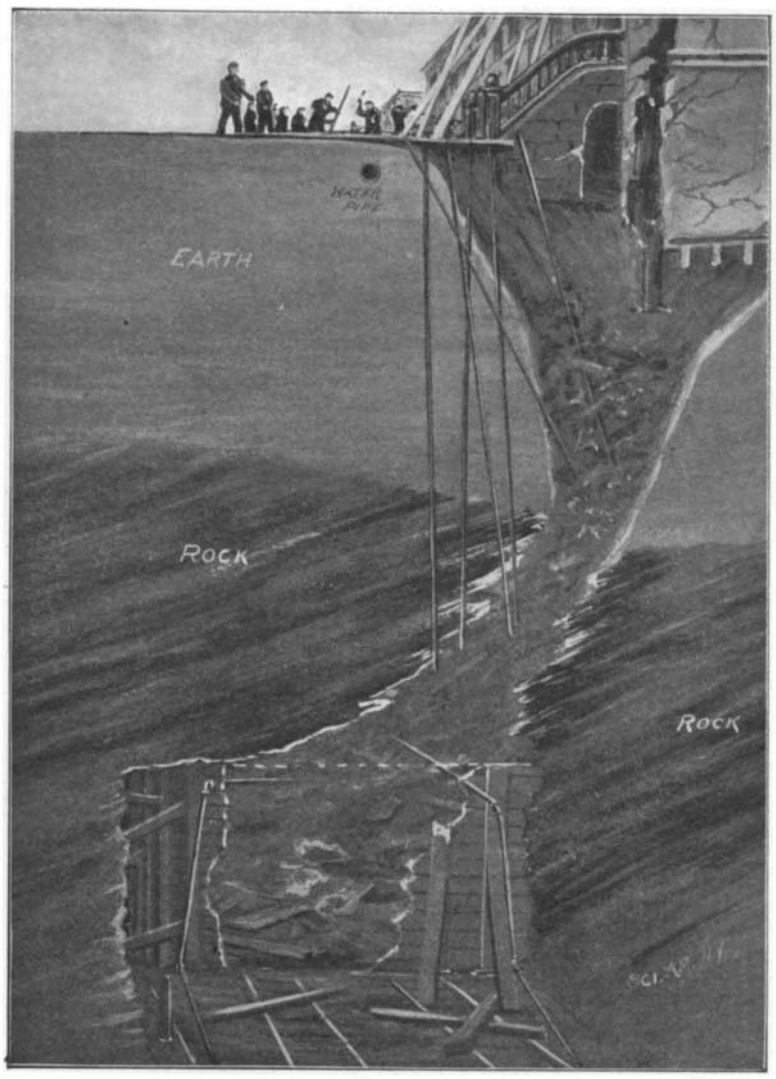
THE PARK AVENUE TUNNEL CAVE-IN.

The preliminary borings which were made along the route of the entire subway during the survey before construction, showed that the tunnel between 34th and 42d Streets would be built through a bed of solid rock. The tunnel has been driven through, both on the east and west side of Park Avenue, for this entire distance of 1,800 feet. In some sections, indeed throughout the greater part of it, the blasting has been done to the full section required. The tunnel as thus roughly blasted out is 30 feet in width, 12 feet in height to the springing of the elliptically-arched roof, and 6 feet from the level of the top of walls to the crown of the roof, making a total height inside of 18 feet. Generally speaking, the tunnel was driven in two headings, the lower heading rectangular in cross section, 12 feet in height by 30 feet in width, and the upper heading 6 feet in height to the crown of the elliptically-curved roof. After the tunnel is blasted out to the dimension given above, the floor, sides, and roof are lined with a heavy wall of concrete, and the space between the wall and the irregular surface of the rock, as left by the blasting, is filled in, rendering any caving in of the rock impossible.

Commencing at 34th Street, on the east side, the first 200 feet of the tunnel has been entirely excavated with the exception of the roof, from which about 4 feet have yet to be blasted off. The next 500 feet have been taken out entirely, the concrete side walls are in place, and for about 80 feet of this distance the roof has been turned in. For the next 300 or 400 feet, from about 37th Street to the middle of the block between 38th and 39th Streets, the bottom heading has been taken out, and in the upper heading a maximum depth of 6 feet has yet to be blasted down. It is in this stretch of work that the slide occurred. In the next 200 feet the upper heading, for a depth of 12 feet from the roof down has been taken out, and about 6 feet remain to be blasted away to bring the tunnel down to the grade. The remaining 500 feet to 42d Street has been entirely blasted out, ready for concreting.

The accompanying illustrations include a profile and cross-section and a plan view of the easterly tunnel, at the point where the cave-in occurred, and show very clearly the causes and nature of the trouble and the means taken to remedy it. The bottom of the tunnel is 60 feet below the street surface. The heading at this point is 12 feet in height by 30 feet in width. The distance from the roof of the heading to the street level is, therefore, 48 feet. In general, the solid rock in which the tunnel lies extends nearly to the surface of Park Avenue; but between 37th and 38th Streets there is a depression or basin in the rock, and its surface lies, as indicated in our drawing, about 28 feet below the surface of the street, or about 20 feet above the roof of the tunnel heading. Above the rock lies a mass of what the engineers call earth, that is to say, a loose material consisting of gravel, sand, clay, etc., of a consistency which can be easily excavated by pick and shovel, and which has no natural cohesion to hold it in place.

