THE MEETING OF THE GREAT SHIELDS OF THE ST. CLAIR RIVER RAILWAY TUNNEL.

In the SCIENTIFIC AMERICAN of August 9 we gave illustrations showing the construction and mode of operation of the Beach hydraulic shields used for the excavation of the great railway tunnel now successfully executed underneath the St. Clair River between Port Huron, Mich., and Sarnia, Canada, by which the tracks of the Grand Trunk Railroad, of Canada, and the Chicago and Grand Trunk, Detroit, Grand Haven and Milwaukee, and the Toledo, Saginaw and Muskegon railroads, of the United States, are to be connected.

We have now to announce the successful completion of the under-river portion or tunnel section of the great work. This interesting event occurred at half past eleven o'clock on the night of August 30, when the two great 21 foot shields, by means of which the tunnel was excavated, were pushed together and made to meet edge to edge, exactly in line with each other, thus entirely finishing the work of excavation. The reader will, of course, understand that two headings were worked in the excavation of this tunnel, one heading being started from the American side of the river and one from the Canadian side. In each heading one of the great hydraulic shields was employed, by means of which the workmen were protected while the earth was being excavated and the iron plates composing the walls of the tunnel were put in place. As the work of construction proceeded, the two great shields were made to advance toward each other from opposite directions, until they finally met face to face, edge to edge, underneath the river torrent above them. This meeting of the great shields forms the subject of our first illustration. The second engraving shows the location of the tunnel as it extends from one bank of the river to the other.

The shield consists of a strong cylinder somewhat resembling a huge barrel with both ends removed. The front end of the cylinder is sharpened, so as to have a cutting edge to enter the earth. The rear end of the cylinder, for a length of two feet or so, is made quite thin, and is called the hood. Arranged around the main walls of the cylinder and longitudinally therewith are a series of hydraulic jacks, all operated from a common pump, each jack having cocks, whereby it may be cut off from the pump whenever desired.

Within the shield are vertical and horizontal braces and shelves. When at work, the iron plates or the masonry, of which the tunnel is composed, are first built up within the thin hood of the shield, the hydraulic jacks are then made to press against the end of the tunnel plates or masonry, which has the effect to push the shield ahead into the earth for a distance equal to the length of the pistons of the jacks, say two feet, or not quite the length of the hood, and, as the shield advances, men employed in the front of the shield dig out and carry back the earth through the shield. By the advance of the shield, the hood, within which the iron or masonry tunnel is built, is drawn partly off from and ahead of the constructed tunnel, thus leaving the hood empty. The pistons of the hydraulic jacks are then shoved back into their cylinders, and a new section of tunnel is built up within the hood as before described. The shield is then pushed ahead, and so on. The extreme end of the tunnel is always within and covered and protected by the hood. In this manner the earth is rapidly excavated or bored out, and the tunnel built, without disturbing the surface of the ground, the workmen being at all times protected by the shield from the caving in of the earth. This machine is the invention of Mr. Alfred E. Beach, one of the editors and proprietors of the SCIENTIFIC AMERICAN, and was first made and used by him in 1868–69, in constructing a railway tunnel under Broadway, New York. The invention was also used in London in 1886–89, in constructing the two subway tunnels, each three miles in length, from the Monument, passing under the Thames River, Kennington Park Road, etc., to Clapham. The cars in these tunnels are to be worked by electricity. The Beach hydraulic shield is also now being used in the Hudson River tunnel, in process of construction under the Hudson River between New York and Jersey City.

In the construction of the St. Clair River tunnel, two deep cuttings were made, one on each side of the river; that on the American side had a depth of 53 feet, and that on the Canadian side 58 feet deep. Upon the floor of each cutting, against the head thereof, one of the great shields was placed, and the work of tunneling began.

