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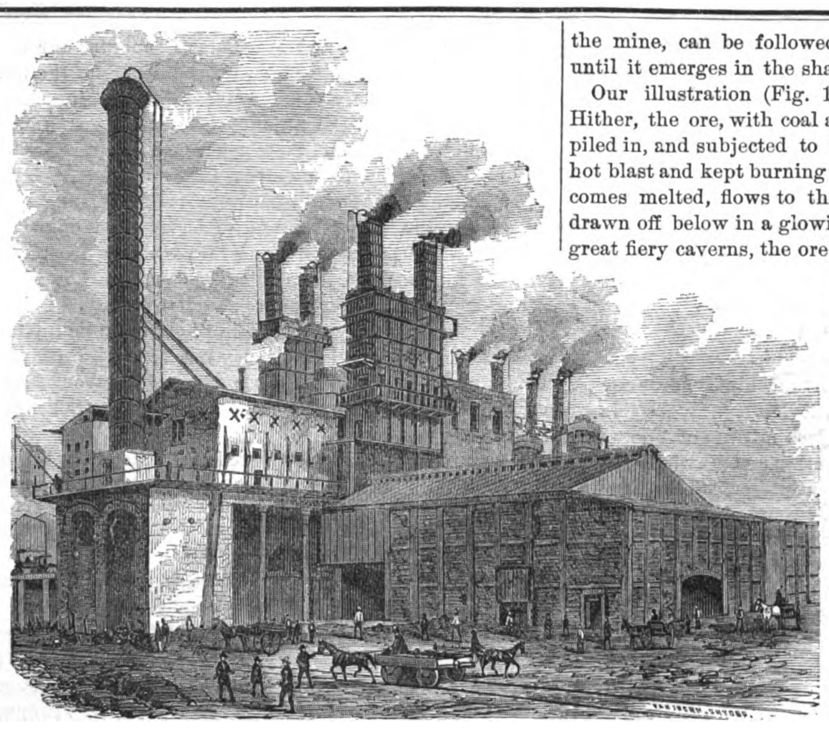

FIG. 1.—THE PHŒNIXVILLE BLAST FURNACES.

IRON BRIDGE CONSTRUCTION.

The various processes by which iron is prepared to be used in bridge building are many of them as new as is the employment of this material for the purpose. The subject is

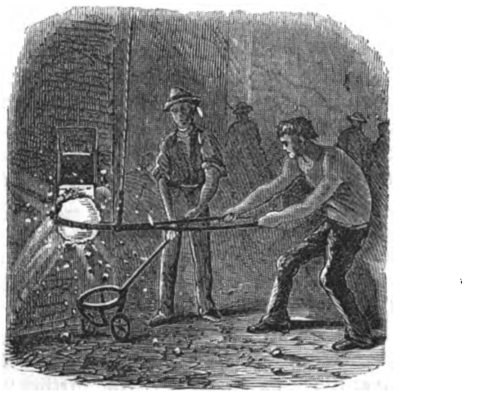

FIG. 6.—BOILING FURNACE.

one of considerable public interest, and hence we extract from an album of designs, recently published by Messrs.

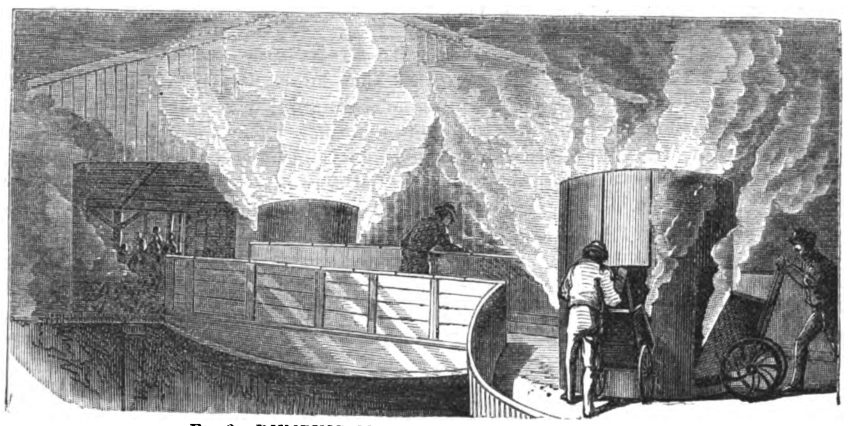

FIG. 3.—DUMPING ORE AND COAL INTO BLAST FURNACES.

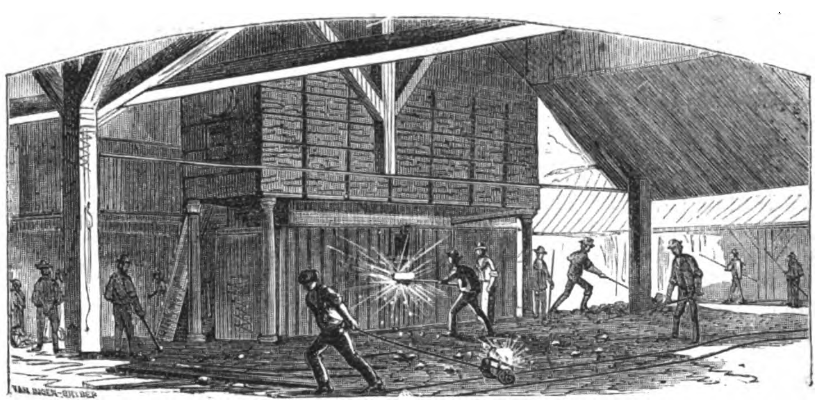

FIG. 7.—CARRYING THE IRON BALLS.

Clarke, Reeves & Co., the well known iron bridge builders, the accompanying engravings and description, deferring, to a subsequent article, illustration and notice of some of the most remarkable structures constructed at the extensive establishment of the above firm.

The Phœnix Iron and Bridge Works are located in Phœnixville, in the Schuylkill Valley, Pa., and were founded in 1790. At the present time over fifteen hundred hands are constantly employed, and the establishment is probably the only one in the world where the crude iron ore, fresh from the mine, can be followed through all its transformations until it emerges in the shape of a finished bridge.

Our illustration (Fig. 1) represents the blast furnaces. Hither, the ore, with coal and a flux of limestone, is carried, piled in, and subjected to the heat of the fires, driven by a hot blast and kept burning night and day. The iron, as it becomes melted, flows to the bottom of the furnaces, and is drawn off below in a glowing stream. Into the tops of these great fiery caverns, the ore and coal is dumped, being raised by elevators (Fig. 2) operated by a blast of air, and then thrown in by the men, as shown in Fig. 3. The blast for the furnace is driven by two three-hundred horse power engines, and is heatted by the consumption of the gases evolved by the material itself.

