EUROPEAN HYDRO-ELECTRIC DEVELOPMENT

HIGH HEAD SWISS PLANTS.

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VII.

It is, perhaps, in hydraulic power practice under high heads, that Switzerland has attained her greatest distinction in engineering work. For this special branch, engineers, the world over, seek the advice of her manufacturers and designers, and in many cases purchase their equipment in that country. The latter custom has been quite marked in America during the past ten years, where high efficiency in large units has been desired.

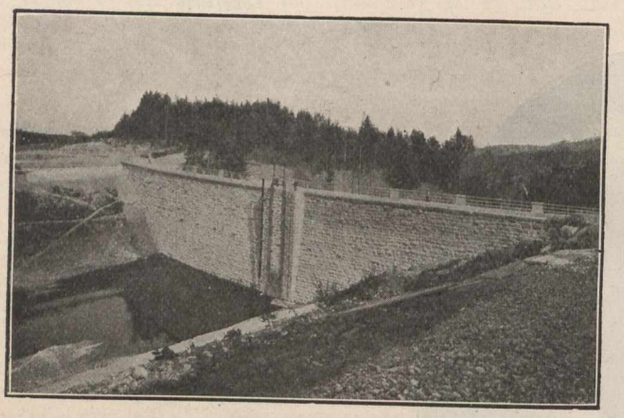

Fig. 1.—Kubel: Reservoir Dam.

Certain localities in Switzerland have been specially developed in this respect, but of recent years, with the advances made in electrical transmission, high head power plants have been constructed in many southern and western localities among the high Alps. These newer installations are all electrical, mainly for light and power purposes thus encouraging manufacturing in the surrounding districts. In the Bernese Oberland, and those districts north of Lake Geneva, new plants are being constantly projected and constructed.

To illustrate this recent development a schedule, based on reports of 1905, is given below, presenting twelve representative plants, which have commenced operation within the past few years. That at Aigle with its head of 3,140'-0" is still said to be the highest in the world.

Principal High-head Swiss Plants.

PLANT AND LOCATION.	Horse Power	Head Feet	Local's served	Miles. Length of Lines	Miles. Max. Trans.	Pop. to be served
Aigle, near Territet ..	2,000	3,140	25	32	15	30,000
Bex, l'Avancon River .	2,400	530	9	40	35	5,700
Engelberg, for Lucerne	8,000	1,030	12	30	23	40,000
Kander, at Spiez	6,000	220	35	150	35	100,000
Kubel, at St. Gall ...	5,600	270	23	32	20	70,000
Montbovon, Saane Rvr.	5,400	220	68	165	35	58,000
Montreaux-Territet . .	3,900	810	12	11	8	30,000
St. Maurice, for Laus'ne	5,200	122	8	50	40	60,000
Thusis, Upper Rhine .	3,580	300	1	2	1	1,300
Vaud at Vallorbe . . .	5,000	770	30	60	30	100,000
Vernayaz, Rhone River..	1,800	1,910	11	25	22	14,000
Wadenswil, Sihl River	2,000	230	18	55	14	34,000

For the purposes of this article the following three typical installations are selected from the above, as embodying interesting features of design and construction.

The Kubel Plant Near St. Gall.

The Kubel plant is situated at Bruggen, a suburb of St. Gall, in north-eastern Switzerland, on the River Sitter. This work, commenced in 1899, and first put in operation in 1901, was constructed to meet the great demand for cheap electric power in St. Gall and the surrounding towns. This region is the main silk and cotton spinning and weaving centre of the country, and consequently has a large demand for small units in motors. St. Gall has a population of about 50,000, and with the surrounding region this plant was, in 1905, serving about 70,000 people in 23 localities. To do this there were 35 sub-stations, with 135 transformers, having an average of about 33 k.w. for each transformer, a total of 4,400 kilowatts.

In general the system of development consists of a series of collecting dams, tunnels, and flumes, bringing water from the upper levels of the tributary streams to a high level valley above the ravine in which the power station is situated. The water is brought down to the station by penstocks and is discharged into the river alongside. In this way 5,600 H.P. is obtained hydraulically under 270'-0" head, and in addition the station has a 1,000 H.P. steam unit as a reserve.

At the present time the water is collected at a point on the Urnasch tributary, about 3½ miles from the station. The first control is by a concrete dam about 12'-0" high and 150'-0" long. At one end of this an intake, at right angles, leads to a head tunnel, and is provided with head gates and a coarse rack. In front and rear of head gates are sluices through the dam 5'-6" and 3'-6" diameter respectively, for draining the stream bed and intake. The head tunnel is driven through rock and is about 15,000'-0" in length with a horse-shoe section, lined with concrete, 6'-0" high inside. This tunnel empties into a reservoir formed by two dams across a valley, transverse to the Sitter River, thus providing a forebay of large area.

The end of the forebay farther from the power station is closed by an earth dam about 1,000'-0" long and 45'-0" maximum height, while the lower end is crossed by a most substantial stone dam, see Fig. 1. The latter dam has a total height of 80'-0", is of gravity type, with a top width of 10'-0" and a bottom width of 50'-0". It is arranged with a low level discharge gate leading to the penstocks, and has an overflow weir in front (left of illustration) which carries surplus water around end of dam. Under working conditions the head water stands from 3 to 5'-0" below the coping.

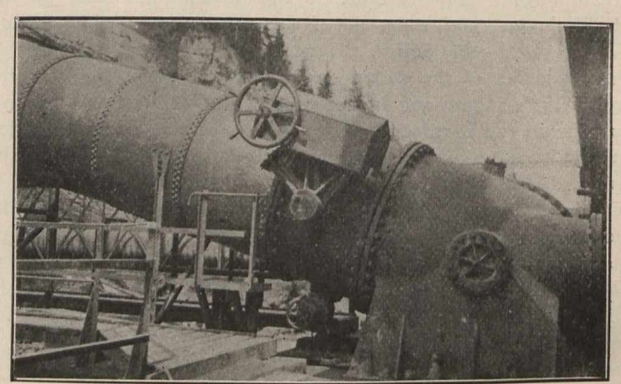

Fig. 2.—Kubel: Abutment of Self-supporting Penstock.

From the dam two steel penstocks 5'-3" diameter lead down the valley and slope to the power station a total horizontal distance of 900'-0". These run side by side and at a maximum slope of 76%. The one first built crosses the Sitter River to the station on a steel lattice bridge, distributing in front of the building into right angle branches serving the wheels. A second penstock, installed for extensions, spans the river without a truss, forming an arch in itself sufficient to carry the combined dead and live loads. This is also connected to the distributing main which supplies 7 units from the two interconnected penstocks. The details of this arched penstock are of special interest and Fig. 2 shows the abutment casting, which serves also as a two way elbow, one side being to the distributor and one to a pound unit.

The power station is a plain, rather American looking, brick building on a concrete foundation, and at the time of