

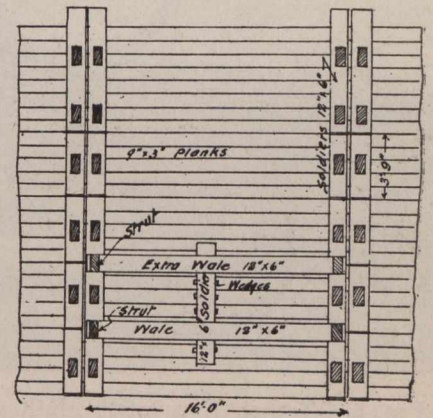
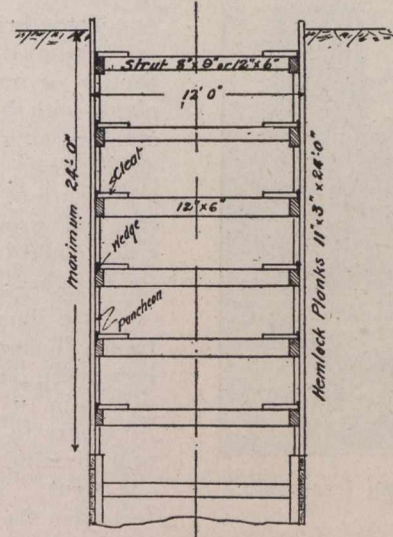
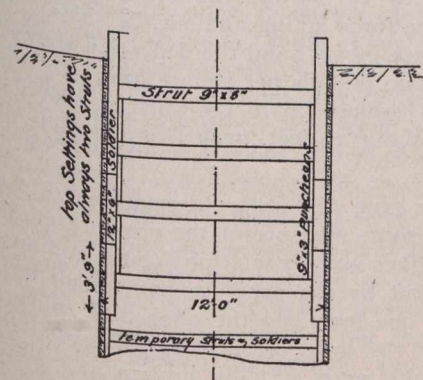
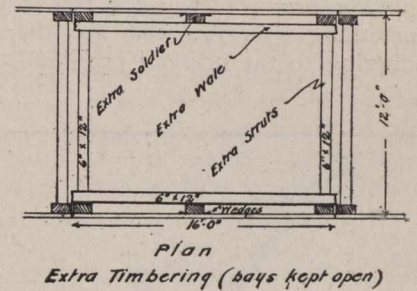
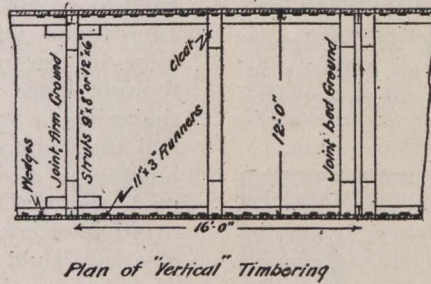
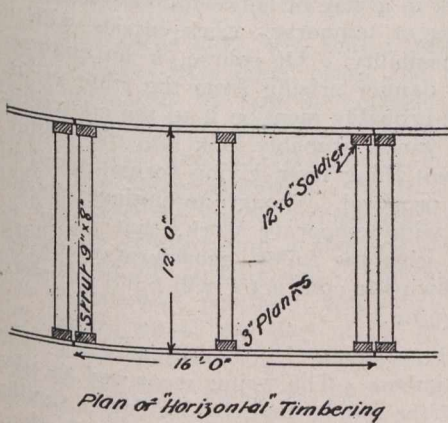
Then the permanent soldiers and struts were put in place. These squared timbers were all of pitch pine and the sheeting of hemlock. There are two points about this system of timbering which are objectionable: (1) It has no strength in tension vertically; when finished it is simply a series of planks laid one on the top of the other and, except for the spikes in the puncheons, has no vertical cohesion. (2) It is necessary to expose an area of the side of the trench equal to each plank at least before placing the plank in position. One advantage it has over the vertical system is that it is not necessary to step in with each new set of runners or piles and so the side of a trench can be maintained vertical to any depth.

Whenever bad ground was opened up the contractors urged the engineer to permit the use of vertical runners

zontal timbering was abandoned in favor of a second setting of vertical timbers though this reduced the width of the trench.

From one cause and another much of this trench stood open for about two years with the result that the ground settled very heavily against the timbers. In many cases the soldiers, though 6 inches thick and only 3 feet 9 inches long, were badly bent and a few were actually broken. At depths of 20 to 40 feet in running sand every horizontal plank was broken in places for many bays in succession and alternate bays had to be closed with new struts and soldiers in the centre while the bays left open for hoisting were dealt with as shown in Fig. 5.

As experience proved, the bays were too long for 3-inch planks in this ground. It is a point to be borne in



Cross Section of Horizontal Timbering
Fig. 3.

Cross Section of Vertical Timbering
Fig. 4.

Elevation of Extra Timbering
Fig. 5.

and finally the engineer consented to the use of vertical timbering for the first setting, as shown in Fig. 4. To take the greatest possible advantage of this permission to depart from the specification, very long runners were used, the planks being 11 in. x 3 in. x 24 feet long in some cases.

As the excavation was being hoisted by three-ton travelling cranes with 18-foot jibs, a difficulty arose in pitching these long planks on the side of the trench next to the crane; but this was easily overcome by starting short temporary runners in the dry sand of the top six feet and, after a certain amount of trench was out, replacing them, one at a time, with the long permanent planks.

The type illustrated in Fig. 4 was adopted for several thousand feet of trench though not all of the runners were 24 feet long, the majority being 17 feet long. The running sand was hard to deal with and in places the hori-

zontal timbering was abandoned in favor of a second setting of vertical timbers though this reduced the width of the trench. The limit of a bay is the strength of a plank, while with vertical timbering, though the bays may be fixed, the spacing of the walings may be altered to suit circumstances.

There was no difficulty in excavating the trench where runners were used or was there much trouble experienced drawing them where the trench was filled with clay. In one section of the trench the ground settled all on one side with the result that some of the struts were nearly two feet out of level but no accident occurred owing to constant care in placing raking struts as the weight came on.

It was specified that all timber was to be removed from the trench as it was filled. Having attempted to remove some of the horizontal timbering in running sand, as the concrete was being placed, without much success,