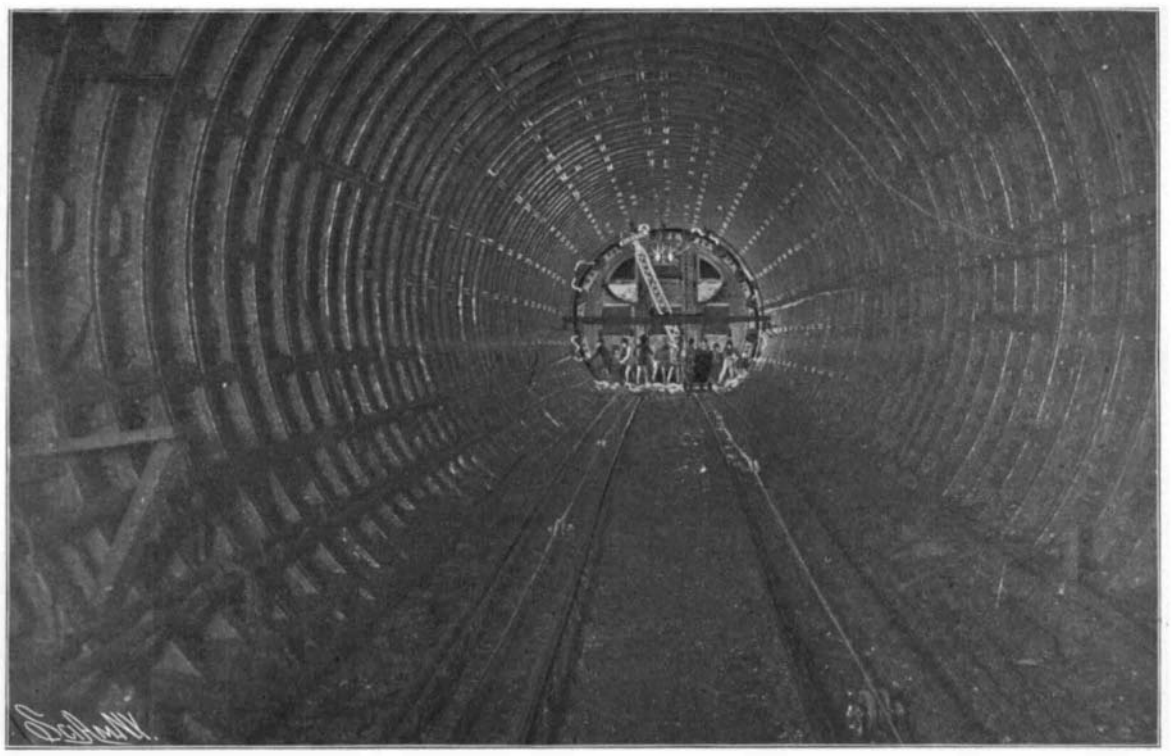
THE HUDSON RIVER TUNNEL.

The work of driving the Hudson River tunnel from Jersey City to Manhattan has progressed so favorably under its present management, that before very long communication beneath the river will be established. The tunnel will provide communication between the trolley systems of New York and Jersey City, and by affording a rapid and continuous service between these cities, will confer a great boon upon the traveling public who hitherto have been restricted to an intermittent ferry service. The original projector of the Hudson River tunnel was Mr. Dewitt Clinton Haskin, one of the active spirits in the building of the Union Pacific Railway, who commenced the construction of the tunnel as far back as 1874. The original plan called for two separate tunnels with a single steam railroad track laid in each. A circular working shaft 30 feet in diameter was dug on Fifteenth Street, Jersey City, 100 feet inside the bulkhead line of the river; it terminated in an enlarged chamber from which the headings of the two parallel tunnels were started on an easy grade toward their deepest level, which lies in the proximity of the Manhattan shore. The New York shaft was sunk near the bulkhead line at the foot of Morton Street, the distance between the two shafts being about 5,400 feet. Mr. Haskin commenced the construction of the tunnel without the use of the customary excavating shield and iron lining, relying upon the compactness of the silt through which the tunnel was driven to prove sufficient, in co-operation with the compressed air, to resist distortion until the 2-foot brick lining of the tunnel could be built in place.

