THE UNDERGROUND RAILWAY, NEW YORK CITY.

NUMBER III.

[Continued from page 323.]

In our paper for November 14, page 307, we began our description of this great engineering work, giving a diagram of New York city and the adjacent territory, showing the position of the Underground Railway, now nearly completed through the northerly portion of the city, 4½ miles, and the route of its authorized extension down town, under Broad way to the Battery, 4½ miles. We also gave a profile of the railway, showing its grades, depths below surface, street grades, character of the work, etc.; also the contract prices paid for the work, outline of the law for construction, names of the official supervising engineers, names of the engineers in charge, contractors, etc. We also gave a view of the first bridge over the railway, at 45th street. In our following number, November 21, page 323, we gave a cross sectional elevation of the open cut of the railway on Fourth avenue, with a view of the bridge over the open cut between 52d and 53d streets, with a description of this open portion of the line, dimensions, etc. We now come to that section of the railway passing entirely under the surface of the ground, where the construction of what are known as the beam tunnels begins.

Fig. 6 is a view on Fourth avenue, looking north, from 59th street to 76th street, and shows the appearance of the surface of the street under which these tunnels pass, and the ventilating openings of the tunnels. Fig. 7 is a cross sectional elevation of the same, showing the mode of construction.

This iron beam tunneling is only resorted to where sufficient headway could not be obtained for the arched brick tunnels. By again referring to the profile (page 308), it will be seen that it has been found expedient to use this latter kind of tunnel only where the difference of railroad and avenue grades is greater than 19 feet, while the beam tunnel is used, with a slight alteration of the street grade, at points where this difference is as small as 11 feet, and, as a consequence, more than five thousand feet, of what would otherwise have been open cut, has been covered in with beam tunnels.

Like most of the other tunnels used on the work, the beam tunnels are divided into three separate tunnels, contained within four walls, two outer and two inner, upholding the roof, which is composed of wrought iron beams with turned brick arches between them; the roof, in its turn, sustains the earth and paving of the street. The two outside walls are a continuation of the retaining walls of the open cut, described in our last paper, and are built of gneiss rubble masonry of the same class as that used in the before described retaining walls, seven feet thick at railroad grade, and sloping off thence with a batter, on the inside face, of one inch to the foot, to a thickness of three feet at top of the wall, which, in general, is fifteen feet above grade. The top course of this masonry is composed of stones fourteen inches thick, two feet wide, and three feet long, with pointed beds and joints.

Between the two outer walls and thirteen feet distant from them in the clear, are placed the two inner walls of brick, resting on a stone or gneiss rubble foundation, three feet thick and three feet wide below railroad grade. The walls which rise from these foundations are built of brick without batter, are twenty inches thick and high enough to receive the roof beams, and are tied with fine courses of North River blue stone, five inches thick and well dressed. Along the top of each of these two inner walls run, side by side, the flanges touching, two H-shaped wrought iron girders, twelve inches deep and bound together by half inch bolts, in the manner shown in Figs. 10, 11, which illustrate the method of binding together the girders, and of fastening the roof beams to the girders. These longitudinal girders are of the best wrought iron, weighing one hundred and twenty-five pounds to the linear yard, and are joined longitudinally in such wise that, should any portion of the brick wall supporting them be by any accident thrown down, the longitudinal girders will offer a rigid support to the roof beams and the earth resting upon them. On top of the longitudinal 12 inch girders and bound to them by half, in bolts passing through the flanges, as shown in Figs. 10, 11, rest the iron beams composing the roof. These are also H-shaped