Each shield is circular, 21 feet 7 inches in diameter, 16 feet long, and is built of plate steel, one inch thick. It is divided into twelve compartments by means of two horizontal and three vertical stays, which are built up to a thickness of two inches. These stays have a knife edge in front and extend back ten feet, leaving six feet of clear cylinder into which the end of the tunnel extends. Ten of the compartments are permanently closed and brazings of angle iron placed across them. The other two are provided with heavy iron doors which can be closed at once in case of accident or danger. These doors are situated at the bottom in the center, and through them is passed all the excavated matter. Flush with this heading (with their cylinders extending forward into the compartments) are twenty-four hydraulic rams at equal distances around the shield. These rams are eight inches in diameter and have a stroke of 24 inches. By their means the shield is forced forward enough to admit of another section of castings, viz., 18 inches. Each of these rams can be worked separately, as may be seen by the sketch of the back view of the shield. The power supplied by a Worthington pump is capable of producing a pressure of 5,000 pounds per square inch, which will amount to 125 tons per ram, or 3,000 tons on the 24 rams. The greatest pressure used was 1,700 pounds per square inch, which is 40 tons per ram and 1,060 tons on the shield.

These shields weigh eighty tons each, and were built by the Tool Manufacturing Company, of Hamilton, Canada. They were brought to their destination in pieces, and erected at the tops of the great cuttings, on the north side in both cases, at which side are also the machines and workshops which have been erected. This immense machine when completed was rolled down the side of the cutting on a wooden track composed of four rails of wood, each one foot square, and placed about four feet apart. It was restrained in its downward course by means of six large ropes which were passed around it, fixed at one end to the upper end on the wooden track and coiled around piles, with a number of men to lower out when the order was given. From the time at which the machine first moved to the time it was resting on the cradle of wood (which was prepared for it) at the bottom was only one hour and twenty minutes. For complete illustrations see SCIENTIFIC AMERICAN of Aug. 9, 1890.

The tunnel is 6,050 ft. in length from cutting to cutting, and is divided as follows: From the American cutting to the river edge, 1,800 ft.; from the Canadian cutting to the river edge, 1,950 ft.; and distance across the St. Clair River, 2,300 ft.

The tunnel proper was commenced in August of 1889, and the shields met August 30, 1890, thus practically completing the tunnels within about one year from the time the shields were fairly set to work.

The expedition with which it has been completed so far (for its manner of construction renders it complete as the shield proceeds) has beaten all previous records of tunnel construction, and proved a success beyond expectations, inasmuch as it shows a fewer number of accidents than other types of tunnel, the most serious accident being a broken leg.

The idea of building this tunnel of cast iron segments originated with Mr. Joseph Hobson, of Hamilton, Ontario, who is chief engineer of the St. Clair Tunnel Company, and is also chief engineer of the Great Western division of the G. T. R. of Canada. The success of this work speaks volumes for Mr. Hobson's skill in tunnel construction. Mr. Thomas Murphy, of New York, was superintendent of excavation. Mr. Murphy is a man well versed in these matters, and is thoroughly competent, having been connected with the construction of several tunnels of note throughout the United States.

The cost of this tunnel was estimated at $3,000,000, but it is now thought that (notwithstanding the immense amount of money expended on the test and brick shafts) it will not reach that figure. Should another tunnel be put through, as now expected, we shall have a much fairer chance to compare the certain and marked advantages which the cast iron tunnel possesses over the old style brick and cement tunnels.

The Great Trees.

At a recent meeting of the California Academy of Sciences, Prof. Gustav Eisen, who has recently returned from a trip to the big tree forests of the Tule and Kaweah rivers, called the attention of the Academy to the magnificent groves of the *Sequoia gigantea* along these rivers, which are now being ruthlessly destroyed. On the Tule river are to be found the largest number of big trees to be found anywhere in the State. A very large portion of this marvelous timber has been purchased by private parties, who are now cutting down the trees as fast as possible. There are hundreds of these monarchs of the forest 20 and 30 feet in diameter which have been cut down and only a small portion of the lumber in them utilized; the rest has been left to rot on the ground.

Professor Eisen saw the stump of a tree near the Tule river, Tulare county, that had just been felled. It was about 33 feet in diameter and the height was not less than 250 feet. The man who cut the tree down sold it for $60. It was calculated that from the top of the tree 60,000 shakes would be made. A part of the trunk has been secured for exhibition at the world's fair. In this same region there was cut a monster tree 41½ feet in diameter and 250 feet high. A part of the trunk of this tree was sent to the Centennial. The rest of the tree was left to rot. Professor Eisen said it was a sad sight to see such great trees destroyed. The stump of the tree which was sent to the Centennial contains 6,126 rings, indicating in all probability that the tree was that many years old.

There are still many tracts of land covered with huge redwoods which the government still possesses, and there is now an effort being made to have these groves perpetually reserved from sale.

