

THE TUNNEL UNDER THE HUDSON RIVER.

This great undertaking, which has been a conception of engineers and the talk of speculators for many years, is at last fairly under way, and our illustrations in this number give a good idea of the manner in which the work is being carried on. One would think that the great railroad lines terminating in Jersey City would give the project of a tunnel under the Hudson their hearty support, but some of them have opposed the plan from its inception, on account of the large amounts of capital they have invested there in the way of docks, storehouses, and depots, and in boats for the transportation of passengers and freight, and possibly, also, from jealousy of each other, lest one should obtain greater advantages than another. For this reason the work on the tunnel, which was commenced about 6 years ago under the laws of New York and New Jersey, has been greatly impeded by tedious litigation. It is supposed, however, that all obstacles of this nature are now removed, and substantial progress is at present being made. The work is carried on by the Hudson Tunnel Railroad Company; capital, \$10,000,000; Dewitt C. Haskin, President and Active Manager; Secretary, L. C. Fowler; Engineers in Charge, Spielmann & Brush; Consulting Engineer, Col. Wm. H. Paine; Superintendent, J. F. Andersen. We are under obligations to all of these gentlemen, especially to President Haskin and Engineer Brush, for facilities in examining the works and for particulars.

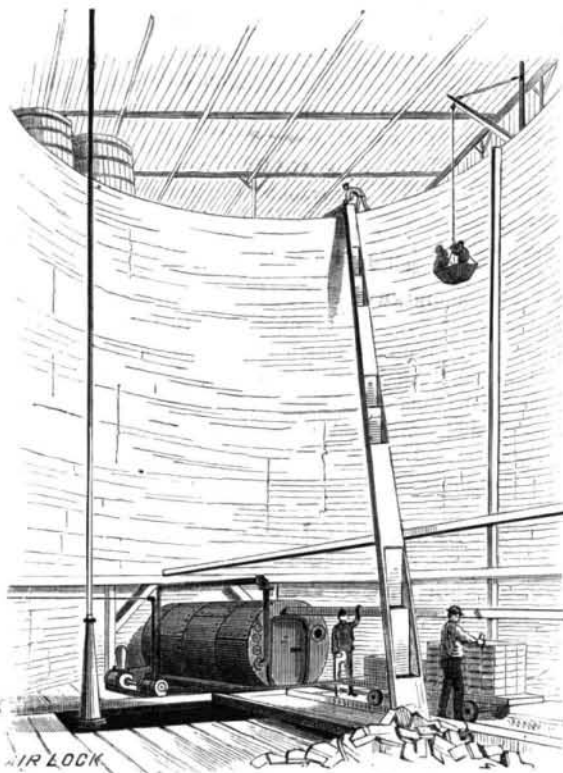
The commencement of the work was made by sinking a perpendicular shaft or well, 30 feet in diameter by 60 feet deep, at a distance of 100 feet from the water, at the foot of Fifteenth street, Jersey City. This shaft is built in a solid manner, and lined with a 4-foot brick wall. The bottom of the shaft is the level of the roadway of the tunnel when the latter is completed, but the work toward the river was started at about half the depth of the shaft, the tunnel thence descending, by a series of steps, till it reaches the grade intended. This, of course, is only a temporary device, but it gives an easy grade at the commencement, which facilitates the furnishing of supplies or material for building the tunnel, and that portion of the shaft below the present entrance is now used as a great receiving cistern, into which is forced water and silt from the head of the tunnel.

The manner in which this tunnel is being built differs from anything heretofore attempted in this line, in that the principle is adopted of using compressed air to keep out the water, and partially to uphold the earth. At the commencement of the work, while the tunnel was being excavated through made ground, consisting largely of cinders, it was found impossible to maintain the required pressure, as the air escaped through the loose material. This difficulty was obviated by placing canvas several feet below the surface; but as the tunnel descended the earth was found sufficiently compact to render this unnecessary. The air pressure now used in the tunnel is from 17 to 20 pounds per square inch. The iron plates which form the exterior shell of the tunnel are rapidly put in, so that the workmen at the heading will always be protected by an iron ceiling, and thus the earth above the tunnel is furnished with a support almost as soon as an excavation is made.

The tunnel is nearly round, and its shell is an iron cylinder, about 22 feet high by 20 feet broad, made of boiler iron and worked forward in sections, as shown in our engravings. This iron is $\frac{1}{2}$ inch thick, and the plates are 2 feet 6 inches wide; some of them are 3 and some 6 feet long, and they have $2\frac{1}{2}$ inch flanges on each side, through which each plate is bolted on all four sides to those around it. Additional strength is attained by the breaking of joints as the different sections are bolted together, the width of the plates, 2 feet 6 inches, forming the width of the several sections or ribs by which the cylinder, which constitutes the framework of the tunnel, is advanced. Inside this outer shell is a wall of hard-burnt brick, laid in cement; this wall, or lining, is 2 feet thick, and, extending completely around the interior, presents the form of an arch against any outside pressure, whether vertical or lateral.

