THE BEACH HYDRAULIC SHIELD.

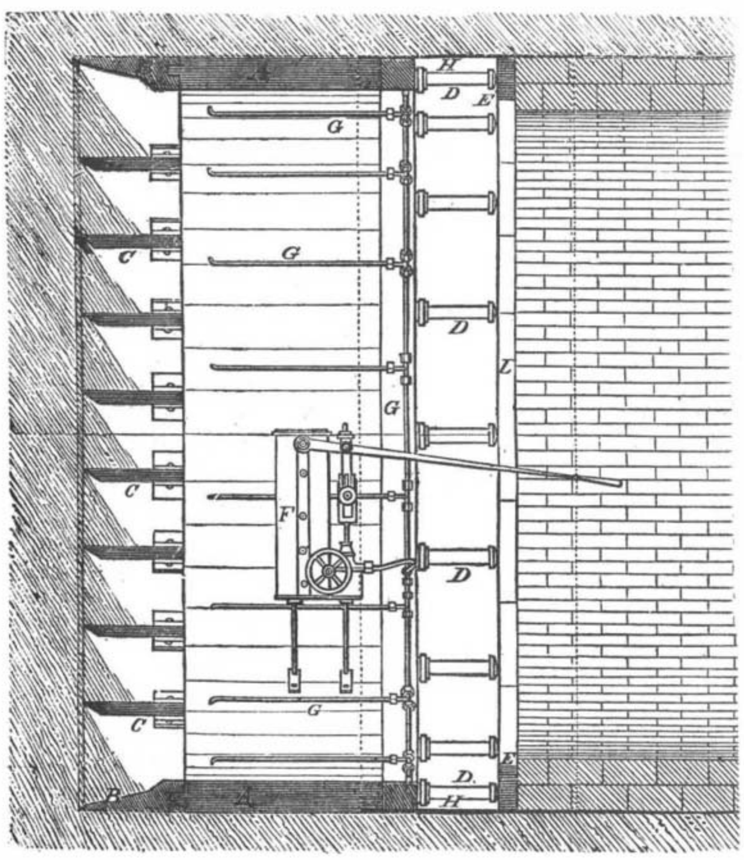
One of the peculiarities in the field of invention is the fact, that has often been mentioned in these columns, of different minds, perhaps in different parts of the world, being engaged at the same time in solving the same problem and arriving simultaneously at the same solution. One of the most peculiar instances of this description is to be found in the case of the Beach shield for tunnel construction. In a recent issue of London Engineer we find the following paragraph :

"In 1869 the Tower subway was constructed by Mr. Peter Barlow and Mr. J. H. Greathead. It is interesting as being the first tunnel in which a shield shoved forward as one structure was used, and for the construction of which cast iron was adopted. The external diameter of the cast iron rings was 7 feet 1¾ inches; the tunnel was driven through the London clay for its whole length, no water had to be dealt with and no difficulties were encountered."