On motion of Professor Eisen the Academy instructed the president to appoint a committee of three to draught a memorial to the Secretary of the Interior requesting that official to do everything in his power to save the remnant of the fast disappearing big trees.

PHOTOGRAPHIC NOTES.

Removing Yellow Stains.—Every photographer is, no doubt, to his own sorrow, familiar with a yellow stain in the negative, caused by taking the plate from the fixing bath before it is thoroughly fixed. Mr. Belitski, the well known photo-chemist, made some experiments recently to remove this stain, and succeeded very well. A slight stain can often be removed by placing the negative in the following solution: 50 parts alum, 1,000 parts water, 10 parts bichromate of potassium, 20 parts muriatic acid. After several minutes the negative turns yellow all through. It is washed now very thoroughly, exposed to sunlight for several minutes, and developed or blackened with the ordinary iron developer. When the stain is very intense this remedy will not prove to be of any avail, and only by leaving it for twenty-four hours in the Lainer acid fixing bath (so often described in all journals recently) he succeeded in removing the stain, and saving valuable negatives. —*Deutsche Photographen Zeitung.*

Steeling Photogravure Plates.—Mr. Wilkinson gives the following instructions for the steeling of etched plates when large numbers of prints are required therefrom:

"When the plate has been proved, the next operation will be to steel-face it, for which purpose it is thoroughly cleaned with whiting moistened with turpentine and naphtha, polishing with a soft cloth; a small portion of the plate behind is scraped clean, and a piece of copper wire soldered to it. The steeling solution is placed in a wooden cell, the positive and negative poles from the battery (Leclanche) ending in copper rods the whole length of the cell. The solution is composed of:

Warm water	20 ounces.
Ammonium chloride	3 "
Sulphate of iron and ammonia	4 "

"When dissolved, filter, and let it stand in the cell twenty-four hours before use. When required for use, the copper plate is hung upon the rod connecting with the negative pole of battery, the positive pole being occupied by the anode (a plate of pure steel), which must be the same size or larger than the copper plate. The two plates being in position, the current is turned on by pushing in the rod of battery, and in from three to five minutes the operation is complete, the copper plate being covered by a very thin film of steel. The plate, when steel-faced, is thoroughly washed and dried, and then cleaned with whiting and turps and naphtha, the copper wire behind carefully unsoldered, and the back scraped flat. If the battery is not to be used again for some time the anode should be removed and wiped dry, the cell being carefully covered up."—*Photo. News.*