In the prosecution of the work the men at the heading first dig and spade forward a thin semicircular opening, representing about the size and shape of the top of the tunnel, leaving the core or main portion of the earth untouched, only excavating sufficiently to allow the top plates to be placed in posi-

tion, where they are bolted and braced before the earth beneath is taken out. In proceeding on this plan the work, as it progresses, shows four to eight sections, or widths of plates, in different stages of completion, the most advanced ones being extended out as a kind of hood, well braced up, until all of the earth in this core be removed, and the plates are put in position around all sides of the shell. After this is done the bricklayers follow, and, in making



THE AIR LOCK.

their two foot thick lining to this shell, are careful to lay the wall to fit close and solid to the plates, to which it is anchored by the $2\frac{1}{2}$ inch flanges in the latter. This work and that being done at the heading is illuminated by an electric light, which enables the workmen to see what they are doing as well as if they were above ground.

The removal of the earth taken out has thus far been a very easy task. It is a tenacious mixture of blue clay and sand, the latter markedly from a gneiss formation of rock. As taken from the heading it is puddled with clear water pumped in from a stand pipe in the shaft at the mouth of the tunnel, and is then forced out through a 6-inch pipe by the air pressure in the tunnel. It is thought that this material will make excellent brick, and arrangements are now being made to use it for that purpose on ground adjacent to the tunnel opening for the supply of the immense amount of brick that will be needed in the work.

The air lock, at the mouth of the tunnel, is made of boiler iron, is 6 by 15 feet in size, and appears much like an ordinary steam boiler. Twenty men can easily be passed through at a time; and a narrow railway track runs through it, on which a car with brick and other materials for the work is run into the tunnel. When the lock is closed on the outside the inner door opening into the tunnel is open, and communication is now had with the workmen in the interior by placing written messages against a plate glass window in the outer end, when they can be read from the inside; this is to be superseded, however, by a telephone. In the interior of the air lock are what are called "equalizing" pipes, for regulating the air pressure in harmony with that in the tunnel, as may be desired. The operation of the air lock is extremely simple: on entering the tunnel one steps into it as in a sort of ante-chamber, where it would be dark were it not for such light as is given by a candle; the inner door, connecting with the tunnel, is, of course, closed, and, when the outer door is closed the compressed air is gradually let into the lock, either from the tunnel itself or from the air reservoir. From five to ten minutes is generally taken for this purpose, so that the change will not be too sudden, and particular care is taken in this respect when those who have never been in before are entering the tunnel. One of the foremen, however, went through the lock in two minutes a few days ago, and the men employed in the work seem to suffer no inconvenience or disagreeable effects from the changes in pressure of the air, either in going in or coming out. The pressure used here is considerably less than was employed in the building of the foundations for the East River Bridge.

