nel is at the end of this line and measures 2½ miles in length this summit tunnel having a 2 per cent. rising grade eastward. At an altitude of 3,375 feet above the inside level is located the eastern portal, and the eastbound trains continue beyond it through the Tumwater canyon to the crossing of the Columbia River at the Washington State eastern boundary.

Two of the largest mallet steam locomotives were necessary to handle these trains over the neacy grade charging the tunnel with smoke and seriously interfering with the operation of the train.

In using three-phase alternating current for the electrification of the Great Northern Railway, at this point it was necessary to take care of enormous fluctuations of loads at the Tumwater hydro-electric power plant.

The power house was located in the middle of the canyon down the mountain side into the river, creating a natural dam down the mountain side into the river, creating a natural dam and providing a reservoir of 40 acres, forming an excellent storage basin.

Between the crest of the dam and the power house, located about two miles down the canyon and about the same distance from the town of Leavenworth, there is a fall of from 180 feet to 200 feet. This power site noted in illustration Fig. 1, is about 30 miles east of the cascade tunnel where the electric current is utilized for operating the high power electric motomotive. The crest of the dam, which is built of concrete, is from 12 to 20 feet high, with an elevation of nearly 1,500 feet above mean tide level.

From the gate-house the penstock has an internal diameter of 8½ feet and a total length of 11,870 feet, passing over a steel bridge of 200 feet span across the river near the power house as indicated in illustration Fig. 1.

Continuous wood stave construction is used as shown in the accompanying illustration Fig. 2, for more than 10,000 feet of this penstock. It is hooped with round steel rods varying in size and spacing according to the head, and made of Washington fir, a head of 170 feet of water being sustained by the lower end of this wood stave penstock. Steel plate construction is used for a penstock for the last section of about 1,000 feet at the power house.

Fig. 2.

The arrangement of the two main turbine units, with a space reserved for a third unit and two exciter turbine generator sets may be noted in the plan of the power house seen in drawing Fig. 3, each of the main turbines having a capacity of 4,000 horse power and operating at a speed of 375 revolutions per minute, while the two exciter turbines operate at 750 revolutions per minute and develop 175 horse power each.

The steel penstock at the power house has three outlet feeders of 7½ feet diameter which supply the 42-inch Victor-Francis turbine, each taking 465 sec.-ft. of water, the mean velocity in the penstock being 8.2 feet per second when developing 8,000 horse power with the two main turbines in operation.

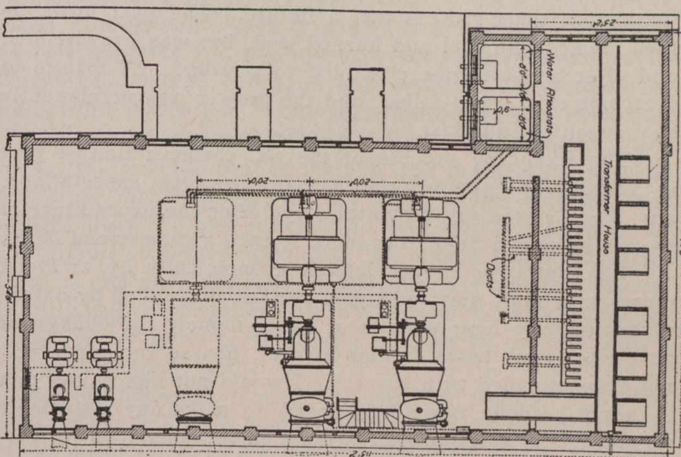

Fig. 3.

Each of these water wheels has an efficiency of 80 per cent. from full load to 50 per cent. overload on the electrical generators. The three-phase alternating current generators which are directly coupled to the turbine are of the general electric type as well as the direct current exciter dynamo.

An interesting feature of this Great Northern Railway hydro-electric power plant is the surge tank near the power house as noted in illustration Fig. 1. It is located on the end of the penstock at a point just beyond where the turbine feeders leave it, and is 183 feet high extending 10 feet above the level of the crest of the dam. The penstock is really extended into an upright pipe 8 feet in diameter while within the tank and this vertical pipe there is a waste pipe which extends 7 feet above the level of the crest of the dam.

The top of this waste pipe is nearly 8 feet in diameter and forms a circular weir nearly 24 feet in length and reducing in diameter to about 3 feet near the bottom of the tank.

The operation of this surge tank and waste pipe in the speed regulation of the turbines is unique, as when the power is instantly thrown onto the turbine by the electric generators taking a heavy load as the electric locomotives start a heavy train on grade, the surge tank supplies water to the turbine as a storage reservoir, until the water in the penstock is accelerated to the proper speed. In case the heavy load of 4,000 to 8,000 horse power is suddenly thrown off and the turbine gates closed, the great amount of water in the penstocks travelling at a speed of 8.2 feet per second surges into the tank and finds relief by overflowing into the waste pipe for a minute or so.

THE EXPLOITATION OF OUR PEAT BOGS

(Continued from page 128).

ports received by us regarding two very promising processes employing artificial heat in the production of peat fuel, are very disappointing; namely, the process of the Electropeat Syndicate, with head office at Newcastle-on-Tyne, England, and the somewhat famous Ekenberg process.

The Electropeat Syndicate erected an extensive plant at Kilberg in the County of Kildare, Ireland, for the production