the attack less disastrous, or at least punished her assailants more severely.

Another point to be noted is the number of torpedoes fired. One account says three were discharged before an effective hit was made, another says seven. Whichever number is correct, it shows, considering the circumstances, that even the best form of torpedo is an unreliable weapon, but if a hit is made, the effect is appalling.

The Lynch and Condell are recently built torpedo cruisers of the latest design, and the torpedoes used are the most modern development of the Whitehead auto-mobile torpedoes.

The Encalada was an iron armored, twin screw, central battery ship, 219 feet in length, 45 feet and 9 inches in beam, 19 feet and 8 inches in draught, and of 3,500 tons displacement. She carried six 12 ton, muzzle loading Armstrong rifles, four lighter pieces, and seven machine guns. In the SCIENTIFIC AMERICAN of June 6 will be found a full description of the Lynch and the Condell. B.

THE DISPOSITION OF MINING DEBRIS IN CALIFORNIA.

Among the reports submitted to the last Congress was one from the Secretary of War on the treatment of mining debris in California. The report contained the conclusions of the Board of Engineer officers which was prepared in compliance with an act of Congress, approved October 1st, 1888, which directed that three officers from the Engineer Corps of the United States army be constituted a commission for the purpose of making a thorough examination of the mining debris question in California, and determining whether some plan cannot be devised whereby the present conflict between the mining and farming sections may be adjusted, and the mining industry rehabilitated.

For several years past hydraulic mining has been suppressed in California. In the early stages of placer mining the possible effect upon river channels and adjacent lands of dumping debris in the cañons does not seem to have received any attention. No great flood was recorded until 1861–62, when very serious damage was done by the overflow of certain rivers, notably the Yuba, and other floods occurred in 1875. After a number of decisions by the lower courts the United States Circuit Court rendered a decision which puts a stop to hydraulic mining in the State.

It was estimated that $100,000,000 was invested in this branch of mining previous to the restriction, the effect of which has been that many costly works connected with this industry have been allowed to go to decay, mining camps have been deserted and large districts depopulated, while the yield of gold in the State has been considerably reduced, as shown by the following table.

Product of gold in California from January 1, 1880, to December 31, 1890.:

1880	$17,745,745
1881	17,166,676
1882	15,520,325
1883	13,841,297
1884	12,896,594
1885	12,338,014
1886	13,208,034
1887	11,836,957
1888	10,076,091
1889	10,329,044
1890	9,986,851

In the prosecution of hydraulic mining all the material in the bank is moved, whereas in drift mining only the gravel and sand adjacent to the bed rock is taken out. It follows as a consequence of hydraulic mining that some depository for the debris must be found, and until the decision of the United States Circuit Court was rendered, this debris was dumped into the gulches and beds of streams adjacent to the mines, to be removed further down with the winter freshets.

The effect of filling up the river beds in this way was very disastrous to farmers and other persons owning land which was overflowed, and resulted in the formation of the Anti Debris Association, which organization has conducted the litigation resulting in the inhibition upon hydraulic mining. In one of the cases in this extended litigation the following facts among others were brought out. The plaintiff was the owner of a lot in the city of Marysville covered by a brick building and of two farms on the borders of the Feather River. Portions of these two farms were covered by debris brought down by the floods of 1862 to a depth that made them valueless as agricultural land. The winter floods of succeeding years added to the depth of the deposits and the lands are now grown up to willow and cottonwood thickets. The beds of the Yuba and Feather Rivers gradually rose from successive deposits of debris, until in 1868 the people of Marysville found it necessary to build levees to protect the city from overflow. The city is situated upon a high bank of the Yuba River and about one mile from its junction with the Feather.