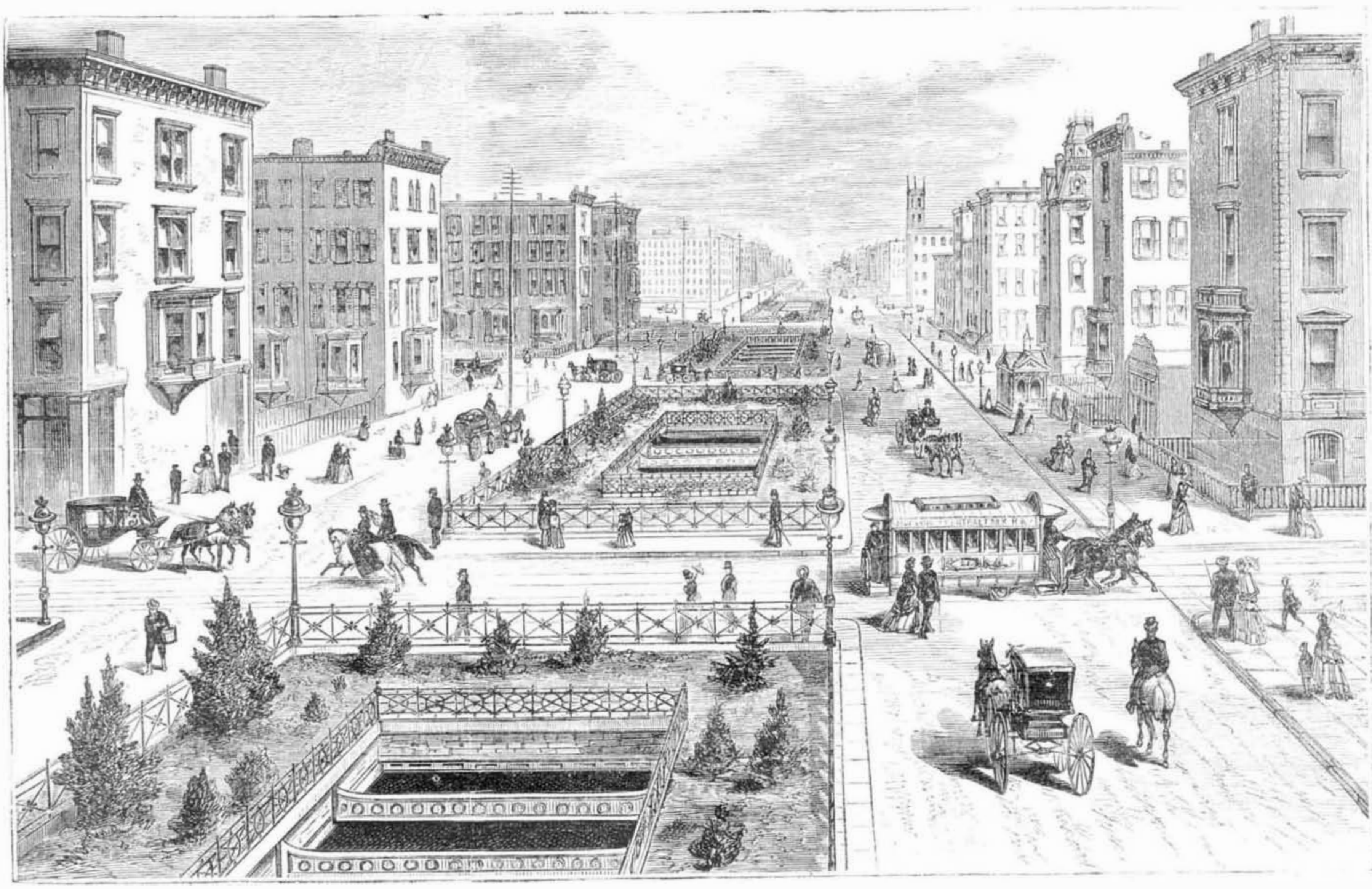


Fig. 6.—THE UNDERGROUND RAILWAY, NEW YORK CITY.—BEAM TUNNEL OPENINGS ON FOURTH AVENUE, 59th TO 76th STS.