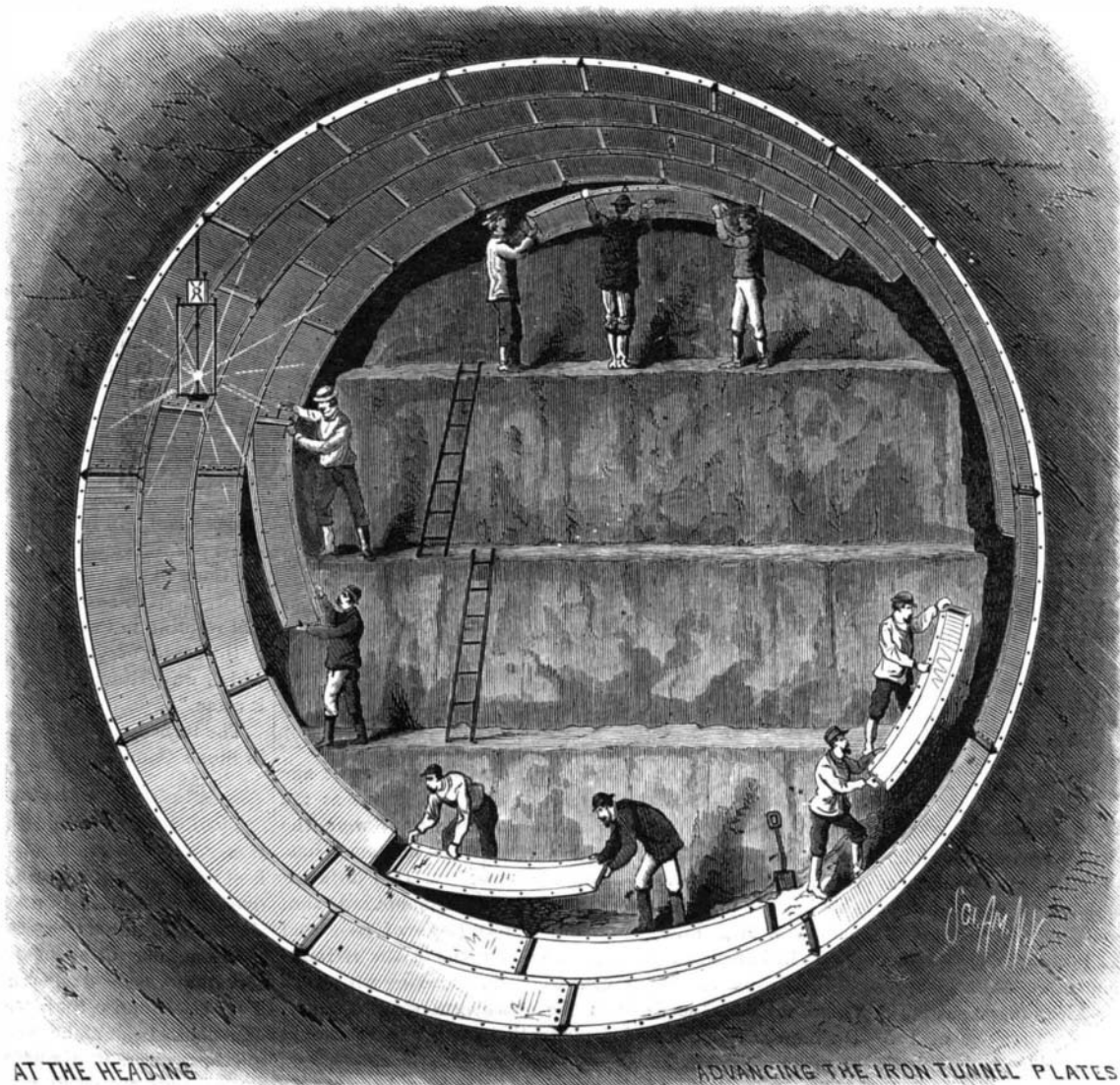
The supply of pure air and the careful regulation of the pressure are, of course, most important essentials in a work of this kind. There is an engine especially to run the compressor, which is worked in connection with an outside air reservoir, 5 by 11 feet in size, and a ventilating pipe in the tunnel secures a constant circulation of fresh air from the surface. There are three sets of workmen, each set composed of about forty men, and working eight hours daily, so that the work proceeds day and night throughout the twenty-four hours. At present the work is progressing at the rate of three feet per day of finished tunnel; but the facilities for construction will soon be increased, and in three years the tunnel is expected to be complete.

At present, the work has been carried forward about 150 feet from the shaft, or a distance of some 60 feet under the river, beyond the dock. The water here is shallow, and the top of the tunnel where they are now working is about 25 feet below the bottom of the river. The width of the river on the line of the tunnel is 5,500 feet, and it gradually deepens all the way from the Jersey shore till within about 1,000 feet of the New York side, where the water is 60 feet deep, and the bottom changes from sand and clayey silt to one of rock. The grade of the tunnel will follow in a general way the gradual drop in the bottom of the river, and will ascend rather more abruptly on the New York side. The tunnel now building is only one-half of what is to make the completed work, as the design is

to have two tunnels side by side, under the river, which will be carried into one larger tunnel at the shore ends; the second tunnel will be commenced in a few days, and work on both will then be vigorously carried on. The terminus on the Jersey shore will be about half a mile from the water, and that on the New York side has not yet been fully fixed upon.

It is as yet uncertain what means will be adopted for taking trains of cars through when the work is done, although it has been suggested that the pneumatic plan might be adopted, and compressed air used as a motor. The different railroad lines terminating in Jersey City will, it is supposed, make common use of the tunnel, on some such plan as the several roads now use the Grand Central depot, each paying pro rata, according to a scheme to be agreed upon with the tunnel company. It is thought that 400 trains a day can be passed through, using the tunnel throughout the twenty-four hours, and doing most of the freight business at night.