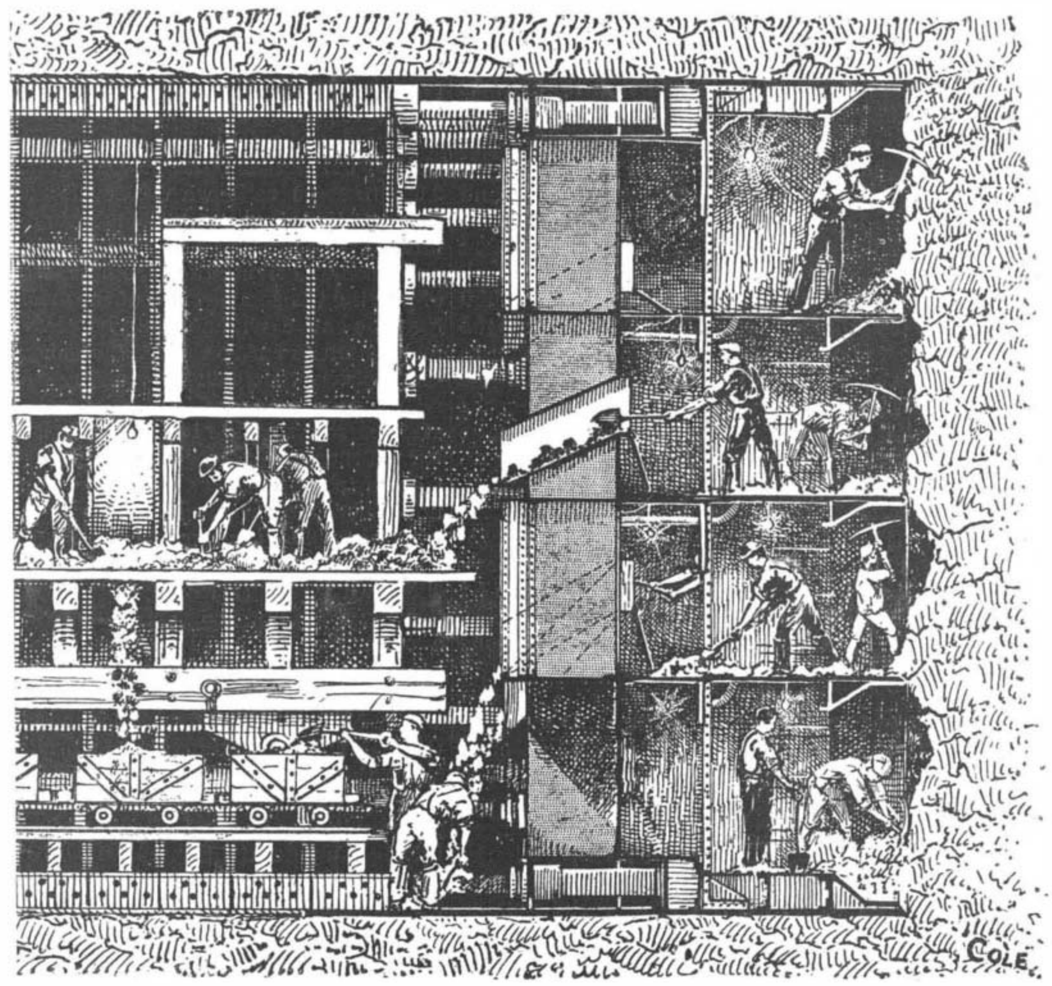
We understand from a perusal of Mr. Barlow's patent that the power employed in the operation of the shield was the jackscrew system. It was also on this line that Mr. Beach's first experiments were made, and when the developments of his ideas as regards the pneumatic system for mail delivery and passenger service had reached an acute stage, it was in this direction that his first experimentation took place. He first conceived of the idea of the shield and the use of screw jacks for propulsive power in 1865, but it was not until 1868 that a model was completed for testing the practicability of his system as applied to actual work.

This experimental device was constructed with the idea of operating the same for excavating the small tunnel for pneumatic postal and parcel delivery, and it was put in operation during the year stated. Its operation seemed to be so satisfactory that Mr. Beach decided to apply for a patent on the device, which was issued on June 8, 1869. It was filed December 29, 1868.

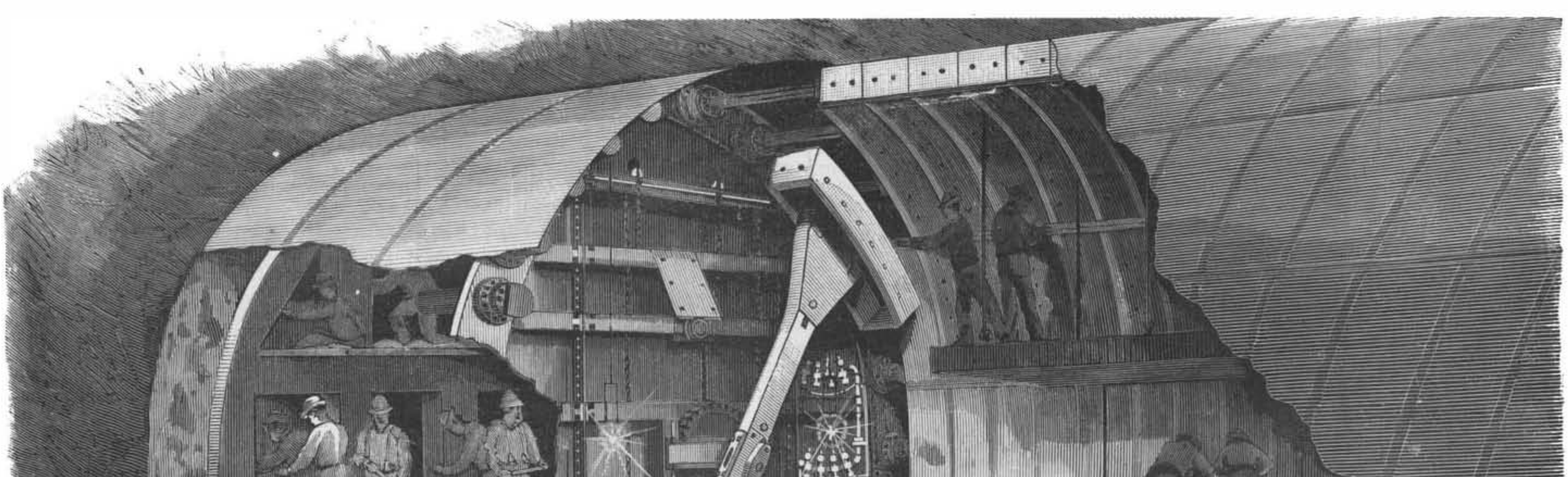
In the meantime the franchise for the construction of an underground railroad under Broadway had been granted by the Legislature of the State of New York, and plans were at once made for the construction of a nine-foot tunnel under that thoroughfare. The necessity for a larger and more efficient system of conducting the work resulted in the construction of a new shield, which was on an advanced and improved system. This measured nine feet two inches in diameter. The use of the antiquated jack screws was abandoned, hydraulic power being substituted as a means for enabling the shield to eat its way into the compact sub-