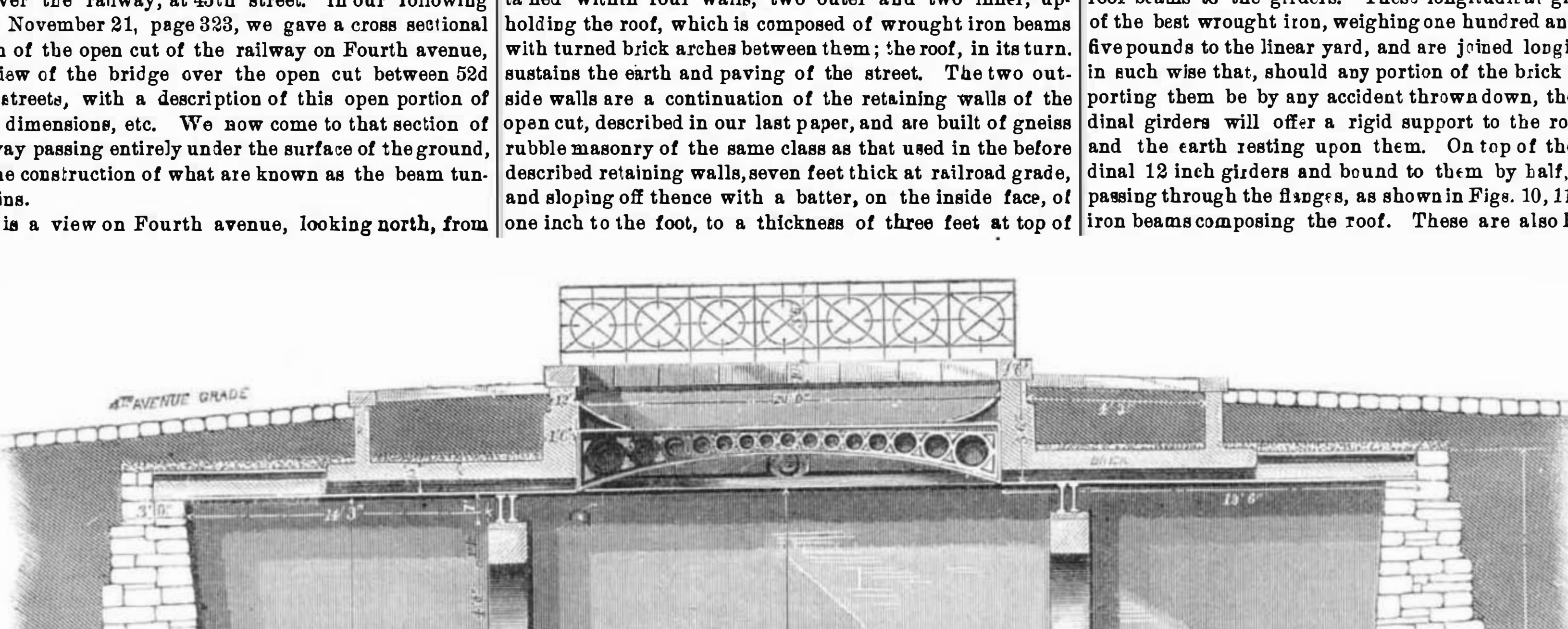


FIG. 7.—THE UNDERGROUND RAILWAY IN NEW YORK CITY.—CROSS SECTIONAL ELEVATION OF THE BEAM TUNNELS AND VENTILATORS 59TH TO 76TH STREETS

but very much heavier and deeper than the girders on which they rest, being fifteen inches deep and weighing two hundred pounds to the linear yard, and varying in length from sixteen to twenty-seven feet. They are placed upon the walls, at right angles to the length of the tunnel, and three feet five inches apart from center to center, strapped and anchored, and tied together with one inch iron tie rods, cast iron thimbles being placed between the beams at each tie rod and at the ends. This manner of tying the beam is illustrated in Fig. 11, which represents a cross section through two of the beams placed over the large central tunnel, as also the horizontal projection of a longitudinal section through the center, showing the thimble at the tie rods. The strapping consists of two iron bands or straps, one of which passes from the top flange of one beam under the bottom flange of the second, and to the top flange of the third; the other, from the bottom flange of the first beam to the top flange of the second, and thence to the bottom of the third, the straps being fastened at each flange.

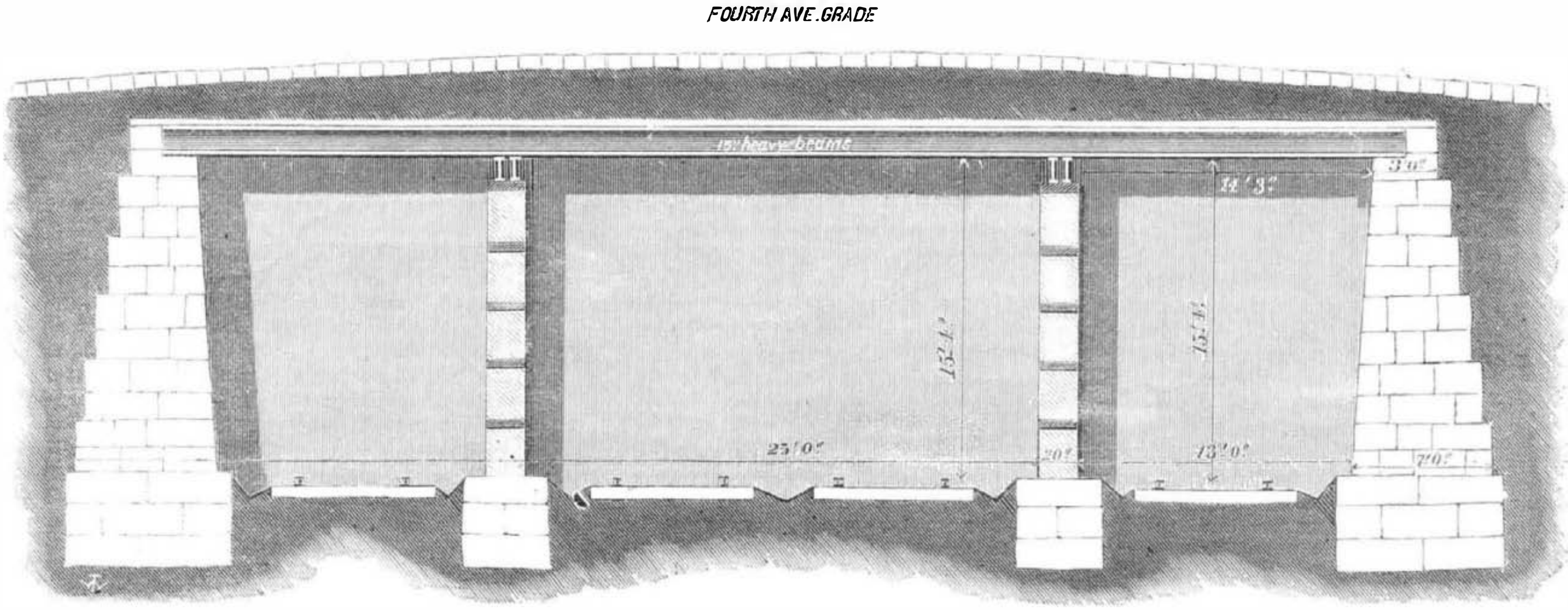


FIG. 8.—THE UNDERGROUND RAILWAY, NEW YORK CITY.—SECTIONAL ELEVATION OF THE BEAM TUNNELS, BETWEEN THE VENTILATORS,—59TH TO 76TH STREETS.