Up to 1862 the Yuba was navigable all the year for ships and boats drawing from 9 to 10 feet of water, and during the winter season deep water ships from around Cape Horn navigated it to the foot of E Street. The site of the city was above extreme high water, and it was never overflowed until after the commencement of modern hydraulic mining. The river beds continued to rise after the building of the levees, and during the flood of 1875, which was much less in volume than in 1862, the levees broke, and for the first time in its history Marysville was inundated. A report to the legislature during the session of 1880 states that during the year 1879, 40,564,000 cubic yards of material were put into the Feather River by the hydraulic mining process and 9,700,000 cubic yards of this debris, about 24 per cent, passed out in suspension. Most of the material so carried in suspension was deposited in the lower Sacramento and in the bays in which the Sacramento discharges.

The above statements clearly indicate the nature of the damage done to streams by dumping mining debris where it will be washed into them, and the consequent injury to property by the overflowing of streams in which large quantities of mining debris have been deposited. The labors of the commission of United States engineers, were directed to ascertaining the amount of damage which had been done to various streams by dumping mining debris into them, and the formulation of a plan by which the injurious effects of this course might be obviated, and hydraulic mining resumed without injury to any other interest.

There are large bodies of workable gravel yet remaining, that could be worked at a fair profit, and, in the opinion of many persons who have given thought to the subject, dams could be erected for the impounding of the mining debris, and thus prevent the filling up of the stream.

The conclusions of the engineers on this method of remedying the evil are given at length. They say: "The board is of the opinion that some partial protection could be afforded the rivers and lands below by restraining a portion of the coarser part of the material mined by structures built in the cañons, ravines, and valleys at points where examinations have indicated the most favorable locations. These works should be permanent stone dams or barriers built across the beds of cañons and carried to such heights as the local conditions may demand. The results obtained by dams now in existence show the feasibility of impounding portions of the coarser material behind properly constructed barriers. As the stability of the dam depends in a great measure upon the apron, the greatest care should be taken in its construction. An economical construction could be obtained by building a low structure first, and raising the succeeding ones upon the impounded material. The faces of these dams would then constitute a series of falls, which would have the effect of breaking the force of the water upon the apron. That considerable coarse material can be stored is shown by the dams already constructed in some of the tributary streams. In Slate Creek material is impounded by two crib dams. The upper one, immediately below the Poverty Hill mine, banks up debris over 27,000 feet on a grade of 50 feet per mile." A number of other cases are cited where mining debris is stored by means of dams.

In concluding their report, the engineers refer to the injuries to the rivers of the Sacramento Valley by the deposition of vast quantities of mining debris in the beds, and reaffirm their faith in the possibility of impounding the debris without injury, and locations are pointed out where this may be done.

The question as to whether the damage from mining debris may be prevented by the erection of dams across streams into which such debris has been washed, was passed upon by the courts in the litigation which resulted in the decision by the United States Circuit Court which renders hydraulic mining in California illegal. In the action brought by the Attorney-General of the State for a perpetual injunction restraining a certain mining company from dumping debris where it would be washed into the river, the lower court granted the injunction prayed for, but affixed a condition in the decree that when efficient means should have been provided to impound the heavier portion of the debris, the defendant should be entitled to have the injunction dissolved. The people appealed from the condition affixed to the injunction, and the Supreme Court affirmed the injunction without any conditions. Judge Sawyer, in that portion of his decision relating to the erection of dams as a remedy for the evils, said: "Whether a dam can be constructed to stand the pressure to which it will necessarily be subject under these circumstances, and whether it will be of any material use in preventing the flow of the debris, and the filling of the river below, are questions upon which I am not fully advised; but from the evidence in the case, and of my observation of the premises, I am strongly impressed with the belief that sufficient of the debris will still pass over the dam in suspension with the water to maintain and even increase the present fill of the river.

"Besides, it is a very serious question in my mind whether any person or community can or ought to be required to submit to the continuous peril of living under or below such a dam as this must necessarily be if it be made high enough to impound the coarser material—and this merely for the convenience of another person in the pursuit of his or their private business. It may be likened at least to living in the direct pathway of an impending avalanche."

The report goes very thoroughly into all details affecting this question, and is signed by Lieut.-Col. W. H. H. Berry and Major W. H. Heuer and Major Thomas H. Handbury, of the Corps of U. S. Engineers.

Opals.