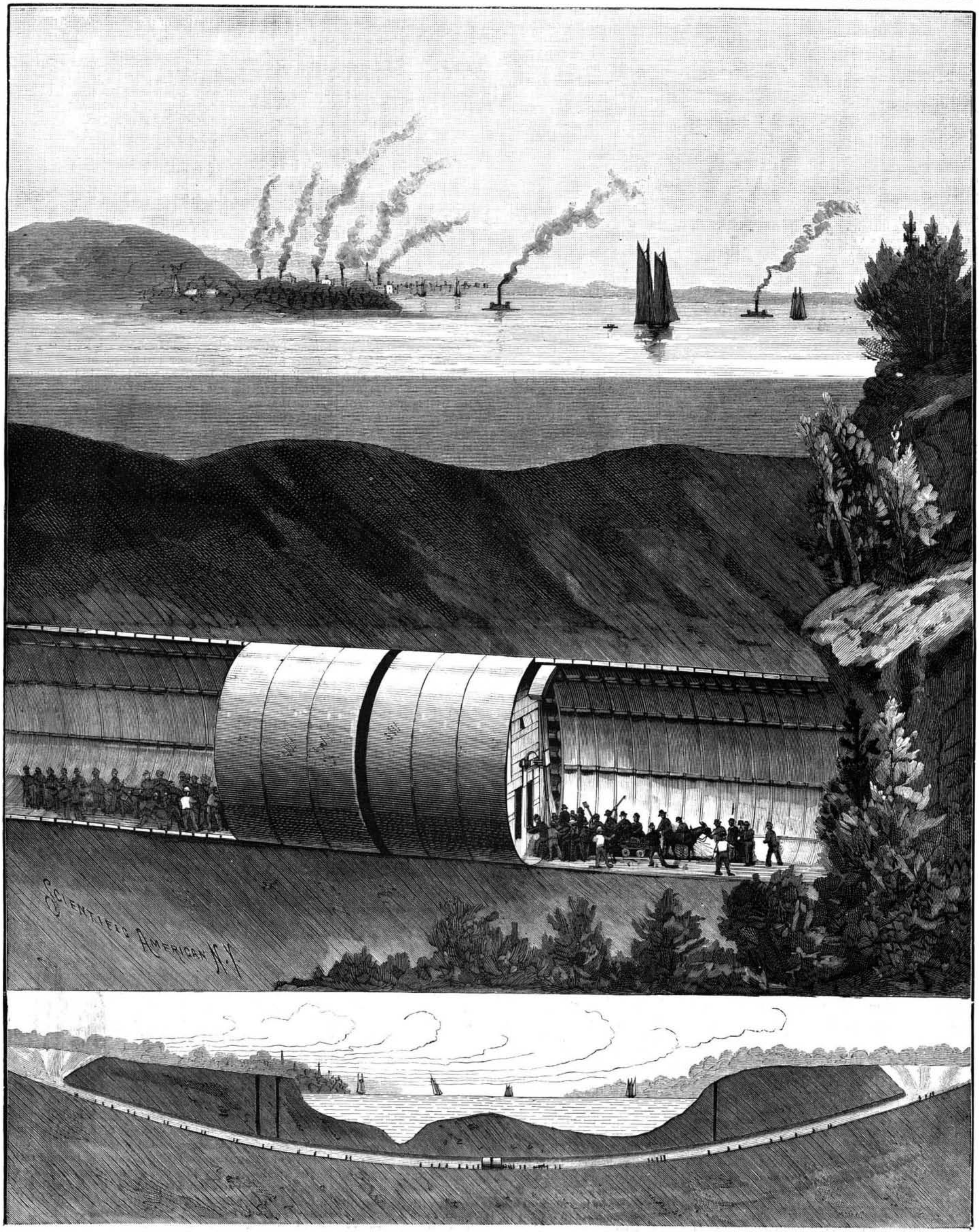
Enameling Photo. Prints.—Use very clean plates and rather larger than the prints to be enameled. Wipe them well, rub them with talc, and remove the excess with a soft brush passed lightly over the surface. In a dish, half filled with ordinary water, immerse the photographs and allow them to soak. This being done, coat one of the talcked plates with enameling collodion in the ordinary way, agitate to cause the ether to evaporate, and when the film has set—that is to say, in a few seconds—steep this plate, the collodionized surface up, in a second dish containing pure water. Now take one of the prints in the first dish and apply the printed side to the collodion, remove the plate from the dish, keeping the print in its place with the finger of the left hand, and remove the air bubbles by lightly rubbing the back of the photograph with the forefinger of the right hand. Care has been taken beforehand to prepare some very pure starch paste, passed through a cloth, and some thin cardboards, or simply thick paper the size of the plates used. The air bubbles having completely disappeared, and the perfect adherence of the print ascertained, dry with bibulous paper, and spread over the prepared cardboard on paper a coating of the collodion by means of a flat brush. Apply this sheet on the print, pass the finger over it to obtain complete adherence, and give it twenty-four hours to dry. At the expiration of this time, cut with a penknife the cardboard or paper even with the print, and detach by one corner. If the plate has been well cleaned, the print will come off itself. We get in this manner a very brilliant surface, and as solid as that obtained by the use of gelatine, which, as it is seen, is entirely done away with in this process. The prints are afterward mounted on thick cardboard in the usual way. It is possible, by mixing with the collodion some methyl blue dissolved in alcohol (a few drops are sufficient), to obtain moonlight effects, especially if a rather strong negative has been used. For sunsets, make use of an alcoholic solution in coccinine.—*F. Tarniquet, in Science en Famille.*

SCIENTIFIC AMERICAN

[Entered at the Post Office of New York, N. Y., as Second Class Matter. Copyrighted, 1890, by Munn & Co.]

A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY, AND MANUFACTURES.

Vol. LXIII.—No. 11.] ESTABLISHED 1845. NEW YORK, SEPTEMBER 13, 1890. [$3.00 A YEAR. WEEKLY.



THE MEETING OF THE GREAT SHIELDS OF THE ST. CLAIR RIVER RAILWAY TUNNEL.—[See page 164.]