It seems to us that no one who has at heart the true interests of the country can hesitate to give encouragement to the progress of this work. It establishes a new line of unbroken communication between the East and West, greatly increases the



HUDSON RIVER TUNNEL—LAYING THE IRON PLATES.

business facilities of New York city, promotes rapid transit, and adds to the wealth and prosperity both of city and State. The legislature of New York should assist the work by promptly granting the most liberal facilities for establishing depots and necessary works on the New York side of the river. Congress has just passed the bill to facilitate the organization of a great International Exhibition, to be held in New York city in 1883. If the State legislature will now act promptly in granting the modest requirements of the tunnel company this great work of tunneling the Hudson will be completed before the exhibition opens and in time to bring millions of passengers from the North, South, and West directly into the limits of the city. The great railway tunnel under the Thames river, at London, 1,600 feet long, is justly regarded as one of the most remarkable engineering works ever undertaken. But this Hudson river tunnel, which will be over 5,000 feet long, puts the Thames work far into the shade. Mr. D. C. Has- kin, the originator and manager of the Hudson tunnel, is entitled to every aid which the citizens of New York can give him in the prosecution of this great undertaking. He deserves the highest honors for his sagacity and perseverance in pressing forward the enterprise, in the face of the most inveterate prejudices, carpings, adverse opinions, and criticisms of engineers, and even active opposition of most powerful opponents. It is plain that we have in Mr. Has- kin the right man at the head of the work.

Our various illustrations require but little explanation. On the front page we give views of the interior of the tunnel, showing the manner in which the iron shell is put in, the earth heading being cut in the form of stairs to facilitate the workmen in putting in and bolting the iron shell, no staying being required. The brick lining, and the mode of mixing the excavated silt with water and its discharge from the tunnel through the air pipe, are also shown. In addition to the engravings here given we publish in our SUPPLEMENT this week a number of additional engravings, showing the sectional view of the river, with tunnel built as proposed, with depths of water and distances; also a side sectional elevation of the tunnel works as far as they have advanced, showing the location of the air machinery, and all parts and appliances of the work; also plans and diagrams of the approaches; and a detailed description of the whole. We shall watch the progress of this great work with pleasure, and keep our readers supplied with all facts of interest thereto relating.

The Franco-Lorillard Expedition.

M. Charnay, in charge of the Franco-Lorillard Explorations in Mexico and Yucatan, sailed from this port for Mexico, April 21. On his arrival at the Mexican capital, M. Charnay will engage excavators and proceed at once to the places marked on the plateau of Anahuac during a previous visit, as likely to yield evidences of the extinct civilization he proposes to study. M. Charnay has already sent from France to Vera Cruz over four tons of implements and machines for use in his work of exploration, including two tons of elastic hemp paper, for moulding purposes, dredges for the sacred lakes of Yucatan, where he intends to search for the jewels cast into the water in idolatrous worship as offerings to the gods, ladders in sections with iron clamps, and photograph materials.

In stating his plans to a *Herald* reporter M. Charnay said: "I do not suppose that I shall reach Central Mexico for five or six months. From my own observations on the spot and from the statements of other writers, I take it that traces have already been discovered in the province of Yucatan of about forty ancient cities. Further, there are unmistakable indications that this district and these cities were more densely populated than is any known portion of the globe at the present moment. It is a puzzle as to how these people subsisted, as the district is rocky and barren in the extreme save for a prodigious growth of underwood or scrub, which presents a formidable obstacle to the rapid prosecution of excavations. During my recent explorations on behalf of the French Government in Java, I was much struck with the general resemblance existing between the traces of the ancient inhabitants of that country and those I found in Mexico. But a much higher degree of civilization is indicated as having existed in Java. We have at present in view a two years' sojourn in Mexico and Central America, but if necessary our stay may be protracted even another year."

Demand for Immigrant Labor.

The Secretary of the Board of Emigration reports that the labor bureau of Castle Garden is besieged with applicants for newly arrived help. The most of the applications for domestics are for German and Swedish girls. There is also a large number of applications from silk mills in Paterson, N. J., and in Connecticut, for factory girls and families. One firm wants thirty families with children old enough to work, and promises them good homes, steady work, and fair wages. The Russell Manufacturing Company, of Middletown, Conn., recently sent for thirteen families. Neither of these orders could be filled at once. There are many inquiries from firms in this city for girls to work at china decorating.

