When the wheelpit for first installation of 50,000-h.p. was about two-thirds excavated, the tunnel excavation had been completed to the wheelpit, and in order to expedite the completion of the plant the writer urged that the general design should be changed, substituting two branch tunnels, turbines resting on the solid bottom, lower penstock elbows ditto, and draft tubes leading from the wheel cases to the branch tunnels, which would admit of tunnel excavation being pushed forward, and wheelpit excavation being completed four months sooner than would be the case if the lower part of the wheelpit was to constitute the beginning of the tail race.

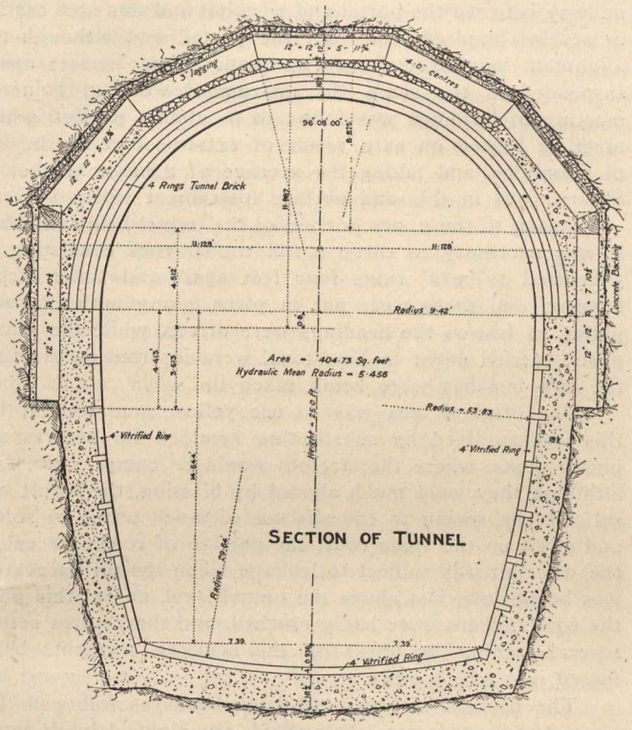

Fig. 4.

The merits of this method had already been suggested by Escher, Wyss & Co., the simplifying of the lower penstock elbow and greater solidity of the turbine unit when in operation being evident, and, in passing, it is interesting to note that the Toronto and Niagara Power Co. has adopted this identical design for the plant they are now building. However, the view of the consulting hydraulic engineer was against the change and in order to hasten the completion of the wheelpit excavation which, on the lower levels, is very much cut up by various checks and recesses, it was decided to carry forward the tunnel excavation immediately underneath, and bring down the wheelpit excavation on the tunnel roof.

This process was fairly successful until about two-thirds completed, when the blasting from above and below had so weakened and opened up the remaining shale that wheelpit water commenced to leak into the tunnel, throwing excessive loads on the tunnel roof, and necessitating increased timbering at this place, until finally tunnelling operations had to be abandoned, and the remainder of the pit excavated in open cutting as originally intended.

The after effects of this effort to hasten operations were that the sides of the wheelpit, where excavated by tunnelling, were badly shattered, and before the brick lining could be placed large masses of shale broke away, so that as the brick lining was being put in it was necessary not only to fill up these enormous cavities with concrete, but the walls had to be continually watched and scaled down for fear of accidents.

As soon as excavation was well forward it was decided to take measurements for anticipated movement of the rock walls, and the following table will serve to illustrate what actually took place, it being understood that excavation was being carried forward continuously from March, 1902, to June, 1903, and that the measurements given are only a few of those taken.

Table of Wheelpit Squeeze.

Measurements taken between steel plugs at centre of a pit 275 feet long, and at a point 15 feet below rock surface.

Date.	Total width.	Depth of pit at time of measurement.
July 8, 1902.	20′ 11 1-2″	35 ft.
Aug. 23, 1902.	20′ 11 1-16″	50 ft.
Sept. 10, 1902.	20′ 10 15-16″	55 ft.
Oct. 13, 1902.	20′ 10 13-16″	65 ft.
Nov. 13, 1902.	20′ 10 13-16″	75 ft.
Dec, 18, 1902.	20′ 10 13-16″	85 ft.
March 6, 1903.	20′ 10 13-16″	100 ft.
April 7, 1903.	20′ 10 12-16″	110 ft.
May 8, 1903.	20′ 10 25-32″	125 ft.
Oct. 15, 1903.	20′ 10 7-16″	full depth.

Giving a total of 1 1-16 inches, although at lower levels a movement of 1½ inches was observed between November, 1902, and October, 1903.

Not the least curious feature of these movements was the fact that the east side next the river moved about twice as much as the west side adjacent to higher ground. But the most noticeable fact of the table is that the movements, which had practically ceased by March, 1903, had again become serious by October, 1903, and this had been caused by the excavation of the wheelpit extension 300 feet further, freeing one end of the rock walls. This is further shown by measurements on thrust girder castings of west wall, which had been set in September and October, 1902. It will

Table of Wheelpit Squeeze.

Total movements of west wall at thrust girder level.

Date.	Unit 1.	Unit 2.	Unit 3.	Unit 4.	Unit 5.
Dec. 18, 1902.	— 1-16″	1-4″	7-16″	7-16″	15-32″
Jan. 27, 1903.	— 1-16″	7-32″	11-32″	7-16″	15-32″
Mar. 6, 1903.	— 1-16″	3-16″	7-16″	11-32″	9-16″
Feb. 13, 1904.	+ 1-8″	1-32″	5-8″	1 1-8″	1″

be seen that the movements had practically ceased in March, 1903, but again commenced as soon as the excavations of the extension to pit were carried down for some depth.

The first generator arch built was at unit No. 4, and during the summer of 1904 it became evident that it was being severely squeezed, and even after several heavy arches had been built, the masonry lining walls of wheelpit at the level of the springing of the arches showed slight movements. It was therefore decided to put in a few heavy cast iron struts across the pit at units No. 4 and No. 5, thrusting against cast iron strut bases, which had been provided in over 20 places in anticipation of trouble.

Four struts at unit No. 5 and two struts at unit No. 4, each of about 250 tons safe capacity, seem to have completely stopped the squeezing movement.

Table of Wheelpit Squeeze.

At unit No. 3 after struts had been placed at various levels at units No. 4 and No. 5.

Date.	Thrust Deck.	Turbine Deck.
Nov. 14, 1904.	18,882 ft.	16,451 ft.
Nov. 23, 1904.	18,881 ft.	16,447 ft.
Nov. 28, 1904.	18,884 ft.	
Dec. 6, 1904.	18,882 ft.	16,450 ft.
Dec. 13, 1904.	18,884 ft.	16,446 ft.
Dec. 21, 1904.	18,884 ft.	16,445 ft.
Jan. 2, 1905.	18,883 ft.	16,442 ft.

The lining of the wheelpit, which consists of 24 inches of solid shale brick from invert up to rack deck, and 12 inches of solid shale brick backed by 4 inches of hollow brick thence to top, is anchored to the rock walls by anchor bolts with wedges and having large plate washers embedded