The engine room, with its giant machines, forms the subject of our fourth engraving. Twice every day the furnace is tapped, and the stream of liquid iron flows out into molds formed in the sand, making the iron into pigs (Fig. 5). Next follows the boiling process, the furnace being an oven heated to an intense heat by a fire urged with a blast (Fig. 6). The cast iron sides of the furnace are double, and a constant circulation of water is kept passing through the

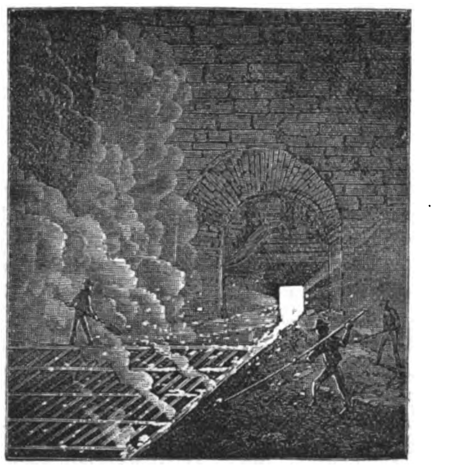

FIG. 5.—RUNNING METAL INTO PIGS.

chamber thus made, in order to preserve the structure from fusion by the heat. The inside is lined with fire brick, covered with metallic ore and slag over the bottom and sides, and then, the oven being charged with the pigs of iron, the heat is let on. The pigs melt, and the oven is filled with molten iron. The puddler constantly stirs this mass with a bar let through a hole in the door, until the iron boils up or "ferments," as it is called. This fermentation is caused by the combustion of a portion of the carbon in the iron; and as soon as the excess of this is consumed, the cinders and slag sink to the bottom of the oven, leaving the semi-fluid mass on the top. Stirring this about, the puddler forms it into balls of such a size as he can conveniently handle, which are taken out and carried on little cars, Fig. 7, made to receive them, to the squeezers. In the latter (Fig. 8) the ball is placed and forced with a rotary motion through a spiral passage, the diameter of which is constantly diminishing. The effect of this operation is to squeeze all the slag and cinder out of the ball, and force the iron to assume the shape of a short thick cylinder, called a bloom. This process was formerly performed by striking the ball of iron repeatedly with a tilt hammer.

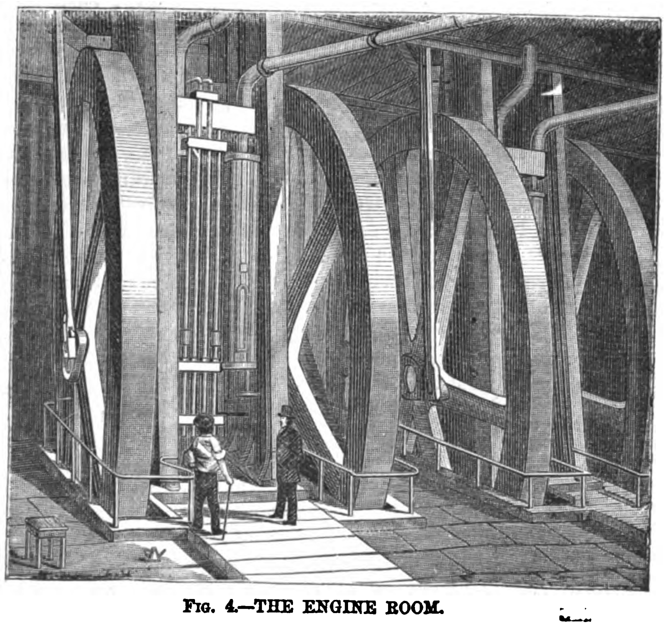

FIG. 4.—THE ENGINE ROOM.

The bloom is now reheated and subjected to the process of rolling. The rolls (Fig. 9) are heavy cylinders of cast iron placed almost in contact, and revolved rapidly by steam power. The bloom is caught between these rollers and passed backward and forward until it is pressed into a flat bar, averaging from four to six inches in width, and about an inch and a half thick. These bars are then cut into short lengths, piled, heated again in a furnace, and re-rolled. After going through this process they form the bar iron of commerce. From the iron reduced into this form the various parts used in the construction of iron bridges are made, by being rolled into shape, the rolls through which the various parts pass having grooves of the form it is desired to give to the pieces. These rolls, when they are driven by steam, obtain this generally from a boiler placed over the heating or puddling furnace, and heated by the waste gases from the furnace. This arrangement was first made by John Griffie, the superintendent of the Phœnix iron works, under whose direction the first rolled iron beams over nine

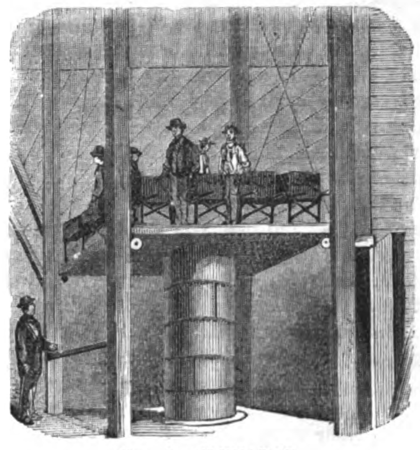

FIG. 2.—ELEVATOR.

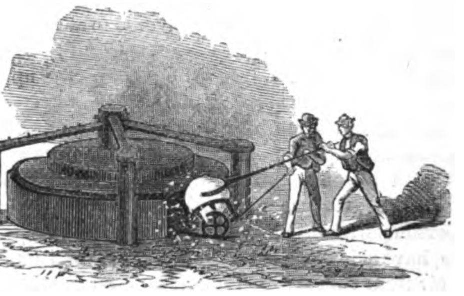

FIG. 8.—ROTARY SQUEEZER.

inches deep that were ever made were produced, at these works. The process of rolling toughens the iron, seeming to draw out its fibers; and iron which has been twice rolled is considered fit for ordinary uses. For the various parts of a bridge, however, where great toughness and tensile strength,

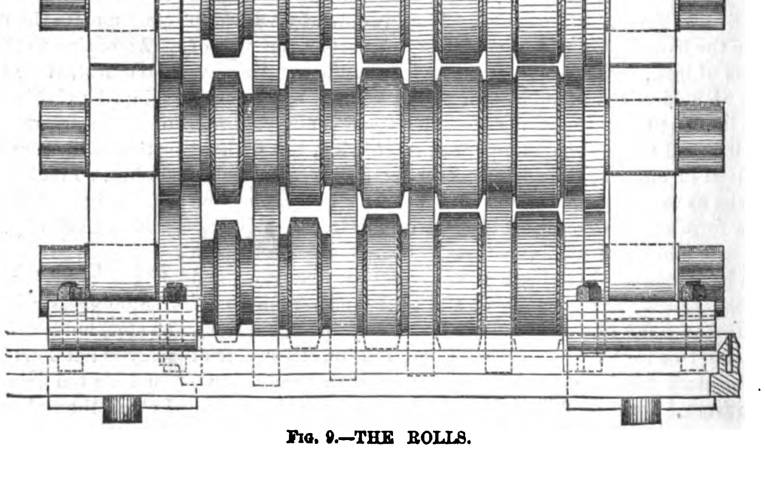

FIG. 9.—THE ROLLS.