Over the small side tunnels, whose span is but 14 feet 3 inches, the roof beams are placed singly; but over the central tunnel, which has a span of 25 feet, they are placed in pairs, that is to say, two beams are placed side by side so that their flanges touch, each pair being 3 feet 5 inches apart from center to center. See Fig. 9.

Between the beams are placed the turned brick arches, 8 inches thick. The whole is then covered, to a depth of 4 inches above the tops of the beams and arches, with concrete, composed of one part Ulster county hydraulic cement and two parts sand and gravel, or stone, broken so as to pass every way through a two inch ring; over this is placed a coating of three-ply roofing felt and cement, and then the earth and paving.

The main central tunnel is lighted and ventilated through openings, twenty feet wide and one hundred and fifty feet long, placed one in each block.

We mentioned that the roof beams varied in length from sixteen to twenty-five and twenty-seven feet. The reason for this variation will now be quite apparent. The sixteen feet beams are used to span the small or side tunnels, which have a width at top of 14 feet 3 inches; the twenty-seven feet beams span the large central tunnel, whose breadth at top is twenty five feet, while the twenty five feet beams are used where the openings occur in the large tunnel, one end resting on the outer wall and the other projecting over the inner brick wall into the central tunnel. See Fig 7.

Around these openings are placed brick retaining walls, which rise to the level of the street and are then coped with a coping of first class pene-hammered granite coping, sixteen inches by ten inches, which supports a light iron railing. The brick face of the opening is faced with cast iron and braced with cast iron beams placed about seventeen feet apart, two feet three inches high, twenty-five feet long, bound to the roof beams by bolts, and anchored in the brick wall. Immediately beneath these openings there occur, in the brick walls which separate the central from the two side tunnels, a series of arched openings, which give light and ventilation to the small side tunnels (see Fig. 9). These openings in the brick walls are placed all along the upper part of the wall for the entire length of the central opening, and are four by eight feet.

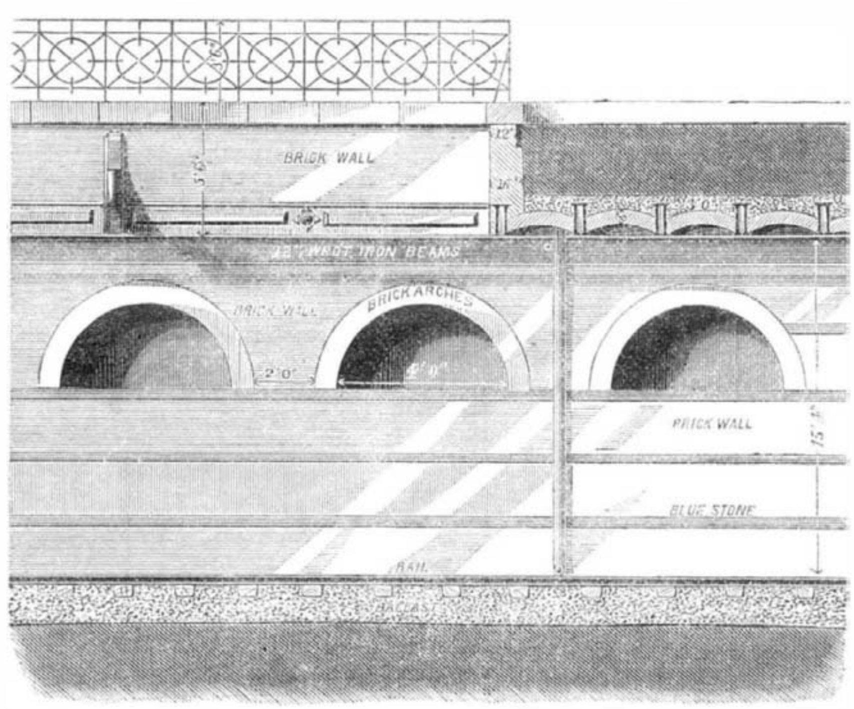


FIG. 9.—THE UNDERGROUND RAILWAY, NEW YORK CITY.—LONGITUDINAL SECTIONAL ELEVATION OF THE BEAM TUNNELS.—59TH TO 76TH STREETS.

