connected with a balloon. In a word, if we take the history as we find it, we learn of a great number of methods by which flight can be accomplished. What we need to know in this art is not so much how to fly, as how to alight with ease and safety. Experimenter after experimenter has found that after he had succeeded in flying, the cost of the repairs due to the accidents of alighting have put an end to his experiments. In other words, what we want to know is not so much how to go up as how to steer and how to come down safely.

Inventors are troubling themselves greatly in regard to balance and power. Lilienthal came to his death because he placed the weight too near the wing surface. Had his machines been arranged so as to bring his body six or eight feet lower, his wings would never have been upset in the air. The bird finds it easy to balance itself with its body, which is but a few inches below the line of the wing, but in the most complex air currents it is often in a condition which would wreck any structure not animate in every part.

It is strange how mistaken ideas of strength relative to weight, among engineers as well as laymen, prevail. Pine is stronger than steel, weight for weight, both in tensile and transverse strength. The bamboo probably exceeds in stiffness anything of the same weight that could be made in metal. The calculations show these facts, and Prof. Thurston's experiments, which have been more than once alluded to in the pages of the SUPPLEMENT, have demonstrated it beyond a doubt. The weak points of wood structures are in the joints. With proper attention paid to this feature, the structure of wood and wire becomes lighter per foot of surface than can be produced with metal.

HARLEM RIVER TUNNEL OF THE RAPID TRANSIT SUBWAY.

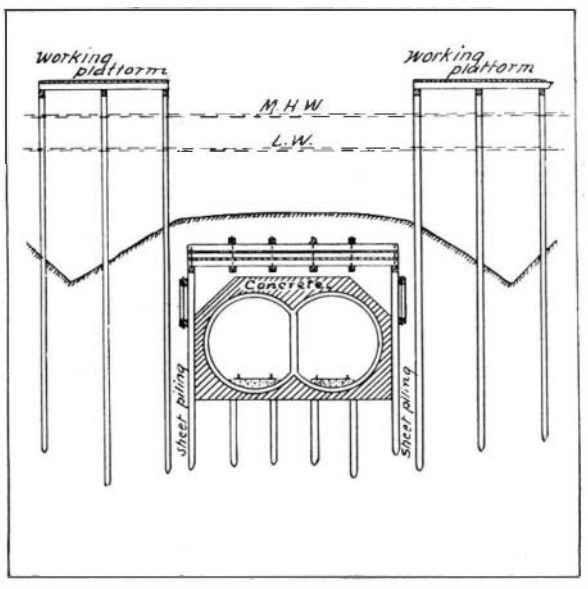
We present on the front page of this issue an illustration of a difficult piece of engineering work which has particular interest for two reasons: First, that it serves to carry the tracks of the new Rapid Transit Subway beneath the Harlem River; and second, that this tunneling has been carried out upon an entirely new system, and through about the most difficult material in which a tunnel could be built. The plans for the Subway called for a two-track tunnel at this point, and they left the character and method of construction of the tunnel open to the judgment of the contractor, the final decision as to whether the plan would be adopted being, of course, left to the Rapid Transit engineers. The work has been done by Messrs. McMullen and McBean, upon a plan devised by Mr. McBean, to whom we are indebted for courtesies in the preparation of the present article.

It was desirable, of course, in this tunnel, as in all tunnels passing below rivers, to keep the grade as near to the surface of the river bottom as possible, so as to avoid the use of heavy grades in the tunnel approaches. In the present case, however, the mud was so thin, weighing only about 80 pounds to the square foot and being of an almost liquid consistency, that the system of tunneling by means of a shield was practically out of the question. To have adopted it would have been to encounter the risks and accidents due to blowouts, which have made the present New York and New Jersey tunnel such a hazardous undertaking, and have rendered it impossible for the contractors to keep the tunnel in perfect line and level. The method used in the present case was to drive two lines of sheet piling parallel with the line of the tunnel, and wide enough to inclose the same; construct a strong roof of timber across from wall to wall of piling; and then, by means of pneumatic pressure and air locks, exclude the water and excavate the soft mud from within the tunnel caisson and build the tunnel structure, which is constructed, part of it of concrete and part of it of cast iron, within the working chamber thus provided. The construction of the caisson involved the driving of piling throughout the full length of the tunnel, and the piling, when cut off before commencing the construction of the tunnel proper, served to give a perfectly unyielding foundation upon which the completed work could rest, thus preventing the possibility of any future settlement.