as well as uniformity of texture, are necessary, the iron is rolled a third time. The bars are therefore cut again into pieces, piled, re-heated, and rolled again. A bar of iron which has been rolled twice is formed from a pile of fourteen separate pieces of iron that have been rolled only once, or "muck bar," as it is called; while the thrice rolled bar is made from a pile of eight separate pieces of double rolled iron. If, therefore, one of the original pieces of iron has any flaw or defect, it will form only a hundred and twelfth part of the thrice rolled bar. The uniformity of texture and the toughness of the bars which have been thrice rolled

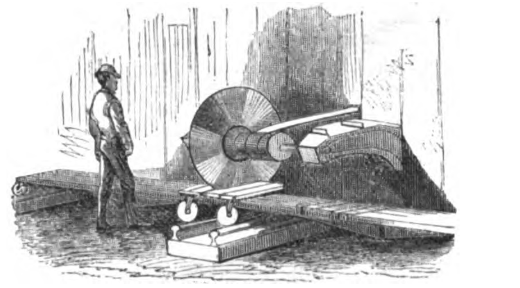

FIG. 10.—COLD SAW.

are so great that they may be twisted, cold, into a knot without showing any signs of fracture. The bars of iron, whether hot or cold, are sawn to the various required lengths by the hot or cold saws, shown in the illustrations, Figs. 9 and 10, which revolve with great rapidity.

For the columns intended to sustain the compressive thrust of heavy weights, a form of the firm's own design is used in this establishment, to which the name of the Phœnix column has been given. They are tubes made from four or from eight sections, rolled in the usual way and riveted together at their flanges (Fig. 12). When necessary such columns are joined together by cast iron joint blocks, with circular tenons which fit into the hollows of each tube.

To join two bars to resist a strain of tension, links or eye bars are used, from three to six inches wide, and as long as may be needed. At each end is an enlargement with a hole to receive a pin. In this way any number of bars can be

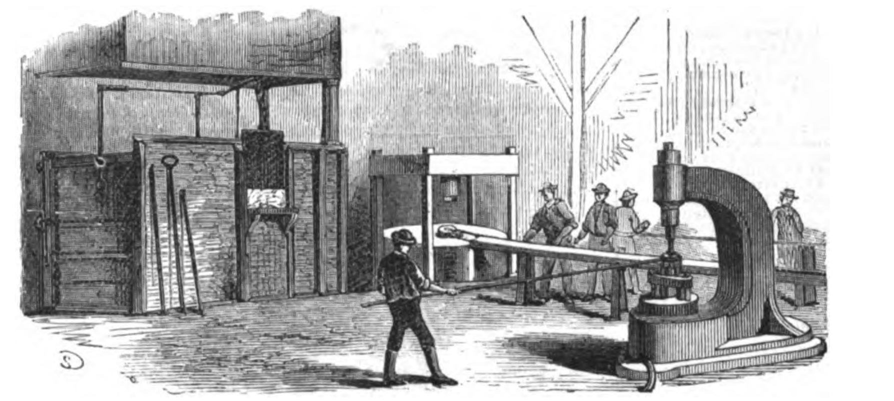

FIG. 13. FURNACE AND HYDRAULIC DIE.

joined together, and the result of numerous experiments made at this establishment has shown that, under sufficient strain, they will part as often in the body of the bar as at the joint. The heads upon these bars are made by a process known as die forging. The bar is heated to a white heat; and under a die worked by a hydraulic pressure (Fig. 13), the head is shaped and the hole struck at one operation. This method of joining by pins is much more reliable than welding. The pins are made of cold rolled shafting, and fit to a nicety.

The general view of the machine shop (Fig. 14), which covers more than an acre of ground, shows the various machines and tools by which iron is planed, turned, drilled, and handled as though it were one of the softest of materials. By means of this application of machines, great accuracy of work is obtained, and each part of an iron bridge can be exactly duplicated if necessary. This method of construction is entirely American, the English still building their iron bridges mostly with hand labor. In consequence also of this method of working, American iron bridges, despite the higher price of our iron, can successfully compete in Canada with bridges of English or Belgian construction. The American iron bridges are lighter than those of other nations, but their absolute strength is as great, since the weight which is saved is all dead weight, and not necessary to the solidity of the structure.

Before any practical work upon the construction of a bridge is begun, the data and specifications are given, and a plan of the structure is drawn, whether it is for a railroad or for ordinary travel, whether for a double or a single track, whether the train is to pass on top or below, and so on. The calculations and plans are then made for the use of such dimensions of iron that the strain upon any part of the structure shall not exceed a certain maximum, usually fixed at ten thousand pounds to the square inch. As the weight of the iron is known, and its tensile strength is estimated at sixty thousand pounds per square inch, this estimate, which is technically called a factor of safety of six, is a very safe one. In other words, the bridge is so planned and constructed that, in supporting its own weight, together with any load of locomotives or cars which can be placed upon it, it shall not be subjected to a strain of over one sixth of its estimated strength.

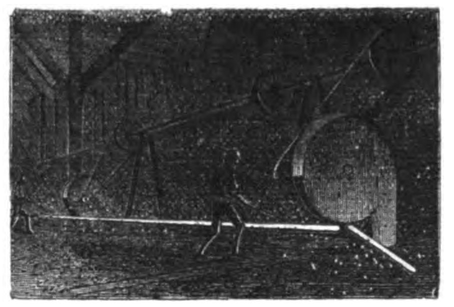

FIG. 11.—HOT SAW.

After the plan is made, working drawings are prepared and the process of manufacture commences. The eye bars, when made, are tested in a testing machine at double the strain to which, by any possibility, they can be put in the bridge itself. The elasticity of the iron is such that, after being submitted to a tension of about thirty thousand pounds to the square inch, it will return to its original dimensions; while it is so tough that the bars, as large as two inches in diameter, can be bent double, when cold, without showing any signs of fracture. Having stood these tests, the parts of the bridge are considered fit to be used.

When completed, the parts are put together or assembled, as the technical phrase is, to see that they are right in length, etc. (Fig. 15).

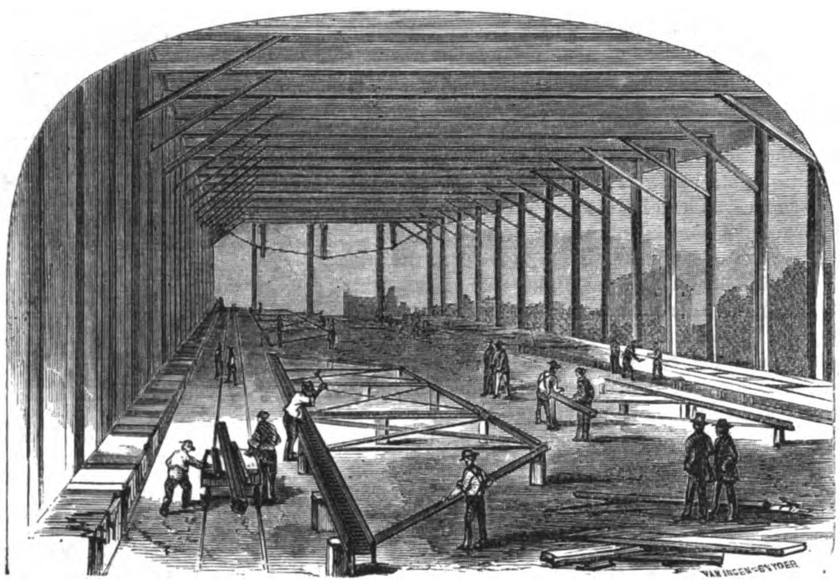

FIG. 15.—ASSEMBLING BRIDGE UNDER SHED.