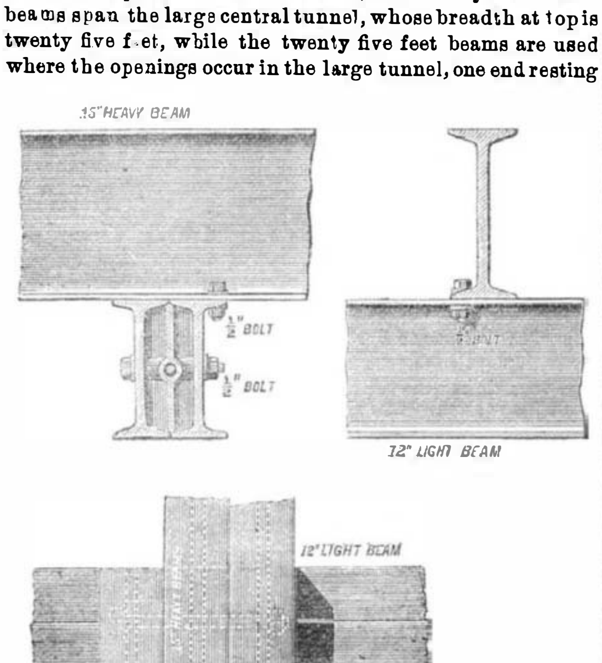


FIG. 10.—THE UNDERGROUND RAILWAY, NEW YORK CITY.—JOINTS AND COUPLINGS OF THE IRON BEAMS.

The Temperature of the Sun.

M. Violle considers that the emissive power of the sun at a given point on its surface will be the relation between the intensity of the radiation emitted at such point and the intensity of radiation which a body, having an emissive power equal to unity and carried to the temperature of the sun at the considered point would possess. So that he defines the true temperature of the sun as the temperature which a body of the same apparent diameter as the sun should possess in order that this body having an emissive power equal to the average of the solar surface, may emit, in the same period, the same quantity of heat as the sun. From experiments made at different altitudes, M. Violle determines the intensity of the solar radiation, as weakened by passage through the atmosphere, and finds, for the effective temperature of the sun, 2,822° Fah.

Investigations conducted with an actinometer by the dynamic method lead the investigator to conclude that steel, as it emerges from a Siemens Martin furnace, has a temperature of 2,732° Fah. If it be admitted that the average emissive power of the sun is sensibly equal to that of steel in a state of fusion, determined under like conditions, it appears that the mean true temperature of the solar surface is about 3,632° Fah.

THE Patent Office has granted a patent for a dummy, for dry goods merchants, to enable them to make a large show on a small stock. It consists of a block of wood, neatly done up in a cover of cloth, labeled and ribboned to represent, in exterior appearance, a full package of real goods.

American Iron.

It is proverbial, at least among the Americans themselves that they, of all nations, possess in its greatest plenitude the faculty of recuperation. From time to time the American world of business is distracted by financial typhoons; the vessel of state is laid on her beam ends; hotels, and even theaters, reduce their prices; and stern admonitions issue from press and pulpit that the period of piping and dancing is over, and that the—possibly mythical—homely habits of the ancient settlers must be revived before there is again health in the land. These lessons are received with very different feelings in various parts of the country. Boston and Providence may perhaps abase themselves in private (for no man has seen them performing that operation *coram populo*), but gay New York and the great West maintain a hopeful, not to say defiant, attitude. Better times must come. Things will get "fixed" at last; and if ruin has been incurred, the boundless resources of a great country will help everybody to begin over again.

This hopeful spirit is not without some admixture of solid truth. A lapse of twelve months has brought about a notable change in the feeling of financial circles in New York. To a less extent this reactionary spirit has made itself felt in other great speculative centers, such as Chicago, St. Louis, and Boston. Especially in the direction of railroad securities has renewed confidence been manifested. Shares long neglected have recently met ready purchasers, and there exists that general disposition to invest which is an infallible sign of the revival of business. Under the influence of the late panic, railway property—the *teterrima causa* of the crash of last autumn—suffered most severely; but recent advices show that things were not so bad as they seemed. Stocks have advanced, and chances are in favor of greater activity and heavier investments than have been known for a long time past.

This revival of railway enterprise is not without significance to the iron trade, both of England and of the United States, which latter country has, within the last few years, immensely advanced in the production of iron.

The Americans have a splendid "forest primeval," but the blast furnace is a great devourer, and will thin the surrounding country in an alarmingly short space of time. Possibly improved railway communication will more than keep pace with the rapid destruction of timber, but the significant fact yet remains that, out of 630 furnaces in blast in 1873, 265 were supplied with charcoal. No charcoal smelting of iron can be long lived; and it is, therefore, clear that, unless increased railway communication be provided, a certain section of the iron industry of the United States will

