thick, in shallow water, on rock bottom so level that the cribs were sunk with their lower course of timbers hewed to fit the smooth surface, as shown in the elevation of the south anchor pier. The north anchor pier is taller the has a different type of crib, which was wurk through a sawdust deposit. The stone masonry of all the channel piers corresponds to that in pier 4. Pier 1 was built without any crib, the masonry being laid at low Water directly on the blasted rock bottom. Piers 2 & 3 were built in much deeper water, their concrete footings were constructed inside of very tall cribs which were sunk by dredging through 20 or 30 ft. of sawdust, water-logged timber & other material difficult to remove. In some places between the piers this deposit was 60 ft. thick, but the piers were located so as to penetrate it in the thinnest places. The crib for pier 4 was essentially like that for pier 2 which is shown in plan & cross section. Its walls were solid courses of green 12x12-in. hemlock timber slightly battered up-stream & on the long sides & braced by 4 cross-beams tied into both sides at every 4th course. These side pieces were dovetailed between adjacent wall courses & projected about 3 ft. beyond them on each side to receive the planking of pockets which were filled with stone ballast to sink the crib. The 8 lower courses were each successively offset 4 ins. so as to extend the base of the crib to 29x40 ft., exclusive of the ^{cutwater.}

The lower part of the crib was built on shore. After it was launched vertical 3x12-in.



ANCHOR PIER.

plank were spiked on outside, projecting below the lower course to conform to the profile of the bottom previously obtained by soundings. The crib was floating with the lower 4 courses submerged when the vertical sheathing was spiked on, covering the sides to the 6th Course. In order to work at the sheathing, a raft was built inside the crib & the edge of the latter was pried up from it with long levers so as to cant the crib over far enough to allow the spiking to be done above the surface of the water. Cribs 2 & 3 were located by the intersection of the bridge axis with transit lens from a fixed point on one shore to different points on the opposite shore.

For sinking the cribs 2 special scows were provided, 80 ft long, 20 ft. wide, 5½ ft. deep, & curved at each end. The bottom & deck verse planks extending across its full width & spiked to the top & bottom chords by 4 longitudinal intermediate trusses. The sides were made of heavy planed timber, butt jointed & spliced to inside vertical posts with 'cover splices and the joints of the top & bottom

courses. The longitudinal trusses were intersected by 3 solid transverse partitions or bulkheads, which divided the scow into 4 watertight compartments & contributed to its stiff-The scows were placed parallel to ness. each other & connected by 2 queen-post combination trusses about 10 ft. deep & 50 ft. long, which were bolted firmly across their decks so as to leave a rectangular 30x60 ft. well between them & the scows, in which the crib was suspended by four 2-in. screw rods, by which its descent was regulated. The scows were anchored in a 3-mile current, to the adjacent piers, when these were available, & by Chinese anchors, & the cribs were also anchored by up & downstream diverging lines, which were also attached to Chinese anchors.

As the cribs were lowered, their ballast pockets were filled with broken stone, shovelled in from the decks of the scows, & their sides were built up with additional timber courses until they were landed on the bottom. Slabs as much as 30 ft. long were found bedded in the sawdust, & it was excavated slowdownward & allowed the concrete to remain on the bottom when the bucket was hoisted. Over 100 bucketfuls were deposited in water 70 ft. deep in one day of 10 hours. At first the concrete mixer was set on the deck of the scow at pier 2, but after about 1,000 yards had been deposited, filling the crib to a depth of about 25 ft., the work on it was stopped by the Dominion Government in Oct., 1898, on account of fear caused by the collapse of the concrete pier of the Cornwall bridge. It was not resumed until April, 1899, when the mixing machine was set up on shore & the concrete mixed with heated sand & water & taken in sleighs across the ice to the crib.

The contractors were also directed to warm the interior of the crib, which was filled with water circulating freely from the river. They accordingly established a to-h.p. boiler on the deck of the scow & discharged live steam from it into the water. The crib was filled with concrete up to 18 ins. of low-water mark ; a tight coffer dam was then built on top of it, pumped out, & the stone masonry laid in it. After the concreting was completed, the Gov-



CRIB FOR PIER 2.

ly & with difficulty by a $1\frac{1}{2}$ -yard clam-shell dredge bucket, which removed about 150 yds. a day. The material was so stiff that the sides of the excavation stood vertical & the portions which were raised to the surface were tough coherent masses. Planks were laid across the tops of the cribs, & they were loaded with rails & other temporary weights piled on to sink them. At pier 2 the water was 40 ft. deep, & the sawdust was 30 ft. deep, & at pier 3 the sawdust was about 20 ft.

The bottoms of the excavations inside the piers were cleaned by divers, who levelled off the irregularities & guided diamond drills, with which holes 12 ins. deep were made. These were charged with dynamite & the worst irregularities of the rock bottom blasted off. A maximum depth of 72 ft. below lowwater level was thus reached. The crib was filled with $1:1:3\frac{1}{2}$ Portland cement concrete made with $2\frac{1}{2}$ -in. broken stone. The concrete was made in a horizontal mixing machine & deposited by a $1\frac{1}{2}$ -yard bucket with double-flap doors on the bottom, which opened ernment required a test boring to be made through it to bed rock with a diamond drill. A 3-in. bit was drilled down to within a few feet of the bottom, the hole cased, & a 2-in. hole drilled the remainder of the distance. A core was recovered from the whole depth of the hole, which was in every way satisfactory, showing that the concrete was well set though still green. One diamond-drill hole was bored nearly to the bottom of the concrete & a second one was bored entirely through it & into the bed rock. The core was recovered in short pieces less than 12 ins. long & did not, of course, measure up equivalent to the length of the hole, but did give data of the condition of the mass at all depths. About 4 months were required for the drilling of both holes. To test the efficiency of the method of depositing the concrete, a bucket full of it was lowered to the bottom of the crib, then drawn up to the surface, again lowered a little, dumped in a submerged box, & allowed to set there. When it was examined it was strong & sound, with no evidence of washing or deterioration by the movement through the water.