In carrying out the work, the first step was to dredge out a channel to within about 6 feet of the sub-grade of the tunnel. Piling was then driven for two lines of working platform, one on each side of the tunnel. Next the supporting piles for the roof of the caisson were driven, each bent containing four piles, and the bents being spaced 8 feet from center to center. The duty of these piles was to support temporarily the timber roof; to assist in putting the transverse braces that held the side walls in line in place; and as we have said above, to give additional bearing to the finished tunnel. To preserve the two side walls of sheet piling accurately in alignment, a pair of continuous longitudinal trusses was used for each wall, the two trusses in each pair being spaced 12 inches apart, or the width of the sheet piling wall. To maintain the side trusses with their wall of piling at the proper distance apart, and preserve both walls in true line, a series of transverse trusses was constructed, which extended from wall to wall and reached almost to a contact with the longitudinal side trusses. Now, it can be seen that with the combination of these longitudinal and transverse trusses with the rigid line of piling, it was possible by the judicious use of wedges at the ends of the transverse trusses to keep the side trusses, and therefore the wall of piling, very accurately in line. The grade of the tunnel was also accurately determined by moving the cut-off circular saw upon a track supported on the working platforms, and giving this track the exact pitch or grade required for the tunnel. Then by moving the saw forward and maintaining always the same reach of the saw shaft, the cut-off of the piles necessarily presented the required grade for the finished tunnel.

The remarkable accuracy of the sheet piling and the tightness of the whole work is due very largely to the use of a compound pile which was designed especially for the work. This consists of three 12x12 sticks bolted together and driven as one pile, each three-fold pile being tongued and grooved to the next pile. The work was also greatly facilitated by the use of pilot piles, which were built of steel channels and plates and measured 12x12 inches in cross section. These were driven with the aid of the jet, and served to open the way for the wood piling. Moreover, by their use it was possible to detect the location and contour of bowlders, and when such bowlders were struck, it was only necessary to withdraw the pilot pile, blast out the obstruction, and drive the wooden pile.

The timber roof was built up, as shown in our drawing, of three transverse layers of 12 x 12 timber and two intermediate layers of 2-inch plank. The whole roof was well bolted and calked, so as to make it watertight. It was built in sections, varying from 40 to 130 feet in length, floated into place between the working platforms, and sunk until it rested upon the top of the sheet piling. The joint between the roof and the sheet



CROSS SECTION, SHOWING TUNNEL COMPLETED WITHIN THE CAISSON.

piling was closed by T-irons, and a very satisfactory air-tight joint was secured. About five feet of mud was then dumped upon the roof, to keep it down in place with a firm bearing.

It was necessary to maintain the Harlem River channel navigation during the prosecution of the work, and consequently, only half of the river was closed at one time. This involved the inclosing of the work by two air-tight coffer dams. In the portion of the work shown in our illustration, one bulkhead was placed at the city bulkhead line, and the other near the center of the river, the total length of the working timber thus formed being about 216 feet. Near the center of the roof of the caisson was built up a rectangular timber caisson with the usual air lock, and in this were placed the pumps for taking out the soft material of excavation. Cylindrical iron material shafts were also built in, as shown in our engraving, these being, of course, provided with the usual air locks. A pressure of 10 pounds to the square inch of air was sufficient for operation; but it can be seen that this method of tunneling would be available for any practicable depth at which it was desired to carry on excavation. The leakage of air from under the roof during the work has been very small, and it should be mentioned that a remarkable degree of accuracy was reached, considering the difficult and unprecedented method employed.