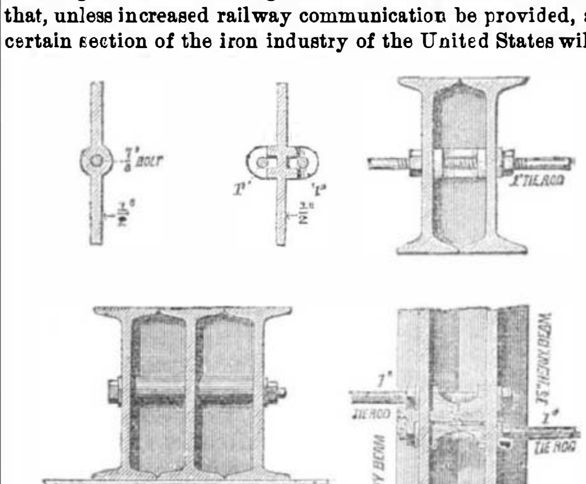


FIG. 11.—THE UNDERGROUND RAILWAY, NEW YORK CITY.—JOINTS AND COUPLINGS OF THE IRON BEAMS.

be soon "played out." Vigorous efforts will undoubtedly be made to put other iron producing centers on a level with Pittsburgh, by improving the communication between coal and iron regions; but the truth will always remain constant, that,however rich iron ore may be,it will not pay to carry it too far.

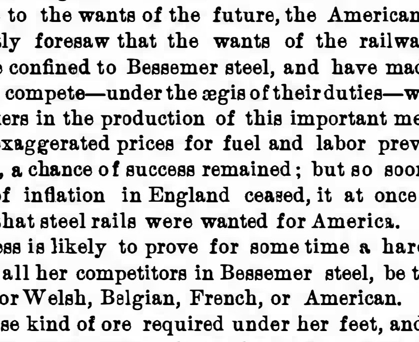
For a long while the American makers had a heavy uphill journey, as, although they were protected by an enormous tariff, and were supplied with a huge home demand,English makers of railway material swept the market. An unprecedented advance in the price of English coal, and consequently of iron, during the last three years,deprived English makers for a while of their advantage, and, despite dear labor, the American ironworks rose last year to a high pitch of prosperity. The delicate conditions of business in the United States failed, however, last autumn to withstand the tension of the financial world, and the American iron and steel trade suffered a paralysis which it communicated in no small degree to the trade of Great Britain. With a keen eye to the wants of the future, the American makers apparently foresaw that the wants of the railway world would be confined to Bessemer steel, and have made great efforts to compete—under the ægis of their duties—with English makers in the production of this important metal. So long as exaggerated prices for fuel and labor prevailed in England, a chance of success remained; but so soon as the period of inflation in England ceased, it at once became evident that steel rails were wanted for America. Barrow-in-Furness is likely to prove for some time a hard nut to crack for all her competitors in Bessemer steel, be the same English or Welsh, Belgian, French, or American. She has the precise kind of ore required under her feet, and in this particular possesses an undoubted advantage over American rivals. That a country may escape ridiculous smallness by being inconveniently large, is proved by the significant fact that Algerian and Bilbao ores cost at the furnace in America $20 per tun, when they may be bought at Barrow or at Cardiff for $6.25. Without "magnificent distances", the superb supplies of iron ore in "the States" would be speedily utilized; but until increased and cheaper railway communication has brought her coal and iron closer together, America will need all her unquestionable energy and ingenuity to compete with England in the world of iron.—*Iron.*

Correspondence.

Universal Joints in Screw Shafts.

To the Editor of the Scientific American:

I have lately noticed in your valuable paper a number of references to the use of Hooke's universal joint in a screw shaft, but I have seen nothing resembling an invention of my own in that direction, and I would like to call your attention to it. The engraving, I think, explains itself, and it



is designed to facilitate the handling of small boats, like launches intended for torpedo work.

The propeller and that portion of the shaft beyond the universal joint is hung in a composition frame, which takes the place of the ordinary rudder. A line passing through the axis of motion of the pintles and gudgeons would also pass through the center of the ball of the universal joint; and by means of the frame, the propeller is thrown to the right and left in steering. My invention has been applied to one of our torpedo launches, and has been in operation for several months. The speed of the boat is exactly the same as it was with the same propeller fitted in the ordinary way; while the rapidity with which she can turn to starboard or port is very much increased, the diameter of her circle being much decreased. The rudder framehead is fitted with an arc which gears into a rack on the side of a cylinder moving athwart the stern of the boat, so that she can be steered by steam or compressed air. An ordinary wheel is, however, fitted, which answers every purpose in a small launch, as it requires very little force to throw the propeller from one side to the other.

I have no patent on my invention; and perhaps, if you print my sketch, some one may get an idea from it.

F. M. BARBER, Lieutenant U. S. N.

Torpedo Station, Newport, R. I.

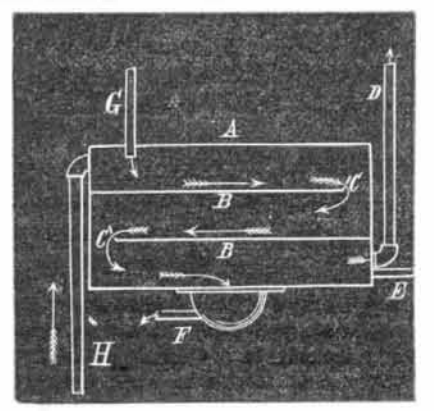
Small Steam Engines.