BEACH SHIELD USED IN THE BROADWAY TUNNEL IN 1869.



HYDRAULIC SHIELD NOW IN USE IN THE BLACKWALL TUNNEL, LONDON.



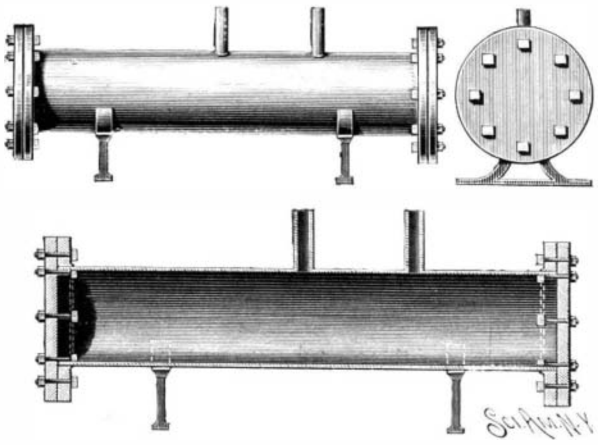
HYDRAULIC SHIELD USED IN THE ST. CLAIR RIVER TUNNEL.

soil under Broadway. In construction, the shield consisted of a wood cylinder made on the principle of barrel staves clamped endwise between two cast iron rings, the front one being tapered to a cutting edge, while the back one was square shaped. Through this hydraulic rams, arranged equidistant apart around the circle of the shield, protruded, and when forced out by the pump fixed on the side of the shield, rested against the edge of the completed tunnel, an intervening buffer plate, composed of wood sheathed with iron plates, being provided to equally distribute the pressure of the rams. These were all connected by pipes to the pump, and all were pushed backward simultaneously. Separate valves attached to each ram enabled some to be shut off at pleasure; thus by increasing or decreasing the pressure on one side or the other, the shield could be diverted in its course to the right or left or upward or downward, and could be made to adapt itself to any of the conditions of the work, such as going around corners or taking a course nearer the surface of the ground or deeper in the earth, according to the exigencies of the case. The shield, in a word, was under the complete control of a single operator.

Extending rearward from the rear cast iron ring, and overlapping the end of the finished tunnel, was a thin metal hood about three-eighths of an inch thick, for a distance of three feet, in which the new tunnel work was built after the extended ram had been pushed inward.

The conditions surrounding the work were peculiar, because debris removed from the tunnel had all to be carried to the street through the basement and cellar of the building where the operations were begun. It was not possible to interrupt traffic in the street above, and access to the opening was effected through this cellar to the side street adjacent to Broadway. This shield was put in operation in 1869, the same year in which Barlow was engaged in putting his shield in operation in the work of the Tower subway in London. It will be seen that the main feature of this advanced method of tunnel construction was being introduced by different engineers in different continents at the same time without knowledge of each other's work, but the Barlow shield was constructed, it would appear, more on the principle of the early Beach shield of 1868, in which jack screws alone were used as a propulsive power, while the new form of hydraulic shield was a direct step in advance, and was, we believe, the first shield of its kind which was put into practical operation in which the entire shield structure was moved forward by hydraulic power.

The hydraulic shield has since that time remained the vital factor in nearly all great tunnel construction. It is probable that the most conspicuous example of its use is in the Blackwall tunnel under the Thames, in London, in which the largest shield ever used is employed, the external diameter of the tunnel being 27 feet, as against 21 feet, the diameter of the St. Clair tunnel. It is a work of the first magnitude and importance and is now approaching completion. It is under the direction of Chief Engineer Mr. A. R. Binnie. We have reproduced an engraving from the London Engineer which represents a longitudinal section through the shield, showing how the work is now being conducted. We also reproduce a cut taken from the SCIENTIFIC AMERICAN of March 5, 1870, which illustrates the method of operation and construction of the Beach shield. The remarkable similarity between the two is at once apparent, even in features of minute detail, and shows what little necessity there has been for change since the earliest days of this form of construction. By comparing the two structures we find nearly all the main features to be common to both. The cutting edges are of the same form, and the hydraulic jacks are mounted in the same manner, and the divisional platforms also appear, although their function was rather to prevent the sand from falling in mass into the shield than to afford a standing place for the laborers. In the cut, B is the cutting wrought iron rim; A is the wooden framework; D are the hydraulic jacks; C are the retaining shelves, and F represents the pump connection.