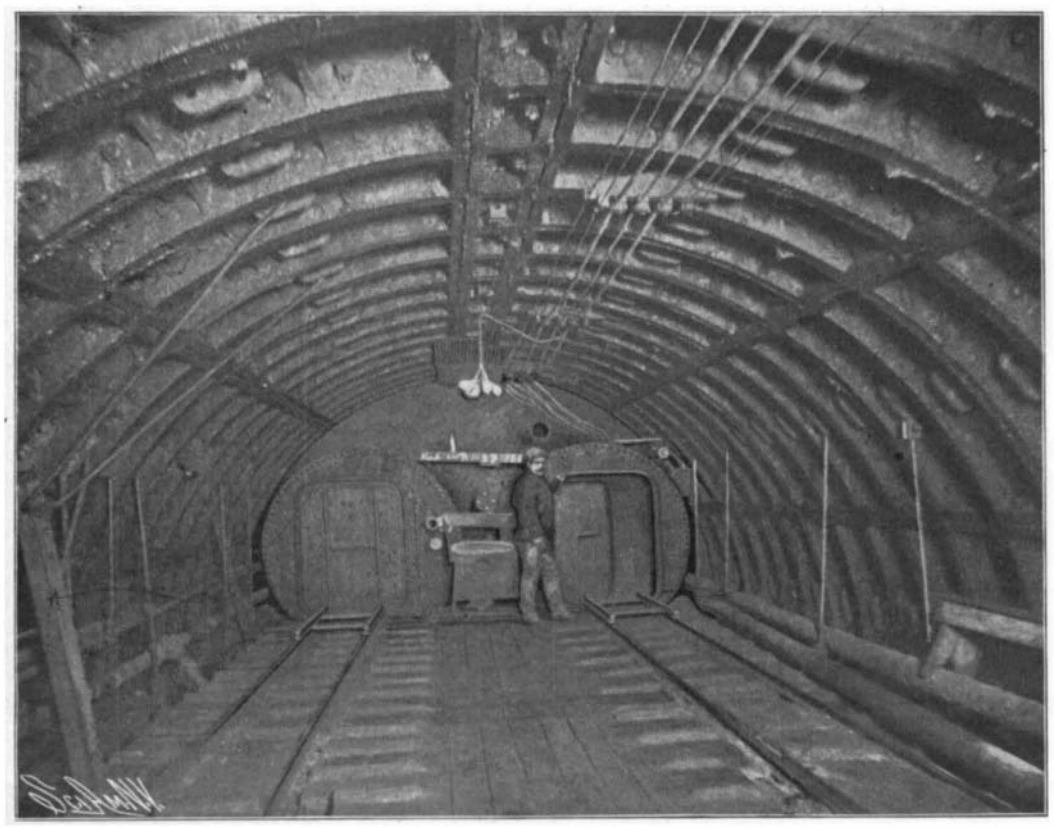


View in Rear of Shield at Heading, Showing Full Diameter of Tunnel (19 Feet 4 Inches).

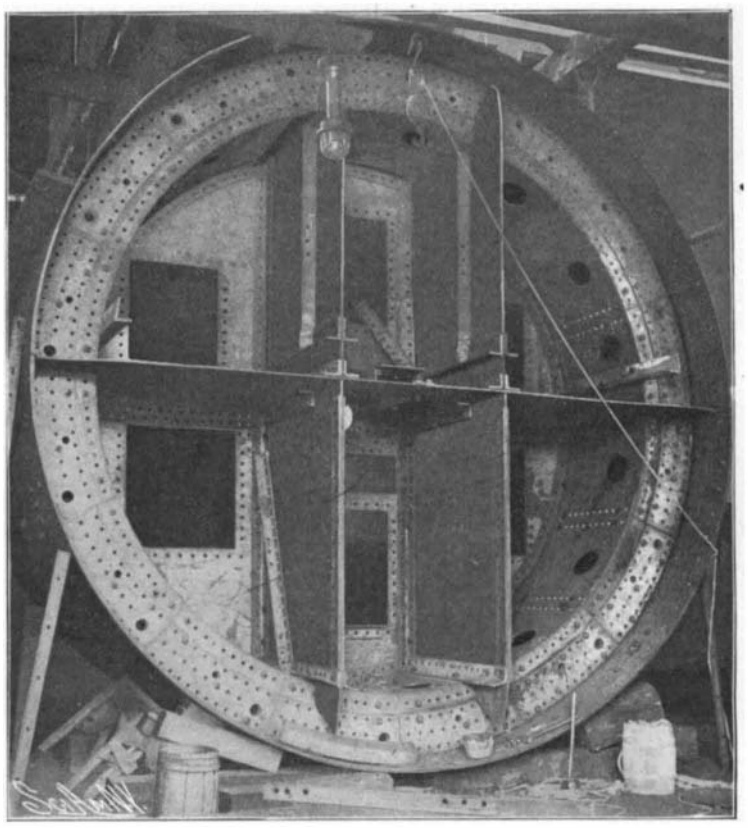
The difficulty of closing air leaks with sufficient alacrity led to the use of a pilot tunnel at the heading. This consisted of a 5-foot iron tube which was carried forward on the line of the axis of the tunnel into the ground ahead. This tube was used as a center from which braces were carried out radially to hold the surrounding wall of the tunnel during construction. On July 21, 1880, a shocking accident occured, due to the shallowness of the overlying silt above the tunnel roof. There was a blow-out which resulted in such a sudden in-rush of water that the air lock became jammed, and twenty of the workmen were caught and perished. The work was carried on with more or less intermission until, with 2,000 feet of the north tunnel completed, the company in 1882 suspended operations. Subsequently, in 1890, an English company was formed with Sir John Fowler and Sir Benjamin Baker as consulting engineers, for the purpose of completing the tunnel; but after carrying the tunnel forward until 3,895 feet was completed, they also abandoned the work. Ultimately the New York and New Jersey Railway Company was incorporated for the purpose of carrying through the great undertaking, and they have prosecuted it with such vigor that the north tunnel will probably be completed in January, 1904.