After the water had been lowered in the working chamber, the work of throwing out the mud and other material proceeded without any difficulties whatever, and when the excavation had been carried down to the desired level, the concreting of the floor was begun and carried up around the head of the piles. These were then cut off, and spikes were driven into them, so as to give them a good grip upon the concrete foundation. After several feet of concreting had been laid, the cast-iron lining was put in place, the concrete carried up around it, and the tunnel completed. There now remained nothing more to do but cut out the upper length of the sheet piling, remove the working platforms, and leave the river unobstructed for navigation.

It is claimed by Mr. McBean that the present system would be perfectly applicable to the North River tunnel; and that because of the fact that it would be possible to open the work at several points at once, the tunnel could be constructed more rapidly than by the shield method.

Reorganization Succeeds Organization.

Judging from the number of reorganization plans that have made their appearance within the last few months, the period of organization appears to have given way to the period of reorganization, in so far as it applies to industrial companies. Among the concerns that are going through plans of reorganization are the United States Shipbuilding Company, United States Leather Company, American Bicycle Company, American Ice Company and American Grass Twine Company. Other concerns are considering the question of reorganization, the plans of practically all of which provide for a radical scaling down of capitalization.

Commenting upon this situation, the Bankers' Monthly remarks that promoters admit the period of mushroom corporations is practically over. They say that any attempt to float a company with an overabundance of water in its stock would meet with dismal failure. Four years ago it was an easy matter for consolidations to sell their stock. The public, with enormous profits in view, was willing and eager to buy it, but the heavy shrinkage in values that the majority of the securities of new consolidations have experienced has resulted in a decided change in the attitude of the people. Most of the recent consolidations have been carried through by means of an exchange of the stocks of the constituent properties for that of the consolidated corporation. No new stock to speak of has been offered to the public for subscription.

If there were any lingering doubt of this change in the attitude of financial interests toward new enterprises, the recent low record prices established by the stocks of some very reputable companies would bring conviction. The troubles of the underwriting syndicate of the International Mercantile Marine Company is a case in point. Here is a company including such thoroughly established concerns as the White Star Line, the American Line, the Red Star Line and several other important shipping companies.

It does not appear that the capitalization of this consolidation is excessive, although every man has his own opinion as to that. The only cause for apprehension on this point is the failure of the company to furnish the public with any sort of information on which an estimate of the worth of the securities may be intelligently made. Brokers admit that to buy the shipping securities is much like the business of school boys when they trade pocket knives, "sight unseen."

And this, it should be remembered, is a consolidation of going concerns, owning property of immense, though uncertain, value. Its creation was the work of the very highest order of financial and legal talent, not to call it genius, which America has to offer. In other times new enterprises backed by the same interests have been received by the public with open arms and have poured millions into the coffers of their sponsors. And the public has not always known any more about these earlier projects than it does now about this one.

To see the public in a violently contrasting mood, it is only necessary to go back a year, to the International Power episode. That a company in the hands of speculators, pure and simple, with a very limited foundation of demonstrated earning power, should have been able to put its stock to 200 with ease looks now like a verdict of insanity against a whole community. It is with reason that the question is asked in Wall Street, Where are the lambs? Not half a dozen are to be found in a day's search, which fact alone is pretty good proof that they have developed into comparatively intelligent mutton.

One Hundred and Thirty Miles an Hour.

Amid the intense excitement of a vast crowd, consisting largely of experts, the Siemens electric train on October 23 achieved the record speed of 207 kilometers, or about 129¾ miles per hour, beating the record of the last previous trial by six kilometers.

After the recent trial on the experimental Marienfelde-Zossen line, near Berlin, when a speed of 125 miles an hour was attained, the engineers declared that this would be exceeded, and that a speed of even 140 miles an hour was practicable. The tests have been going on for several weeks, and are being watched with great interest by the Emperor William. The Reichstag has devoted the sum of 280,000 marks toward the cost.