LABORATORY STILL FOR TAR.

In the larger view we represent the shield used in the St. Clair tunnel. It will be seen from an examination of this view that the shield as used there, as well as in the Blackwall tunnel, had a closed head or drum. The necessity for closing the head became evident in carrying on the work under the bed of rivers, and has always, we believe, been adopted under such circumstances. Of course in Mr. Beach's shield under Broadway, no such conditions existing, and no sudden flood of water being expected, the head of the shield was left quite open.

In this cut there also appears another feature not to be found in the early shield—namely, the movable arm for manipulating and putting the sectional plates in position. This is quite an independent construction, and although it is an exceedingly useful adjunct to the efficacy of the work, it can hardly be considered as a component part of the shield proper, as its function is merely auxiliary to the main work to be done by the shield.

To those who may not be familiar with the circumstances surrounding the work under Broadway, it may be of interest to state that it was in pursuance of a well-formed plan to supply the residents of New York with an underground railway, to be operated by forced draught on the pneumatic system. The tunnel was constructed by Mr. Beach alone, at great expense, a distance of more than a city block, but the work finally had to be abandoned owing to the apathy of the general public. The tunnel, however, is still there, and is often visited by the curious.

LABORATORY STILL FOR TAR.

Chemists who have had occasion to distill tar for one purpose or another in organic laboratories with ordinary equipment no doubt have frequently been perplexed as to how to secure a comparatively cheap yet efficient still. Glass retorts will not do as a rule, says the Pharmaceutical Review, to which we are indebted for engraving and particulars, on account of the water contained in the tar and the bumping caused thereby. Good copper retorts of satisfactory size are expensive and ofttimes not readily obtainable. A still of wrought iron pipe, however, can be readily made even in small cities. Such a still has given satisfaction during the past year in the distillation of pine tar, and for the sake of others may deserve description. Students, while working with charges of from 10 to 20 K° of tar, have not met with a single accident.

This particular still was made of a piece of 8 in. wrought iron pipe, 40 in. long, threaded for an inch at each end. Both ends are fitted with cast iron flanges, 14 in. in diameter and ¾ in. thick. Heads of same diameter and thickness are bolted to the flanges by ⅜ in. × 2 in. bolts. Two 1 inch pipes lead out of the top of the still. One is used as exit tube for the distillate, the other as a safety tube. The still rests upon two cast iron legs, its center being 12 inches above the floor. It is heated by a low gas furnace. Large bottles surrounded by cold water are used as condensers.

THE DAIMLER SIDE WHEEL LAUNCH PRISCILLA.

In the present issue we illustrate a recent production of the Long Island City factory of the Daimler Motor Company. The side-wheeler Priscilla is a little vessel designed for pleasure navigation, and which will doubtless attract much attention in Florida, whither she is destined to go.

The Priscilla is 30 ft. long and 8 ft. wide, drawing 13 in. of water. Her paddle wheels are 5 ft. in diameter and make 45 revolutions per minute, giving a speed of 8 to 9 miles per hour. The engine which drives her makes 540 revolutions per minute, so that the shaft is geared down from it in a ratio of 12 : 1. It weighs 840 lb. and occupies a central position in the hull.

The Daimler launches have the naphtha tank in the extreme bow, and the pipe for conveying naphtha to the engine runs along the outside of the boat, being partially sunk into the woodwork near the rail. Thence it is carried inward to the engine. Thus a fracture of the pipe, if a collision or similar accident should occur, simply results in letting any naphtha that may escape run off upon the water.

The vessel is of a novel and interesting type. For river work the absence of screws is particularly to be appreciated, on account of their liability to entanglement with floating or subaqueous vegetation—a trouble from which paddle wheels are almost exempt. So small a side-wheeler is in itself a novelty. The motor used in connection with these boats has already been described in these columns and was fully illustrated and shown in SUPPLEMENT, No. 1024.

THE DAIMLER SIDE WHEEL LAUNCH PRISCILLA.

AT the great salt deposits of New Iberia, La., the company described to ascertain the depth of the mass of rock salt, and sank a boring for the purpose. The drill penetrated through 600 feet of solid salt, the cores furnishing the evidence.