bridge until the new was completed, consequently, it was necessary to take precautions against impairing the strength of the old piers by the operations in connection with building the new. These precautions consisted principally in substantially shoring the old spans with the idea that if the old piers were undermined or damaged the shoring would support the entire load. This shoring was done preliminary to active operations in the new foundations. Each old span was supported by frame bents supported by piles, one bent under each end of the span. Changes in the point of support in the old spans required rebracing of the trusses. Fig. 2 shows one of these bents.

Bear River is navigable, and the old bridge has a swing span which was kept in commission as long as possible and then shored. Navigation was provided for by cutting through one of the old fixed spans—giving a

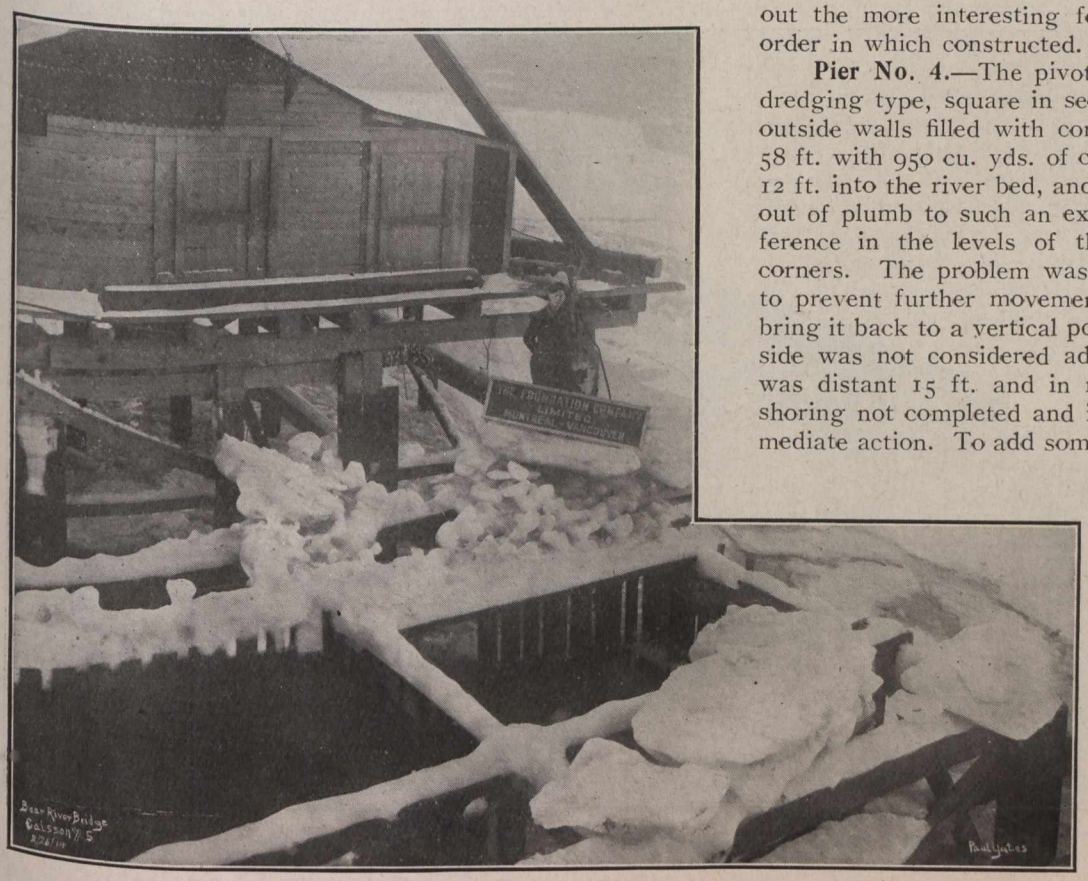

Fig. 1.—An Illustration of Ice Conditions During the Sinking of Caisson No. 5.

38-ft. opening. The railway traffic crossed this opening on a temporary lift bridge, hinged at one end and lifted by a derrick at the other end.

Shoring consumed 400 65-ft. piles and 200,000 B.M. yellow pine timber. As the shoring was completed the work proceeded on the new piers.

To summarize, in the fall of 1913 the five channel piers were yet to be completed. Pier No. 3 had been built to a height of 63 ft. and sunk until its top was a foot or two above water at extreme low tides. Pier No. 4 had been built up 58 ft. and sunk until its top was 12 ft. out of water at extreme low tide. Pier No. 5 had been built up 62 ft. and sunk until the top was about 8 ft. out of water at extreme low tide. Pier No. 6—the caissons had been started but not launched. Pier No. 7—no work had been done at the site of this pier. The general plan of operation was to first straighten the three caissons already in place, Nos. 3, 4 and 5, and then sink to a suitable bearing. While this work was in progress to build caissons for piers 6 and 7 and so scheduling the various operations as to keep the various gangs efficiently employed.

At piers 3, 4 and 5 depths of water and material to sink through were quite similar. Depth of water at low tide varies from 35 ft. at pier No. 3 to 30 ft. at pier No. 5; the main channel being between these piers. Borings indicated silt from river bottom down 25 ft.; below the silt a compact sand and gravel. It was assumed that if the sand and gravel proved satisfactory the caissons would be founded on it. Borings at piers 6 and 7 indicated mud from river bottom down 50 ft., then sand and gravel. It was decided to sink the caissons 18 to 20 ft. into the stiff mud, then drive piles to a firm bearing.

As the construction problems differ, a brief description of the construction of each pier is necessary to bring out the more interesting features. Piers will take the order in which constructed.

Pier No. 4.—The pivot pier caisson was the open dredging type, square in section, 33 ft on a side, double outside walls filled with concrete. It had been built up 58 ft. with 950 cu. yds. of concrete in the walls and sunk 12 ft. into the river bed, and in the sinking process, came out of plumb to such an extent that there was 8 ft. difference in the levels of the southwest and northeast corners. The problem was to at once take precautions to prevent further movement out of plumb and then to bring it back to a vertical position. Dredging on the outside was not considered advisable as the old pivot pier was distant 15 ft. and in none too good condition and shoring not completed and it was imperative to take immediate action. To add some resistance to the settlement, a row of piles were driven 40 ft. from pier No. 4 and a substantial shoring frame built up of 10 x 10 timbers, which, when complete, were floated into position, one end being properly weighted and sunk so as to bear against the row of piles. An even bearing on the piles was made by divers blocking up to the sill of the shoring frame. The unweighted upper end of the bent was placed in position and wedged against the caisson. Provision was made so that jacks could also be placed to assist wedging. A cable sling was placed around the top of pier No. 4 and two 1¼-in. cables run to shore, a distance of 500 ft. These cables were strained by a hoisting engine winding up the cable reeved through a pair of double-sheaved steel shell blocks. Wedges, jacks and the pull on the cable was now tending to hold the caisson from further movement. High-pressure water jets were then operated by divers with the object of removing the material under the high side. This started the caisson, and by carefully conducted dredging operations with a clam-shell bucket, the caisson was gradually brought to a vertical position. All soft ground was removed from the interior of the caisson and concrete deposited through the water by means of a special type of bucket. The concrete was brought up to the elevation of the bottom of the shaft and allowed to set and the shaft form placed in position. This