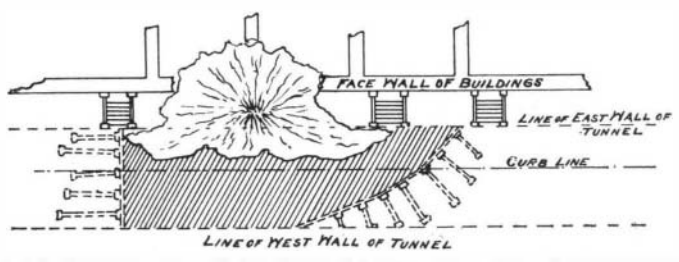
On the Wednesday preceding the day on which the trouble occurred, it was noticed that there were indications of settlement of the rock, and a section of rock measuring about 3 x 6 feet fell through into the tunnel. An examination of the cavity revealed a stratum of decomposed rock, about 4 feet in thickness, which extended diagonally at an angle of about 45 degs. toward the surface. On either side of the rock was a thin layer of greasy decomposed material, somewhat of the nature of soapstone, and the heavy rains and thaws of the winter, aided by a broken water pipe, had thoroughly saturated this material, loosening the 4-foot layer of rock and allowing it to slide bodily into the tunnel. In spite of the endeavors made to stop this sliding by heavy shoring, the timbers were crushed in and a section of the roof 70 feet in length by several feet in width slid into the tunnel. Now, the effect of this section of rock falling in, was, roughly speaking, as though the valve at the bottom of a hopper had been opened, allowing the loose contents above to flow down through the opening thus formed. The loose gravel, sand, earth, etc., poured into the tunnel, forming above the rock layer a crater-like opening of the kind shown in our illustrations. Unfortunately, the foundations of the front wall of the adjoining houses on Park Avenue were resting upon this loose material—a perfectly secure foundation so long as the rock beneath was undisturbed, but, as the event proved, a very unstable one when the rock fell away. The crater extended beneath the foundations of this wall, with the consequence that the areas, front steps, foundation walls and a portion of the brownstone front of the houses affected fell.



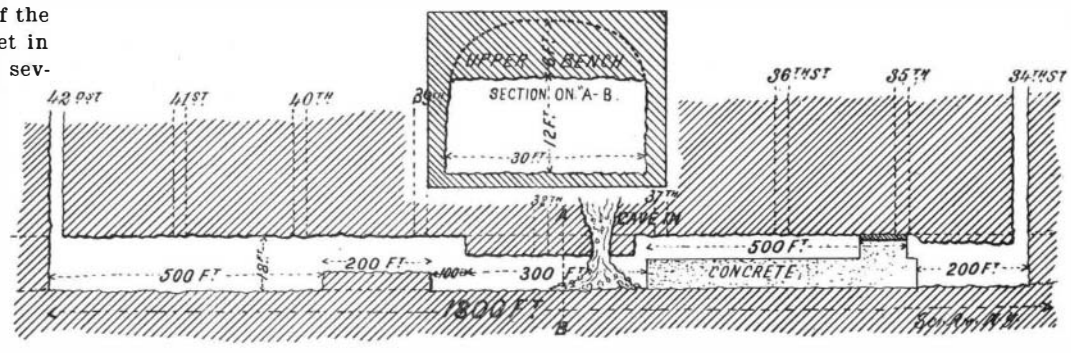
CAVE-IN, SHOWING THE METHOD OF REPAIRS BY BULKHEADING AND GROUTING.

It was first proposed to make an open cut at this point, build a concrete lining for the tunnel, and subsequently filling in above it; but it has now been decided to carry out the repairs in the manner indicated in our sketch, employing a system of grouting which had been used on a previous occasion by Mr. Shaler, the contractor, during repair work in the construction of the new Croton Aqueduct. It is well known to engineers that a mass of loose material (broken rock, gravel, etc.) may be formed into one solid monolith by introducing pipes into it and forcing through them fine "grout," a liquid cement of the proportions of one of sand and one of cement. Driven in under pressure the grout flows throughout the whole mass, filling the interstices, and, in its subsequent solidification, bonding it in one solid monolith.

In applying the principle in the present case, strong bulkheads of timber were built across the tunnel at either end of the slide, and a mass of broken rock and stone was dumped into the crater above; about a dozen pipes were then carried into the interior of the mass, six of them from the surface above and three from the bulkheads at either end, and the grouting driven through them into the material by means of force pumps. No effort is being made to solidify the whole mass of debris in the tunnel, but merely that which lies around the roof in the neighborhood of the break. Similarly, only the material in the lower half of the crater will be thus grouted. When the mass has set, it will be perfectly safe to excavate the tunnel to its full width. The new foundations for the front of the houses that have been injured will be then carried right down to the underlying rock, and, as thus restored, they will be perfectly safe against any further settlement.



PLAN VIEW OF CAVE-IN, SHOWING CRATER AND BULKHEADS.



PROFILE OF THE EASTERLY TUNNEL, SHOWING PRESENT STATE OF THE WORK.

THE NEW BERMUDA FLOATING DOCK.

BY H. J. SHEPSTONE.

The new floating dock recently launched on the Tyne, England, from the works of Messrs. C. S. Swan & Hunter, for the use of the British fleet at Bermuda, claims the distinction of being the longest and heaviest dock so far constructed. It has a length over all of 545 feet, while the hull weight of the structure, by which is meant the quantity of steel plates, bars and shapes, rivets, bolts, etc., and all other material essentially necessary to a dock, but not including machinery, timber or any other fittings, is just over 6,500 tons. The great Algiers dock at New Orleans certainly runs it very close, having a length of 525 feet and a hull weight of 5,850 tons.

The dock is to replace the famous old structure at Bermuda which was towed across the Atlantic in 1869, and has now become obsolete, not through age, but through the insufficiency of its dimensions. The length of the old dock was 381 feet

LAUNCH OF THE NEW BERMUDA DRYDOCK, THE LARGEST OF ITS KIND YET CONSTRUCTED