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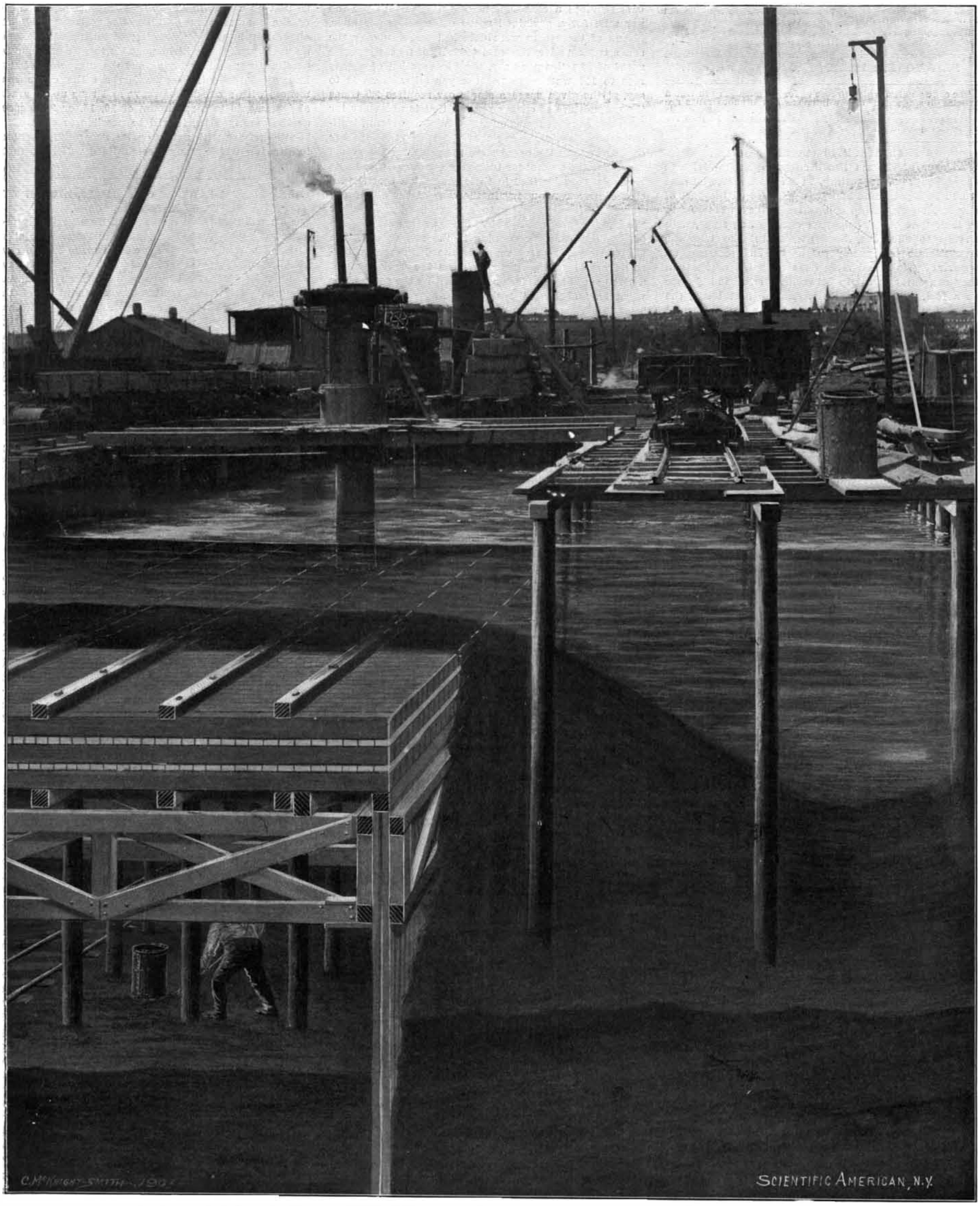

By this method an air-tight caisson is built on the line of the tunnel and the water is expelled by pneumatic pressure. The mud is then excavated and the cast-iron tunnel is built within the working chamber thus formed. Our illustration shows the excavation of the mud in progress.

CONSTRUCTION OF THE RAPID TRANSIT TUNNEL BENEATH THE HARLEM RIVER.—[See page 307.]