To the Editor of the Scientific American:

Several of your correspondents having written somewhat upon the performance of small engines, I would like them to see what I am doing.

My engine cylinder is 4 inches by 10 inches stroke, and runs at 120 revolutions per minute; it has a common D valve, and cuts off at ⅝ of the stroke; it has a boiler pressure of 60 or 70 pounds. With this engine I run my machine shop, which has 52 feet of 1⅞ inch shafting, running at 200 revolutions, driving two engine lathes of 8 and 6 feet bed respectively, one planer of 6 feet bed, one upright drill (medium size), one small drilling lathe of 4 feet bed, one drop hammer (hammer weighs 300 pounds), one blower, one grinding machine for grinding rolls, etc., beside a grindstone and an emery wheel. These tools are in my own shop. I run a quarter-turn 4 inch belt into the next building, and drive 32 feet of 1⅞ inches shafting, and one large iron blacksmith's or boiler maker's punch and shears combined, and one medium-sized upright drill. I also take another quarter-turn 4 inch belt from my shaft, and (by three countershafts and pulleys) reach the second story of the second building, and go thence up into the third story of the same, and there drive 54 feet of one inch shafting, and 30 sewing machines running upon heavy cotton goods. I also take from my main line in my shop a rope belt of 1½ inches diameter, and drive (in the third store adjoining me on another side, 56 feet distance between shafts) some coffee-roasting and spice mills.

My boiler is of locomotive style, with a 26 inch shell, 6 feet long, with twenty-nine 2¼ inch flues; the fire box or grate surface is 22 x 28, with a smoke stack 40 feet high and 10 inches in diameter, with a damper. I use no blower; I burn coke and bituminous screenings mixed (about 2 barrels per day). I evaporate about 20 gallons of water per hour, introducing it into the boiler, through a heater of my own construction, at about 206° Fah.



A, heater of sheet iron; B B, two sheet iron pans; C C, points where the pans are turned up a little, and small holes drilled through; D, pipe where steam escapes; E, overflow pipe; F, pipe by which hot water is taken to pump; G, cold water pipe from tank; H, exhaust pipe from engine.

You will see that I introduce the exhaust steam and cold water at a point as near to each other as possible, and that both steam and water travel together over the two pans to their exit, the water falling down upon each pan successively, and through little holes drilled in the ends of the pans for that purpose, in order to expose as much of the surface of the water to the action of the steam as possible, until it reaches a little well in the bottom of the heater, whence I convey it to the pump. I admit only just enough water to this heater to keep my boiler supplied.

If any of your readers are doing more work with less engine, I would like to hear from them. O. B. FENNER.

San Francisco, Cal.

Cribbing in Horses.

To the Editor of the Scientific American:

The letter upon cribbing in horses, from D. Cook, Elmira O., is calculated to do a great deal of harm, without any advantage arising therefrom.

He says that the habit is caused by some foreign substance being pressed between the teeth, or by the front teeth growing too close together, thus causing pain. If this were the case, I ask him: Why a great many horses, during the act of cribbing, always apply the under jaw, instead of the teeth, to the manger? His treatment for the same, which no doubt he offers as an entirely new idea, has been known to horsemen for years, but is seldom practised by them.

Instead of crib-biting or wind-sucking being caused by pain in the teeth, it is due to a derangement of the stomach.

Filing the incisor teeth apart, in the place of relieving pain, very often produces it; and therefore, whenever it is successful in preventing the animals from indulging in the habit—which is but seldom—it is on account of the soreness of the teeth occasioned by the operation.

To enable a horse to swallow wind, it is necessary for the muscles of the neck to contract, and the only object in applying the teeth or jaw to the post or manger is to afford a fulcrum for these muscles to act from. J. C. HIGGINS.

Millstone, N. J.

Forming and Tempering Taps.

To the Editor of the Scientific American:

I find that T. I. B.'s tap, a quarter inch in diameter, which has tapped "over two hundred thousand hot forged nuts," was made according to the instructions given by Mr. Rose in his valuable practical essays. It was forged to as near its finished size as possible, so that it would true up. It was passed through a hardened steel gage. It had three half round grooves, the only clearance being to ease off the tops of the threads. It was heated to a cherry red, "red without being hot enough to scale," then dipped endways, and the shank made the softest and tempered on a piece of iron, as given in "Practical Mechanism" for dies. All these operations are precisely those recommended by Mr. Rose: and it is curious that it broke from being applied to a hole that was too small, giving it, as Mr. Rose puts it, "more duty than it should be required to perform."

As a mechanic, I agree with T. I. B. as to his method of making and of sharpening a taper tap, and thank him for giving to the world, through your columns, the method and result of his practice, which is truly remarkable.