The tunnel descends from the Jersey side on a grade of about two per cent, and at a depth below the river bottom which varies from 5 feet to over 60 feet. The shaft already referred to at the western end of the tunnel is 30 feet in diameter and 65 feet in depth. It is brick-lined and opens into the power house in which the new operating plant has been installed. The external diameter of the northern tunnel is 19 feet 5¼ inches and its internal diameter 18 feet 1¼ inches. The southern tunnel, which is being built of a diameter to accommodate the trolley cars which it is now intended to run through the tunnels, is 15 feet 3 inches in internal diameter, and 16 feet 7 inches in external diameter.

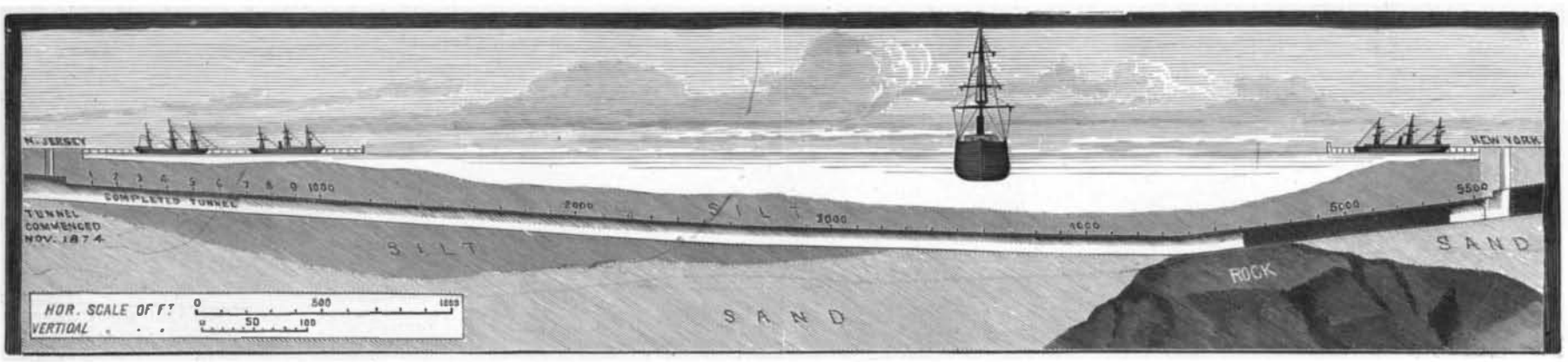
Both tunnels are being built by the Greathead shield system and lined with a cast-iron shell which is made in segments provided with internal flanges by which the shell is bolted in place. It is interesting here to recall the fact that the first use of the system of tunneling now known as the Greathead system ever made in this country occurred in the construction of a short section of the projected Broadway underground railway in this city, when the method designed by the late Alfred E. Beach, one of the editors and proprietors of this journal, was successfully used.



View of Twin Air-lock in Tunnel, Showing Shifting Rails for Entering Lock Chamber.



Front View of New Shield for South Tunnel.



Profile of the Hudson River Tunnel, Showing by Black Shading the Portions Yet to be Excavated.