Then they are marked with letters or numbers, according to the working plan, and shipped to the spot where the bridge is to be permanently erected.

As an example of the architectural beauty as well as the engineering skill displayed in the manufacture of these fabrics, we give on our front page an engraving of the Girard avenue bridge, in Philadelphia, Pa. Its width is one hundred feet, equal to six railroad tracks. It has three spans of one hundred and ninety-seven feet and two of one hundred and thirty-seven feet, with seven trusses.

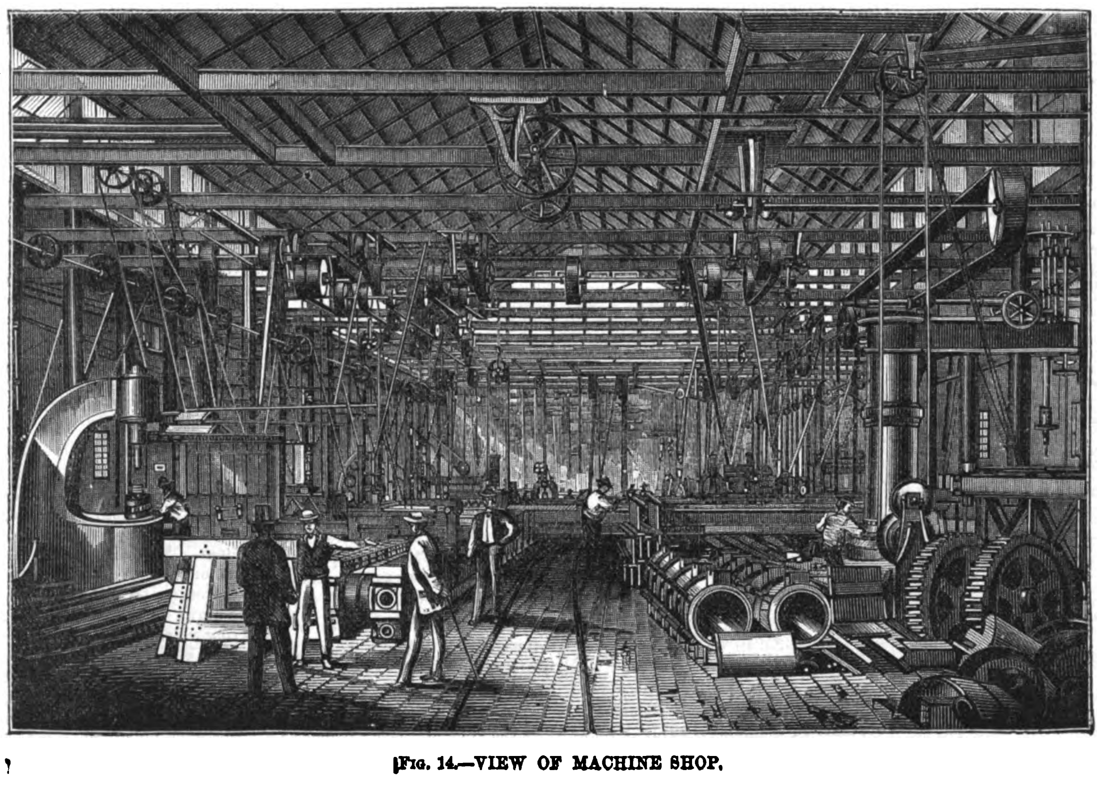

FIG. 14.—VIEW OF MACHINE SHOP.

Corns in Horses.

There is a wide-spread fallacy that corns usually depend upon some peculiar form of foot, and that with such feet they are, like coughs and colds, almost unavoidable even with the best management. The truth is, that corns are always caused by an ill-fitting shoe. So long as a level shoe rests evenly upon the proper bearing surface of the foot, no corn can occur, but when the surface of either foot or shoe is irregular, then the most prominent point of contact is pressed upon unevenly and bruised. A corn is a bruise and nothing more, save that usage has confined the term to bruises of one part of the foot—the angle of sole between the wall and bar. This part of the foot is most liable to injury by uneven pressure, because it is in relation to the termination of the shoe. If the end of the shoe does not reach the extremity of the heel, it forms a point upon which the yielding horn is pressed at every step. Short shoes then are most objectionable, and, we find, a frequent cause of corns. They are often purposely employed on hunters, and on horses with capped elbows, seldom really necessary, but if so, should be very carefully fitted. By way of avoiding corns, it is the common practice of many farriers to "ease the heel of the shoe," that is, to so fit it that the last inch of the shoe takes no bearing on the foot. A space is thus left between the shoe and foot in which one might place a penny piece. This is one of the greatest evils of shoeing, for not only is an inch of the best bearing surface of the foot unused, but increased pressure is thrown upon the spot where shoe and foot are in contact. Instead of preventing corns, it is a common cause, and why it should be so will be understood when we say that the seat of the corn is about an inch in front of the extremity of the foot, in fact, just at the spot upon which this "eased heel" throws most weight. Corns may be due to an uneven surface of foot, not of shoe, as when the wall at the heels is lower than the bar, in which case a level shoe is almost certain to act as an exciting cause.

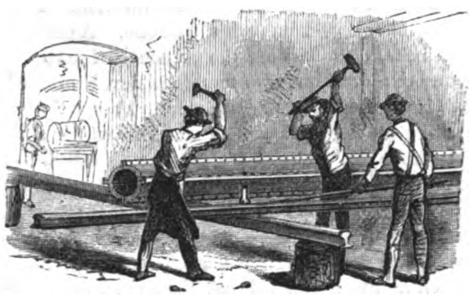

FIG. 12.—RIVETING A COLUMN.

Lameness from corn usually shows itself about a week after the horse is shod, depending of course upon the degree of pressure existing. In some cases, however, a corn is the cause of lameness after a shoe has been on for a month or more. This may be due to the shoe having shifted on the foot, or to the growth of horn carrying the shoe forwards and within the wall.

The inside heels of the fore feet are most commonly affected, because the shoes for them are always fitted closer on the inside than the out, and hind feet are hardly ever affected, because the shoes for them are always fitted long and wide.