East New York, L. I. MACHINIST.

[The above is only one out of many scores of letters which we receive, constantly testifying to the value of the articles on "Practical Mechanism."—EDS.

A New Friction Brake.

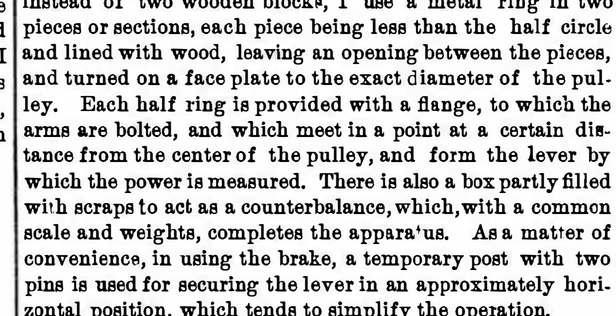
To the Editor of the Scientific American:

In your issue of October 31, 1874, is an illustration and description of a simple friction brake for testing the power of small engines. Having given some attention to the various kinds of dynamometers for such purposes, I submit for your inspection a modification of a brake somewhat similar The difference between this brake and that referred to consists in the weights of my brake being suspended from a center line horizontally through the shaft. It does not require the piston in oil which forms a part of your brake; and instead of two wooden blocks, I use a metal ring in two pieces or sections, each piece being less than the half circle and lined with wood, leaving an opening between the pieces, and turned on a face plate to the exact diameter of the pulley. Each half ring is provided with a flange, to which the arms are bolted, and which meet in a point at a certain distance from the center of the pulley, and form the lever by which the power is measured. There is also a box partly filled with scraps to act as a counterbalance, which, with a common scale and weights, completes the apparatus. As a matter of convenience, in using the brake, a temporary post with two pins is used for securing the lever in an approximately horizontal position, which tends to simplify the operation.

A is the shaft, revolving at seventy revolutions per minute; B, a pulley fastened on the same, the diameter of which is immaterial, but should neither be very small nor very large; C C, two wooden arms which form the lever; D D, two pieces of a metal ring, each piece being less than the half circle: F, a scale whereon weights are placed in making a test; G, a box with scrap which counterbalances the lever C C, and scale, F, when hanging loosely on the pulley; H, a temporary post, with two pins, *a* and *b*, for securing the lever in nearly a horizontal position. The weight of the lever, with rings, scale, and counterbalance, is 300 pounds, when the said lever is perfectly level and loose on the pulley. The length of lever from center of shaft, A, to point, E, is 5 feet.

First find the friction caused by the lever and counterbalance when loose upon the pulley. The coefficient of friction with wood or cast iron, lubricated, is 0·21; 300 × 0·21 = 63 pounds.

Tighten up the brake until the speed of the shaft, A, falls a revolution below its usual speed; slack the brake until the speed comes close up to the full number of revolutions; place weights on the scale, F, adding thereto until the lever, C C, falls down to a perfectly horizontal position. This accomplished, take the number of pounds weight on the scale, F



and multiply this by the circumference of the circle in feet of which the lever, C C, is the radius, measured on the horizontal line, and by the number of revolutions of the shaft, A, per minute; this will give the number of foot pounds (or the number of pounds raised one foot high in one minute), to which product add the friction of the lever as previously found, and divide the whole by the standard horse power, 33,000 lbs. raised one foot per minute, which will give the horse power transmitted by the shaft, A, which shaft may be either that of a small steam engine or a countershaft in a factory or mill.

Example: A lever is 5 feet long; this gives a circumference of a circle described from the center, A, through the point at E, 31·4 feet. Weight in scale when lever is level, 75·05 pounds; speed of shaft, 70 revolutions per minute; 31·4 × 70 = 2,198 feet per minute; 2,198 × 75·05 = 164,959, and 164,959 + 63 = 165,022, and 165,022 ÷ 33,000 = 5 horse power transmitted by the shaft, A.

I consider this apparatus better adapted for the purpose of testing power than the one referred to in your journal. The friction brake in this apparatus is more rigidly secured, and will not cause the end of the lever to vibrate when testing, so that it will come to the desired position more readily than that with the two blocks and long bolts, which latter will cause vibration of the lever. Secondly, the center line is the proper line to hang the weights on. Thirdly, the piston in oil will affect to a certain extent the accuracy of the test.

Toronto, Canada. WILLIAM GILL

Wear of Grindstones.

To the Editor of the Scientific American:

W. Kapp's idea, on page 228 of your current volume, for arranging grindstone spindles to prevent the uneven wear of the stone, is good. But the difficulty is not wholly removed by his plan, as the greatest cause of uneven wear is attributable to the stone being softer on the lower side, caused by the drip or by standing in the water. A good idea is to remove the crank, and this may apply advantageously to his plan. C. C. BLAKEMORE.

Washington C. H., Ohio.