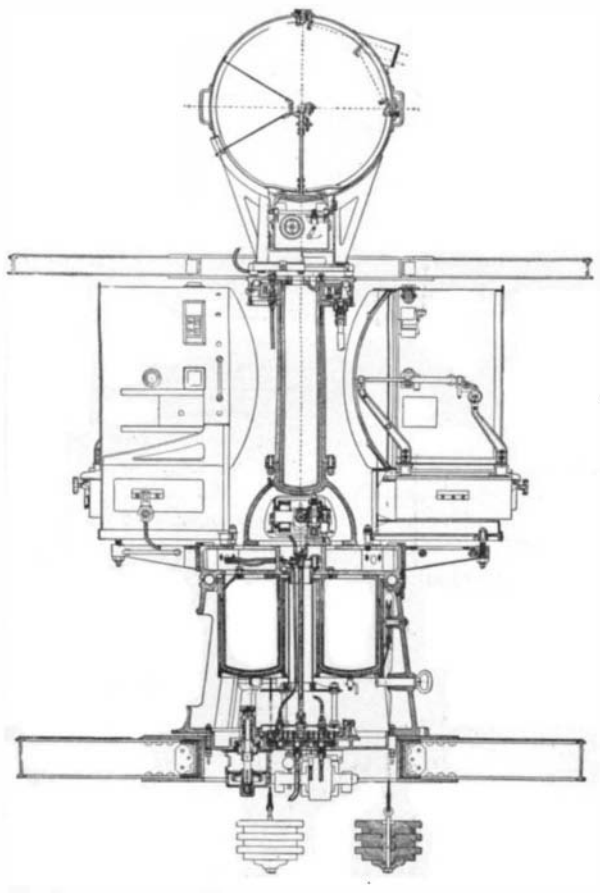
THE HUDSON RIVER TUNNEL.

After the English company abandoned the construction of the northern tunnel in 1891, it was allowed to fill with water. When the work was taken in hand by the present company the tunnel was pumped out, and it was found that with the exception of some 470 feet, the work already done was in good condition. This was in the latter part of 1896, and from that time until 1902, when orders were given to proceed with construction, the tunnel was regularly pumped out and maintained in good condition. A new building was erected at the Jersey shaft, equipped with a very complete power plant, including hydraulic pumps and air compressors, etc. The shield which was used by the English company was overhauled and is being used in completing the north tunnel. It was designed for use only in silt, and as the tunnel has now reached a point where rock and boulders are encountered in the lower half of the excavation, it has been found necessary to build a heavy apron, extending 6 feet in advance of the upper half of the cutting edge of the shield, and reaching from side to side of the shield. This apron is built of 12-inch I-beams and ¾-inch steel plates, and it is strongly braced. Under the shelter of this apron, which is heavily shored up, the workmen are able to pass forward of the shield and drill and blast out the rock below it. This work is unique in horizontal shield excavation, and so far it has been carried forward with complete success.

The method of operating the hydraulic shield is so well known as to need no detailed description here. It is forced forward into the silt by means of hydraulic rams which are set up between the front edge of the completed iron lining of the tunnel and the rear edge of the shield. As it moves forward, the silt is squeezed through open inlets into the interior of the shield, where it is broken off, loaded into trucks, and drawn away from the heading by a cable. The finished tunnel is divided into three lengths by two air locks, one of which is shown in our accompanying engraving. It should be explained that the lower half of the tunnel, at the point where our picture is taken, was filled with excavated material from the heading, on which the two tracks are laid. Ultimately this material will be taken out and the full diameter of the tunnel exposed. In our engraving the two trolley tracks are clearly shown, together with the doors by which the cars pass through the air-tight diaphragm. Another of our engravings was made from a photograph taken in the rear of the shield at the present heading. In this case the material has been entirely removed, showing the full diameter. The two tracks shown are merely narrow-gage working tracks for the contractors. Ultimately, of course, a single track will be laid for the operation of trolley cars. The cable-hauling system is built in three sections, separated by the two air-locks. The first of these, which is 1,575 feet in length, extends from the Jersey shaft to the first air-lock; the second, 1,660 feet long, extends from the first to the second air-lock, while the third section reaches from the second air-lock to the working face. The cables are driven at a speed of 300 feet a minute and are capable of handling 300 tons of excavated material in every ten hours. One of our engravings represents a profile taken across the North River in the plan of the north tunnel. The completed portion of the tunnel is shown by light shading, while the darker shading shows the amount, about 800 feet, that has yet to be excavated.