Let us repeat, a corn is simply a bruise, similar in every way to a bruise of our nails. There is injury to the sensitive parts, followed by discoloration of horn. When a horse is lame, if on removing the shoe and gently trying the foot all round with the pincers, tenderness is shown at the heel, we suspect a bruise or corn. The farrier would at once cut away the horn at the part until he saw it discolored, and then would say he "had found a corn." Imagining this discolored horn to be the offending substance, he would proceed to remove it, layer after layer, until he reached the sensitive and now bleeding tissues. We need hardly point out the absurdity of this practice. The stained horn is simply a sign of injury to the sensitive foot, and the removal of this horn, while it does no good

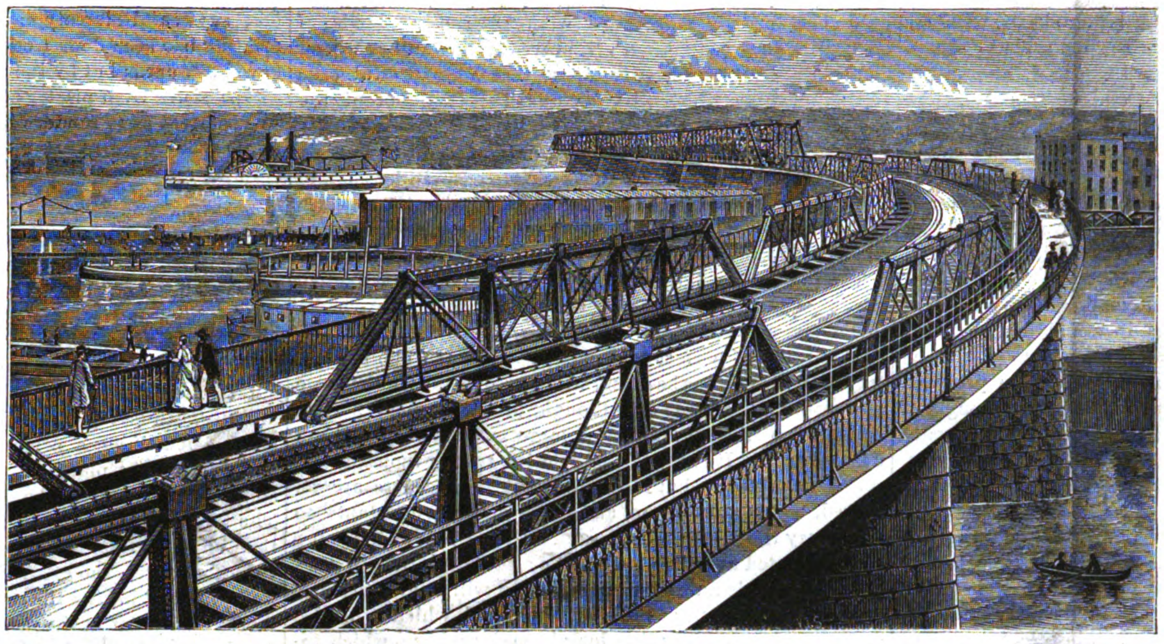

FIG. 1.—BRIDGE AT ALBANY.

FIG. 2.—BRIDGE AT AUGUSTA, MAINE.

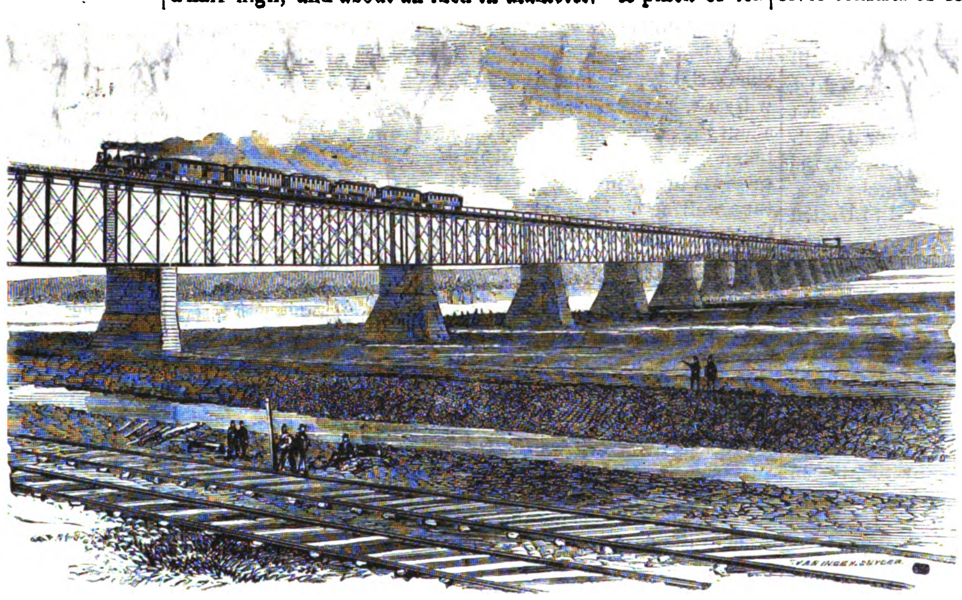

FIG. 3.—LA SALLE BRIDGE.

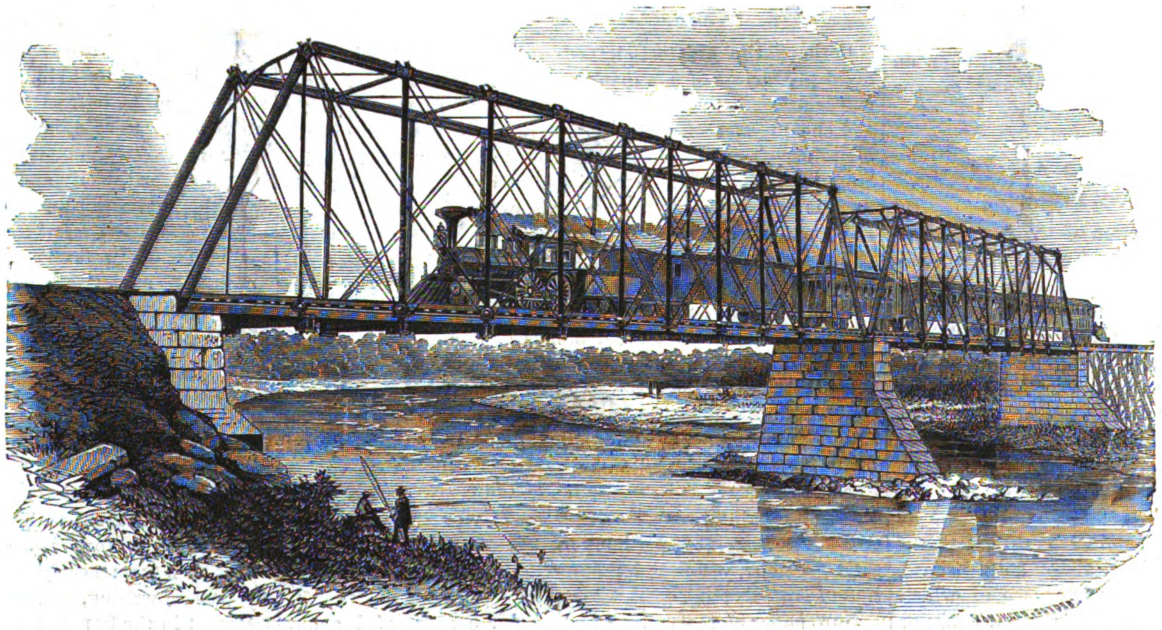

FIG. 4.—SACO BRIDGE.

ABOUT TEA.