At a recent meeting of the California Academy of Sciences, the following paper was read by Melville Attwood, M.E.:

The precious, or noble, opal is one of the most beautiful gems in nature. When held between the eye and the light, it appears of a pale milky reddish blue, but when seen by reflected light, it displays all the colors of the rainbow.

Opals are always cut *en cabochon*, on both sides, and the true beauties of the gem only display themselves when the stone is moved about, as then a fine opal really appears to have an actual life within itself.

Fine stones of a large size are rarely found. They seldom exceed an inch in diameter. When held in the hand to impart warmth to the gem, it is much more brilliant.

Some varieties of opal (the common) are found with galena and blende in metalliferous veins. They also occupy the interior of fossils in sandstone. Its formation is due to the solubility of amorphous silica in water, especially in hot water, or water containing carbonic acid, the silica being dissolved out by spring waters from decomposed silicates, and deposited under favorable circumstances in a state more or less approaching to purity.

At a former meeting I presented the Academy with opals in the matrix from the State of Washington. Since that I have cut another microscopic section of the Washington rock, which I now donate to the Academy. The section shows the rock to be basalt, consisting of a mixture of fine grains of labrador, feldspar, etc., with a small quantity of magnetic iron.

Through the kindness of Adolph Sutro, Esq., I am now enabled to give the Academy specimens of opals in the matrix from Mexico, Australia, and Hungary.

The inclosing rocks of those from Mexico and Australia are so altered, or decomposed, that I could not cut a satisfactory section from them. They are, however, without doubt, trachytes. The two specimens from Hungary are very interesting, being the same rock, but the one much altered or decomposed and the other fresh or unaltered. From the latter I managed to cut a section sufficiently thin to prove it to be a trachyte, with small crystals of leucite in it.

The result of my examination of the inclosed rocks of the different precious opal deposits, and from all the information I can obtain by papers written on the subject, is that the precious opals occur, or are found, mostly in dikes of intrusive volcanic rocks, and in those parts of the dike near the surface, and where the rocks are greatly altered or decomposed.

Naval Torpedoes.

A permanent board of torpedo experts has been recently established by the Navy Department to take charge of experiments, tests of firing and launching tubes, installation on board, stowage, and torpedo supplies. It consists of Commander G. A. Converse, senior member; Lieut. F. J. Drake, and Lieut. T. C. McLean. The headquarters of the board will be at New York, with experiments conducted also at Providence and Newport, and practical steps have been taken to obtain a supply of torpedoes for our war vessels at an early day. Messrs. E. W. Bliss & Co., of Brooklyn, N. Y., having arranged with the proprietors of the Whitehead torpedo for its manufacture in this country, the Navy Department has contracted with that firm to make one hundred of these torpedoes at $2,000 each, and parts to be added by the Carpenter Steel Company will considerably increase the cost. Thirty torpedoes of the type invented by Capt. J. A. Howell, of our navy, have also been ordered, at a cost of $2,200 each, and it is expected that the first of these will be ready for trial in August.

The competitive tests of these two torpedoes will be looked for with much interest, particularly as public attention has been so strongly directed to the performance of the Whitehead torpedo by its work in the recent sinking of the Chilean warship the Blanco Encalada, as described in the SCIENTIFIC AMERICAN of June 6. In the Howell torpedo there are four sections. The first contains the firing pin and its mechanisms; the second, just behind it, the explosive charge and detonator; then comes the third, containing the flywheel and screw gears; finally, the stern, which holds the driving mechanism. The characteristic feature of this torpedo is the heavy flywheel which propels it, and which is spun up by a steam turbine motor, which forms a permanent attachment of the launching tube. The torpedo having once been placed in the tube, the steam motor clutches the flywheel, and when steam is applied it spins up the latter, and all the succeeding movements until the torpedo reaches its target and is exploded are performed automatically.

Brick Making, from a Trade to an Art.