TRUNKS AND LIMBS OF TREES GNAWED BY BEAVERS.

On the south tunnel new air-locks have been installed, the necessary machinery is being built, and it is probable that the actual construction of the tunnel will be taken up again in the fall of the present year. The shield for this work, which was designed by Jacobs & Davies, engineers of the company, is shown in the accompanying engraving. It will be seen that it is divided by one horizontal and two vertical frames and by transverse diaphragms. The shell is double and the whole construction is calculated to give great stiffness and resistance to distortion. It is provided in front with a movable working platform which, if necessary, may be carried forward of the cutting edge. In the rear it is provided with the necessary hydraulic jacks, valves, etc., for carrying forward the shield and for swinging the erector—a massive arm which moves something like the hands of a clock, and is used for picking up the cast-iron plates and placing them in position ready for bolting up. It is interesting to know that in spite of the difficult nature of the material through which the tunnel is now being driven, there being rock below and soft silt in the upper half of the tunnel, progress is being made at the rate of between 4 and 5 feet a day. The work is rendered particularly hazardous by the fact that there is a hydraulic head due to 65 feet of water, and that there is only 10 feet of soft silt between this hydraulic pressure and the roof of the tunnel. The successful financing of the company was completed through the efforts of Mr. William G. McAdoo, the president, associated with a few trolley capitalists, and to him we are indebted for the facts given.



SECTIONAL VIEW OF HELIGOLAND LIGHTHOUSE PROJECTORS.

MODERN SEARCHLIGHTS.

BY FRANK C. PERKINS.

(*Continued from first page.*)

carried to an extreme. Undoubtedly one-tenth of a second is sufficient to make the maximum impression on the eye, when the light is brilliant. But with a hazy atmosphere, and the light much diminished, it is doubtful whether a longer duration should not be allowed. The experiment will be watched with great interest, both on account of the bold deviation from the ordinary plan which has been so long followed, and also on the ground of economy, which is claimed for the new method. It is stated that on the first night of trial the light was seen at the pier at Büsum, a distance of 40 miles, which in itself seems sufficient to clear away all doubts of the visibility of a flash of short duration.

The front-page illustration shows a Schuckert searchlight with an Iris shutter, half closed, which has a diameter of 6 feet 6 inches and throws a beam of light of 316 million candle power. This search light is electrically controlled by two levers, one of which controls the motor mounted in the base of the searchlight which operates the projector in a vertical direction through a train of gears, and the other starts or stops the electric motor which controls the horizontal movement of the beam of light. The Iris shutter is used in order to make the projector perfectly light-tight at any moment desired, and it operates similarly to this type of shutter as applied to modern cameras. The leaves of the Iris diaphragm slide within a fixed diaphragm located in the axis of the ray of light and provided with a fold. On some of the German searchlights an apparatus known as a "double disperser" is provided, in order to convert concentrated light rapidly into diffused light. This arrangement consists of two parallel systems of cylindrical lenses, which may be slid against one another, whereby the angle of dispersion of the emitted ray can be varied at will. By means of this apparatus the angle of dispersion of the light can be varied within limits of from 2 degrees to 45 degrees if desired.

THE BEAVER AS A DAM-BUILDER.

A remarkable beaver dam has lately been discovered near Stroudsburg, Pa. The work of the animals is so extensive that it seems almost incredible they could have built the dam in question, but this is proved by the evidence of residents of the vicinity, who are strictly reliable.

The dam in question was discovered about two years ago, by a farmer living near its site. It is located in a swamp, which for many years had been drained of its surface water, except in a few spots. Noting that most of the swamp was under water, although but little rainfall had occurred, the curiosity of the farmer was aroused, and he made an investigation which led to the discovery. The dam has been constructed around the northern edge of the swamp, extending in a zigzag course, evidently to avoid obstruction, and to increase its strength. It is about 125 feet in length, and the top is wide enough for a man to walk upon, without difficulty, ranging from a foot to two feet in width. At present the top is about three inches above the surface of the pond which has been created by the dam, the water being from two to four feet deep.

The farmer who made the discovery at first thought that the work had been done by boys for sport, but noticing the footprints of animals upon the top of the structure, he followed these, and found some pieces of wood, which apparently bore the marks of an animal's teeth. The wood was taken to a naturalist who resided in the vicinity, and after careful examination the latter pronounced the marks to be from beaver

PROJECTORS OF THE HELIGOLAND LIGHTHOUSE.