Mr. Chan Lai Sun, Chinese Imperial Commissioner of Education, recently delivered a lecture in Springfield, Mass., on the subject of tea and its culture. He began by stating that tea grows in every province in China except three or four upon the northernmost Siberian border, but the quality and quantity depends largely upon the locality. The leaves resemble those of the willow, and are gathered during the spring and early summer. They are first exposed in a cool dry place for a day or two, then rolled into a ball on a table of bamboo slats, and dried in the sun. The rolling is to extract a portion of the juice of the leaves. After they have been dried in the sun, they are put into an egg-shaped iron pan over a charcoal fire, and incessantly stirred until a certain point of dryness is reached. The operator stirs with his hands, thrusting them in all portions of the pan, and practice enables him to dry the leaves almost exactly alike. The raiser superintends this process, and then brings his tea in bamboo baskets to the tea merchant, who adjudges its quality, and buys it at prices ranging from $15 to $20 per picul, equal to 133⅓ pounds. The merchant mixes his purchases together in a large reservoir, and at his convenience weighs out a number of pounds of tea leaves, and women and children spread them upon a large stage, and separate the leaves into grades according to quality. The tea stalks are the lowest grade, and the sorters are paid by the number of ounces of stalks they bring in. Children earn from 4 to 5 cents a day; the very best workers rarely earn as much as 10 cents a day. Americans could hardly live upon such wages, and until other nations can raise tea for 12 cents a pound they cannot compete with China in its production.

After the sorting each grade is packed by itself in chests or bamboo baskets, the first for exportation and the latter for home consumption. It is ordered by importers abroad through a tea taster, who receives a salary of some $3,000 a year and operates as follows: He has a long, narrow table, on which 60 or 70 cups are set; a boy weighs exactly one ounce from a small box into one of these cups, and if he has samples enough, all the cups are used. Hot water is then poured into each cup, and after five minutes the boy calls the master, who sips from every cup, holds the liquid in his mouth a moment, then ejects it and notes in his book the quality of the tea. The purchaser orders upon his taster's estimate, and when his packages arrive at the warehouse, about one in twenty is opened for comparison with the sample. If it proves of inferior grade, a material reduction is at once made in the price, so that without connivance with the tea taster the adulteration of tea is next to impossible in China.

The tea is always examined to determine its age, as it is choicer when young. It is a vexed question whether black and green tea belong to the same species; it is probable, however, that they are branches of the same variety, and the color depends upon the locality. If a seed of black tea be planted in the green tea region, a few generations will make them both alike. When black tea is high, green can readily be turned into black, but black cannot be made to appear green. The latter obtains its bluish color artificially, Prussian blue being used in the coloring, but in such small quantities as to be harmless. The annual average yield of a tea plant is about twenty ounces, and too much rain affects the quality as well as the amount. The plants live from 20 to 30 years, and, when old, are frequently cut down, and a young shrub grafted into the old stock. Quicker returns are thus obtained, but the plant does not last so long.

Tea is drank pure in China, but there are very different ways of preparing it. The Chinese tea connoisseur purchases an article costing variously from $16 to $20 per pound. If he uses this choicest kind, which is only grown on the tops of mountains, and of which only ten or fifteen piculs are produced in the kingdom, he has a baby teapot, an inch and a half high, and about an inch in diameter. A pinch of tea is put in, about twenty drops of hot water turned on, and it is ready to sip. It would be very intoxicating to drink much; even the taste of a sip will remain in the throat for hours after the tea has evaporated. The more common way of tea drinking is to have a teapot six feet high and three feet in diameter, kept warm, ready for any one to drink who chooses.

The speaker considered that, as long as the tea is of good quality, it matters little how it is prepared. The best way is to warm the pot with boiling water, then put in the tea and pour the water upon it. It should never be boiled.

The seeds of the plant are about the size of a small cherry; and from those not wanted for planting, oil is expressed, used for cooking purposes. The tea in this country is generally much injured by long conveyance by sea, and has a moldy taste to one who has drunk it in its freshness. The individual consumption of tea is much greater in China than here.

IRON BRIDGE CONSTRUCTION.

In our preceding article, we traced the manufacture of iron bridges from the state of crude ore to the finished fabric, ready for shipment to the locality where it is permanently to remain. We will now give our readers views and particulars of some of the most important bridges erected by Clarke, Reeves, & Co. The view of the Albany bridge (Fig. 1) will show the style which is technically called a through bridge, having the track at the level of the lower chords. This view of the bridge is taken from the west side of the Hudson, near the Delavan House, in Albany. The curved portion crosses the basin or outlet of the Erie canal, and consists of seven spans of seventy-three feet each, one of sixty-three, and one of one hundred and ten. That part of the bridge which crosses the river consists of four spans of one hundred and eighty-five feet each, and a draw two hundred and seventy-four feet wide. The iron work in this bridge cost about $320,000.

The bridge over the Kennebec river (Fig. 2), on the line of the Maine Central Railroad, at Augusta, Maine, is another instance of a through bridge. It cost $75,000, has five spans of one hundred and eighty-five feet each, and was built to replace a wooden deck bridge which was carried away by a freshet.

The bridge over the Illinois river, at La Salle, on the Illinois Central Railroad, shows the style of bridge technically called a deck bridge, in which the train is on the top. This bridge consists of eighteen spans of one hundred and sixty feet each, and cost $180,000.

The bridge on the Portland and Ogdensburgh Railroad, which crosses the Saco river, is a very general type of a through railway bridge. It consists of two spans of one hundred and eighty-five feet each, and cost $20,000.

The Lyman Viaduct (Fig. 5), on the Connecticut Air Line Railway, at East Hampton, Conn., is one hundred and thirty-five feet high and eleven hundred feet long.

The New River bridge, in West Virginia (Fig. 6), consists of two spans of two hundred and fifty feet each, and two others of seventy-five feet each. Its cost was about $75,000.

Before the erection can be begun, however, a staging or scaffolding of wood, strong enough to support the iron structure until it is finished, has to be raised on the spot. When the bridge is a large one, this staging is of necessity an important and costly piece of work. In Fig. 6 is shown the staging erected for the support of the above mentioned New river bridge, which is on the line of the Chesapeake and Ohio Railway, near a romantic spot known as Hawksnest. About two hundred yards below this bridge is a waterfall, and while the staging was still in use for its construction, the river, which is very treacherous, suddenly rose about twenty feet in a few hours, and became a roaring torrent.

The method of making all the parts of a bridge to fit exactly, and securing the ties by pins, is peculiarly American. The plan still followed in Europe is that of using rivets, which makes the erection of a bridge take much more time, and costs, consequently, much more. A riveted lattice bridge, one hundred and sixty feet in span, would require ten or twelve days for its erection, while one of the Phœnixville bridges of this size has been erected in eight and a half hours.

These specimens will show the general character of the iron bridges erected in this country. When iron was first used in constructions of this kind, cast iron was employed, but its brittleness and unreliability have led to its rejection for the main portions of bridges. Experience has also led the best iron bridge builders of America to quite generally employ girders with parallel top and bottom members, vertical posts (except at the ends, where they are made inclined toward the center of the span), and tie rods inclined at nearly forty-five degrees. This form takes the least material for the required strength.