The great size and height of modern buildings in our large cities has compelled more attention than ever to fire-proof construction. Twenty years ago, iron was the preferred material, taken presumably for its fire-resisting quality. But conflagrations like those of Chicago and Boston demonstrated that iron was the worst possible material. Then followed a general use of stone. Brick was not preferred from its then lack of artistic appearance and want of capacity for effect and expression. Stone, however, proved unreliable as a fire-resisting material, and some of them, in fact all except the sandstones, were found to easily disintegrate with the heat of a common, not to say a great, conflagration.

But brick making has developed from a common mechanical occupation into an art. Forms have altered from the stiff 4x8 formula, to suit artistic situations in fronts, pilasters and cornices, and finally the crowning development is reached in the rapid and cheap production of the most elegant art forms and expressions in terra cotta, until now clay workers produce the best material for the most pretentious or elaborate structures, while retaining and in fact increasing the well known fire-resisting qualities.

Only one thing is yet desired in order to render fire-proof conditions absolute, and that is a fire-proof mortar. The brick itself is practically indestructible by any heat in a conflagration. The mortar will crumble, with its lime base, and weaken the wall. A mortar has recently been invented by a German chemist that answers perfectly, it is said, but its great cost precludes its use, except, perhaps, for some particular purpose, as fire-proof vault construction, where expense is no object. There is not a single field for invention that would reward the one better who can discover a mortar that would be both fire-proof and sufficiently cheap to be available.

But, however, brick and terra cotta are being generally preferred, and never has there been such general preference shown for these materials as is foreshadowed for the coming season. Safety and durability are beginning to usurp all other conditions in the erection of large buildings—a usurpation that has been rendered permanent to brick and terra cotta by their becoming thoroughly artistic.—*The Clay Worker.*

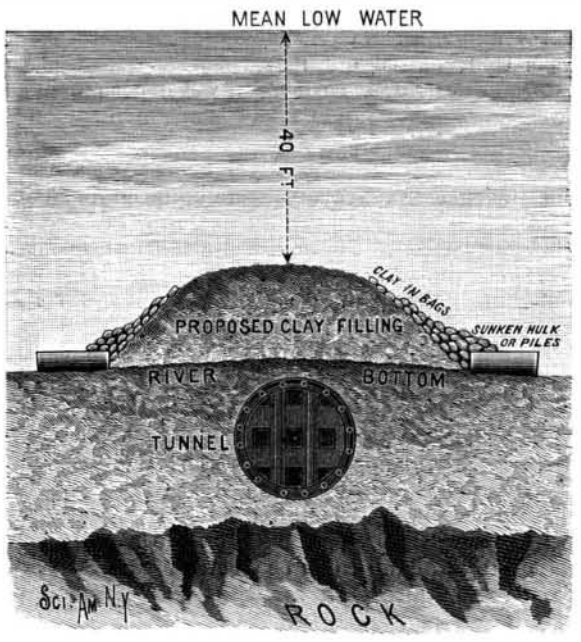
Government Note Paper.

Anybody who wishes can go into the big Crane & Co.'s factory at Dalton, Mass., and see the workmen place the blue silk on the machine that makes the paper for all the United States notes. The silk comes in spools, and is made by Belding, of Northampton. It is sold here in Bangor. There is no more secret about it than there is about the water flowing over the dam above the toll bridge. The real secret is in the composition of the paper. The silk thread idea is secured by patent, to be sure, but the making of the paper, the compound of the ingredients, is safe in the head of J. Murray Crane, who received the art from his father, who made bonds for Salmon P. Chase, Lincoln's Secretary of the Treasury, away back in war times. The pure linen pulp is in a big room, looking for all the world like any linen pulp. Then comes J. Murray Crane with a gripsack. He and the "grip" enter the room together, and it is presumed that he locks the door, for the door is locked on the inside, and the "grip" does not look able to do it. They are closeted a half an hour. When they come out the pulp goes to the paper machine, and Mr. Crane and the grip go home. But the pulp is changed by that visit, and nobody has been able to penetrate the Crane secret. The company gets about fifty times as much for that paper as for other linen paper made in the same mill.—*Bangor News.*

A STICK of California redwood is being prepared in Detroit for the World's Fair. Its dimensions are given as 16 feet wide, 13 feet long and 5 inches thick.

