 1,200 H. P. Wheel.

In the electrical equipment no particularly unique features are incorporated, as all power is distributed at the generating voltage, 10,000 V., without transformation. The generators are all of the same type of the various powers and are by Lachmeyer & Co., of Frankfort. The exciters are directly connected on ends of generator shafts. The whole station is arranged to run in parallel through either of two bus systems.

In order to form an idea of the cost of such projects, according to European practice, the following approximate figures are given for this particular work, assumed to the end of 1904, when 4,200 hydraulic, and 1,000 steam power was available on the shaft corresponding to about 3,600 kilowatts for delivery.

| | | | |
|---|---|---|---|
| A. | Preliminary, concessions and lands | | $170,000 |
| B. | General Works:— | | |
| | Collecting dam, etc. | $ 15,600 | |
| | Head tunnel | 146,000 | |
| | Reservoir dams | 135,000 | |
| | Penstocks, overflows, valves, etc. | 47,000 | |
| | Power station structure | 66,400 | 410,000 |
| C. | Hydraulic equipment | | 29,000 |
| D. | Steam equipment | | 36,000 |
| E. | Electrical Equipment:— | | |
| | In power station | 109,000 | |
| | Distribution, transformer stations, etc. | 320,000 | 429,000 |
| | Total | | $1,074,000 |

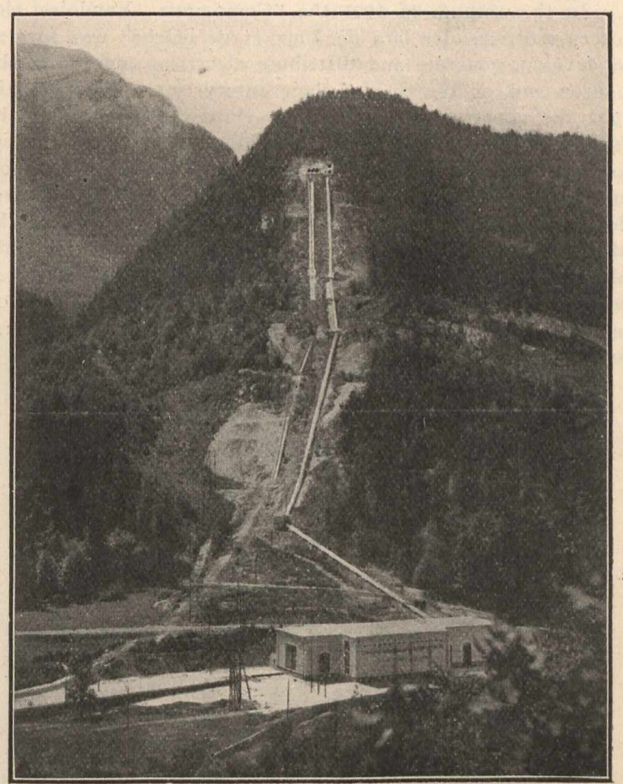

Fig. 5.—Vallorbe: General View of Station.

In the above it must be noted that portions of classes A, B and E are available against extensions so that ultimately the capital cost per kilowatt would be much reduced. Thus while the cost as shown is almost $300 per kilowatt it may subsequently fall to $200 when the plant is developed to its utmost.

The sale of power from this plant is in a flourishing condition and the market has quite exceeded the facilities. For lighting, prices obtained for 16 C.P. lamps are from $2.50 per year for 400 hours to $4.50, using 1,500 hours per year, such as required in residences at all times or in offices and factories until 6 p.m. For motor load, prices are as follows: One H.P. $80 per year; 5 H.P. $65; 10 H.P. $55; 20 H. P. $45; 50 H.P. $36.

### The Vallorbe Development.

Vallorbe is a small city in Canton Vaud, situated on l'Orbe River, a short distance north of Lake de Joux, and about two miles from the French frontier. The river empties from the lake, which is 800'-0" above the valley, through an underground passage beneath Mount d'Orzeires, and emerges after its downward rush at the foot of a high cliff, about a mile and a half from the lake. This gigantic