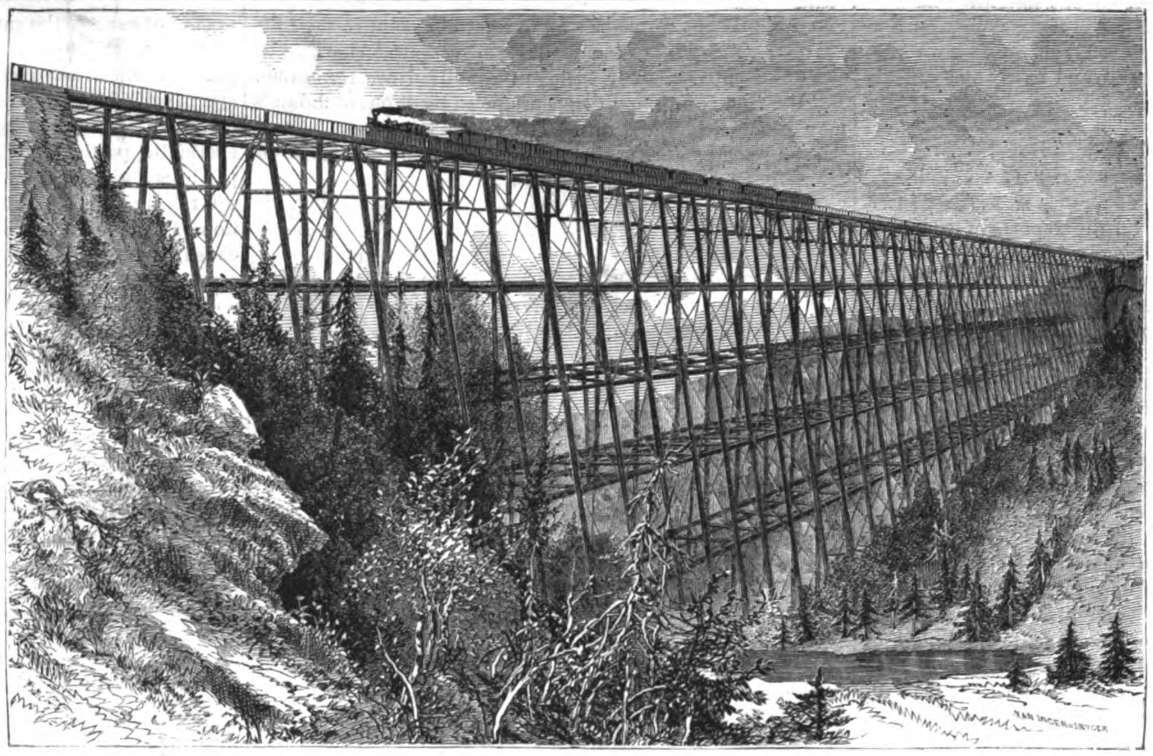

FIG. 5.—THE LYMAN VIADUCT.

The safety of a bridge depends quite as much upon the design and proportions of its details and connections as upon its general shape. The strain which will compress or extend the ties, chords, and other parts can be calculated with mathematical exactness. But the strains coming upon the connections are very often indeterminate, and no mathematical formula has yet been found for them. They are like the strains which come upon the wheels, axles, and moving parts of carriages, cars, and machinery. Yet experience and judgment have led the best builders to a singular uniformity in the treatment of these parts. Each bridge has been an experiment, the lessons of which have been studied and turned to the best effect.

There is no doubt that iron bridges can be made perfectly safe. Their margin is greater than that of the boiler, the axles, or the rail. To make them safe, European governments depend upon rigid rules, and careful inspection to see that they are carried out. In this country government inspection is not relied on with such certainty, and the spirit of our institutions leads us to depend more upon the action of self-interest and the inherent trustworthiness of mankind when indulged with freedom of action. And so we find that the best security for the safety of iron bridges is to be found in the self-interest of the railway corporations and others, who certainly do not desire to waste their money or to render themselves liable to damages from the breaking of their bridges, and who consequently will employ for such constructions those whose reputation has been fairly earned, and whose character is such that reliance can be placed in the honesty of their work.

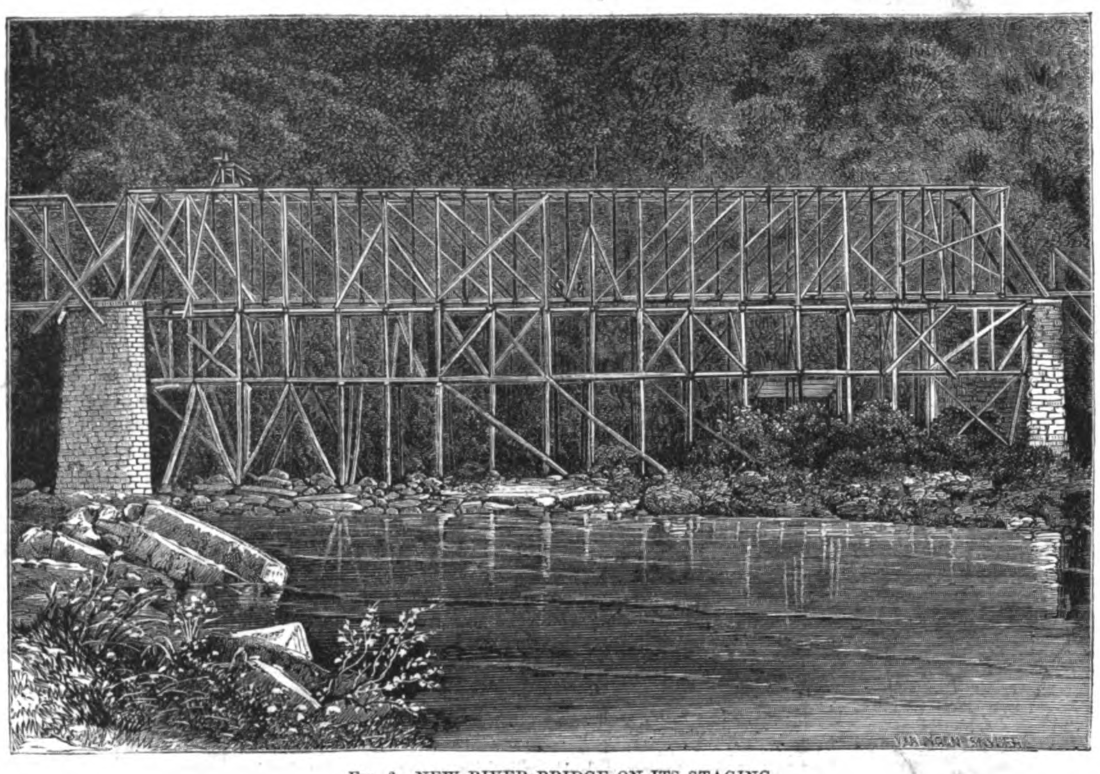

FIG. 6.—NEW RIVER BRIDGE ON ITS STAGING.