PROGRESS OF THE NORTH RIVER TUNNEL.

The progress of work upon the North River tunnel has brought the main heading to a critical point. The rock upon the New York shore has been almost reached and the problem of getting over or through it



SECTION OF RE-ENFORCING FILLING OVER THE TOP OF THE TUNNEL.

now presents itself. The original plan would have carried the tunnel right through the crown of the rock, necessitating blasting, with its attendant dangers and risk. The present contractors propose to attack the matter differently. Starting well back from the shore, at about the 3,800 foot mark, measuring from the west or New Jersey end of the tunnel, they propose to increase the up grade to two per cent and to approach the eastern terminus on an even slope. This will carry the line over the summit of the rock, as shown in the upper cut.

In doing this the bottom of the river is nearly reached, but five feet of silt and clay lying above the arch or top of the tunnel at one place. This introduces an element of danger. The air pressure system as applied to sustaining a vertical heading introduces an element of unstable equilibrium that can only be counteracted by a large overlying depth of solid material. If the tunnel had but five feet of wet silt or sand over it, there would be great danger of a disastrous and perhaps fatal collapse. Just above the tunnel there is a deep channel, giving a very characteristic section to the river at this point. The sudden deepening is the cause of the trouble. The method of dealing with the problem that is proposed is the following.

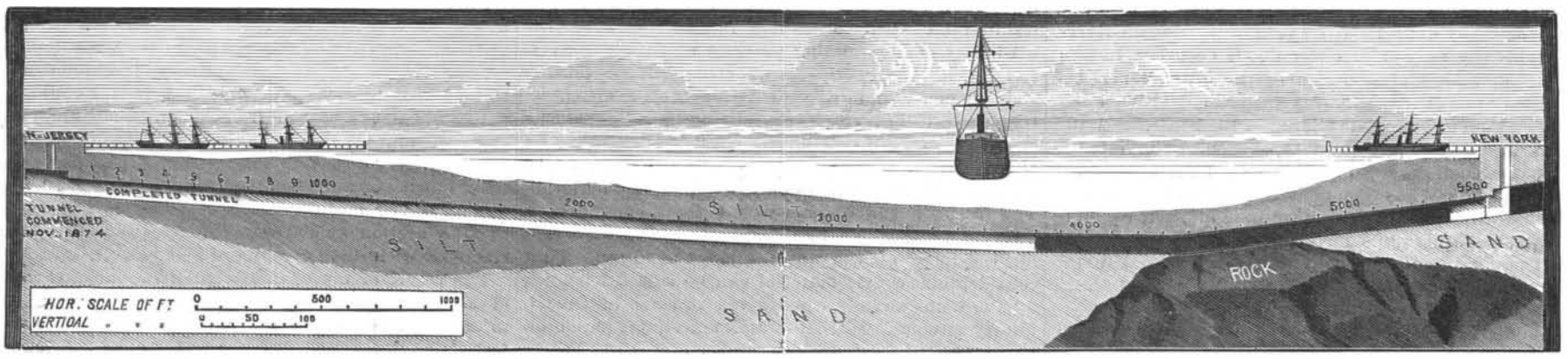
Good clay properly prepared is to be dumped into the channel at slack water, immediately above the line of tunnel. This will be continued until the depth of earth over the line of the top of the tunnel is increased to at least twenty feet. The depth of water at the critical places is from sixty to sixty-four feet. The filling to be introduced in no case is to reduce this depth to less than thirty-one feet six inches at low tide: 15,000 to 20,000 cubic yards it is thought will suffice.

To secure the mass from washing away, it may be put in bags wholly or in part and riprap and even piling, if necessary, may be used at the sides. The general section of the re-enforcing mass is shown in one of the cuts.

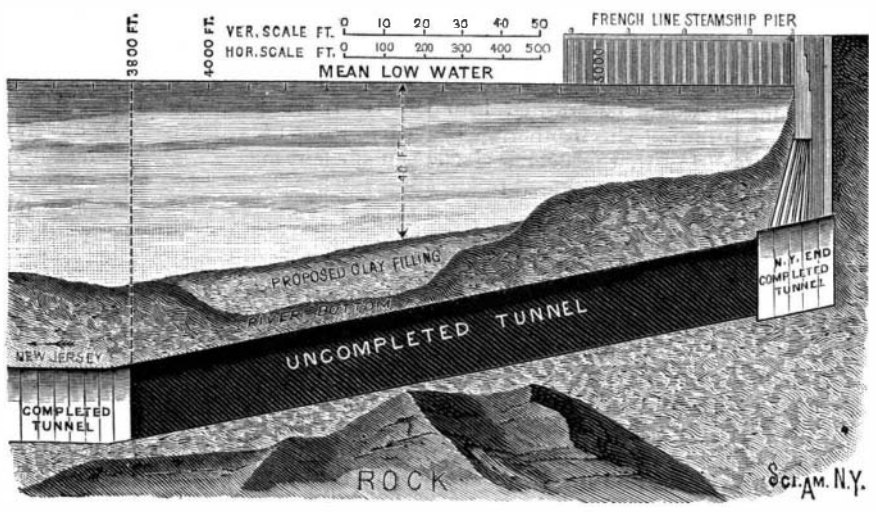
Upon completion of the work the filling will be useless and the clay is to be dredged out and the river bed left in its original condition. Any injury done to neighboring piers from scouring is to be paid for by the tunnel company.

The approval of the acting Secretary of War has been received, based upon the recommendation of a board of engineers consisting of Cols. Henry L. Abbott, C. B. Comstock, and G. L. Gillespie. Adequate safeguards in the way of supervision by the war department, and consent of the supervisor of the harbor of New York, with a bond of $200,000, have been arranged for in the permit.

From an engineering standpoint the proposed operation is of considerable interest. The weak point in the compressed air system of tunneling, which has been the sustaining a vertical heading, has been met, to a great extent, by the shield. This, by subdividing and protecting the exposed vertical area, has made the work safer. The adding to the overlying layer of earth operates in the same direction and appears quite adequate to overcome the weakness of the bottom. The sectional view of the river and tunnel is also of interest, as showing how far the work has progressed. It will be seen that but little remains to be done to complete the connecting link between the New York and New Jersey shores.



THE NORTH RIVER TUNNEL—SECTION SHOWING THE PROGRESS OF WORK.



THE EASTERN GRADE—SURMOUNTING THE ROCK.

A Volatile Compound of Iron.

On this subject a paper was lately read before the Chemical Society, London, by Mond, Langer, and Quincke.

Pursuing the researches which led some little time ago to the startling discovery that nickel formed with carbon monoxide the volatile compound $N(CO)_4$, these investigators have obtained a similar body containing iron. Its preparation is difficult, and the yield scanty. The method adopted consisted in reducing ferrous oxalate in a stream of hydrogen at a temperature of 400° C., and passing carbon monoxide over the product heated to about 80° C. Like the nickel compound, the new body is volatile, and is decomposed on heating, depositing a mirror of metallic iron. The supposition that (as but little of the substance can be obtained even from large quantities of iron) the formation of the mirror may be due to the presence of a trace of nickel in the original iron salt is negatived by the fact of the deposited metal giving the reactions of iron, and thereby allowing its identity to be definitely established.

It can be readily understood that as only extremely small quantities of the new substance could be obtained, its satisfactory analysis was difficult; but the authors' numbers point to its being of composition similar to that of the nickel compound and consider it to be represented by the formula $Fe(CO)_4$.

The bearing of the existence and properties of the new substance upon the cementation process for converting iron into steel was discussed.

It appears unlikely that the substance $Fe(CO)_4$ is an agent in this conversion, inasmuch as it is decomposed at 150° C., but it may well be that the transference of carbon, that undoubtedly takes place, is due to the activity of some similar body.