The fall of the Dixon bridge, with its three score of victims, and similar disasters which have, from time to time, shocked the community, go far toward proving the truth of this proposition. Experience, we trust, has fully demonstrated the futility of intrusting the construction of fabrics, to which the lives of hundreds may be confided, to parties whose sole claim to consideration is a plausible-appearing invention on paper or in the model, but whose ideas have never withstood any prolonged or severe ordeal of practical use.

We close our description in presenting a general view of the Phœnix Works (Fig. 7). From this a good idea of the large extent of the establishment may be gained.

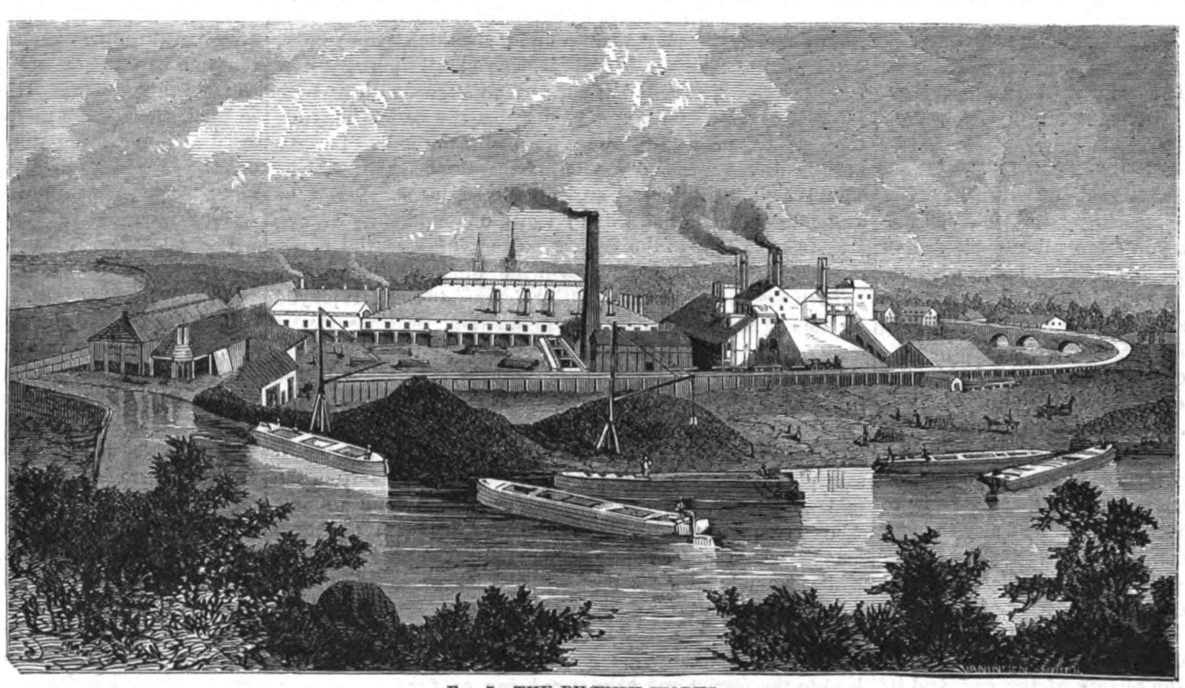

FIG. 7.—THE PHŒNIX WORKS.

The extent of this important center of industry fully justifies us in giving the public this ample and detailed description of one of the most interesting of American manufactures. For the engravings we are indebted to the publishers of *Lippincott's Magazine.*

Recent Life Boat Experiments.

Experiments recently made at Liverpool with an iron life boat, constructed from the designs of Mr. Hamilton, of the Windsor Iron Works, have given some very satisfactory results as far as its strength and stability are concerned. The boat is 25 feet long, with 7 feet beam, and 3 feet 3 inches inside depth. She is double bowed, with side and end air chambers. The boat, when empty, had 2 feet 8 inches free board amidships. Eleven men were made to stand upon the edge of the gunwale until the water just touched the edge of the gunwale on the loaded side. The boat was kept in this position for five minutes. Twenty-one men then jumped on board, and the boat being trimmed level, the freeboard was found to be 2 feet 1⅝ inches, or only 6⅞ inches deeper in the water than when empty. The boat was then tested as to her carrying power. She was filled with as many men as she could conveniently hold, and her ample accommodation for passengers, in proportion to her width and length, and her remarkable air buoyancy, were shown by the fact that, with forty-seven men on board, the boat preserved a freeboard of nineteen inches. With this number of men on board the boat was rocked heavily from gunwale to gunwale, but shipped no water. The men were then ordered out, and told to jump into her hurriedly, in order to realize the behavior of a life boat under circumstances of confusion or emergency arising from fire, collision, etc. The steadiness and buoyancy of the boat enabled her to stand this test also satisfactorily. The boat was then filled to the outside level with water, and with twenty-one men on board she had still a freeboard of 16¼ inches. She was again rocked heavily, when it was seen that the water acted as ballast and promoted steadiness, the motion of the water being checked and confined to the center of the boat (in conformity with the requirements of the Ships' Life Boats Committee) by the perpendicular shape of the inner sides of the side and end cases or compartments. As another test of buoyancy, the boat was filled to the outside level with water, but with no one on board, when the freeboard showed 20½ inches. The boat was then filled with water to the thwarts, in order to show her manageability in the event of being filled by a heavy sea. Two plugs in the bottom of the boat were then drawn, and the boat gradually relieved herself of the water until it had subsided to the level of the water in which she floated. The last test of buoyancy was to fill the boat with water to the outside level, and then to direct twelve men to stand on the gunwale. The water of the dock thereupon just touched the edge of the gunwale, showing that the water ballast gave her really greater buoyancy and stability. Lastly, to test the enormous strength of iron boats constructed on this principle, a dingy of a size suitable for coasting vessels—12 feet long by 5 feet beam, and 2 feet 4 inches in depth inside—was dropped from the crane bodily into the dock—a hight of upwards of 21 feet. It fell perfectly flat, with a tremendous force of impact and a noise as of thunder. On examination it was found that the bottom of the dingy ,on the starboard side, was slightly flattened, but that not a single joint or rivet had been started, and that the buoyancy of the boat had in no wise been affected.

The London *Times* says that the impression made by these crucial trials was that Messrs. Hamilton & Co. have, in their patent life boat, in the words of Captain Ward, Inspector of Life Boats to the National Life Boat Institution, provided a "*bonâ fide* life boat for passenger ships and merchant vessels, and that if the Northfleet and Atlantic had been supplied with these boats and a proper boat lowering apparatus, hundreds of lives might have been saved." The extra buoyancy of these boats, which secures their manageability after being filled by a heavy sea, is obtained by means of inclosed air. The lateral stability and steadiness in a heavy sea are secured by distributing this air buoyancy along the sides of the boat, while an ample amount of end buoyancy gives longitudinal stability and prevents the water being shipped in a heavy sea from rushing to either end of the boat. This side and end buoyancy is obtained by means of a series of portable water-tight cases or boxes, conforming