The demand for men is much greater than for women, principally for experienced iron workers, miners, brick-makers, and weavers, and the supply is inadequate. In one day 152 men and boys were sent to different parts of the country, and the day before 178 more were sent from the

Castle Garden labor bureau. Of these some were engaged to work in coal and iron mines in this State and Pennsylvania; several Germans were sent to Frary's cutlery works in East Bridgeport, Conn.; 40 Hungarians were sent to brick-yards in New Jersey; 20 Hungarians were forwarded to the brickyard at Northport, L. I., and a few farm laborers were sent to Connecticut. Applications are on file with Mr. Jackson from fifty different places for silk weavers, wrappers, and winders, cotton and woolen weavers, spinners, and card-room hands. One application was received for 200 carpenters to work on the new hotel at Rockaway Beach, the wages offered being \$2.25 a day, with an average of two days' overtime each week in good weather. Applications were received from the Columbia Stone Company, North Amherst, Ohio, for 20 or 30 Germans to work in the stone quarries; 100 stonemasons in other places; 10 moulders; machinists, pattern-makers, rollers, heaters, puddlers, and skilled hands of all kinds employed in iron manufactures. Not more than 300 silk weavers have arrived here since January 1, and most of them were engaged before they left home.

The total number of immigrants landed at Castle Garden from January 1 to April 20 was 56,404, a number surpassing any previous record in the history of emigration to this country.

Of the new arrivals there came from Germany 9,884; Ireland, 7,143; England, 4,537; Sweden, 3,003; Norway, 307; Denmark, 481; Netherlands, 565; Belgium, 304; Switzerland, 1,479; France, 508; Italy, 1,770; Greece, 138; Russia, 718; Luxemburg, 161; Bohemia, 300; various other countries, 193.

CRIME IN BENGAL.

The area of Bengal under British control is about that of Great Britain and Ireland, with about the same number of inhabitants. The population is made up principally of native Hindoos and the Mohammedan descendants of the ancient Mogul invaders.

In a lecture on what the English have done for the Indian people, delivered to the members of the Philosophical Institution, Edinburgh, Dr. W. W. Hunter, Director General of Statistics to the Government of India, said, according to the *London Times* report: "There was now only about one-third of the crime in Bengal that there was in England. While for each million persons in England and Wales there were 870 criminals always in jail, in Bengal, where the police was very completely organized, there were not 300 convicts in jail for each million; and while in England and Wales there were 340 women in jail for each million of the female population, in Bengal there were less than 20 women in jail for each million of the female population."

A well-paid and highly disciplined police, the doctor said, now deals efficiently with the small amount of crime in Bengal; a happy state of things attributable to British rule, if the British view of the case is to be accepted.

It would be interesting to know how many of the Bengal criminals are of European parentage; and why it is that British rule at home shows results so poor in comparison with India. Of course it would not do to suspect that those benighted pagans and Mohammedans are naturally inclined to lead more wholesome and honest lives than the masses of Great Britain. Christian civilization would stand aghast at such a thought. Perhaps the missionaries, who tell us so much about the land where every prospect pleases and only man is vile, may be able to make clear the puzzle.

The Milling Roller Suits.

On February 2, Judge Treat, in the United States Circuit Court, rendered a decision in the case of R. L. Downton vs. The Yaeger Milling Company, of St. Louis, for the alleged infringement of Mr. Downton's process patent No. 162,157. The case came up for hearing on January 10, and on the date given above the court dismissed the bill and gave judgment for the defendant. The points at issue in this case are too well known to need extended expatiation in this connection. Mr. Downton's patent claimed the process of removing the germ from middlings by passing the latter through rolls. An erroneous impression prevails that the claims put forward by Mr. Downton were broader than this, but such is not the case. The patent did not cover the use of rolls on wheat, bran, or purified middlings, but simply the extraction of the germ by means of rolls. The Yaeger Milling Company purchased a number of Wegmann's Porcelain Rolls of E. P. Allis & Co., of Milwaukee, and it was for the use of these that Mr. Downton brought suit, which has ended in the courts declaring that Mr. Downton's patent lacked novelty. Mr. Downton has appealed the case to the Supreme Court of the United States, and has given notice that he will bring suits in other circuits.

The *American Miller* says that this decision frees the Millers' National Association from paying the royalty agreed upon in the compromise made last spring by that body in its annual convention. By the terms of that agreement the members of the association were to pay the Downton Purifier Manufacturing Company a royalty for the rolls then used in members' mills of \$25 per set for the first three sets of rolls, \$15 per set for the second three, \$10 per set for the next four, and all over that number (ten sets), \$5 per set, the payment to be made when the validity of the patent should be sustained by a decision of a Circuit Court of the United States. For the time being, therefore, the roller litigation may be regarded as over, and millers using rolls can breathe easy for awhile.

NEW INVENTIONS.

A means for determining the action and effect of steam in the retorts when manufacturing water gas has been patented by Mr. Henry C. Bowen, of New York city. In the manufacture of water gas the method heretofore in general use is to charge a retort or generator with coal, then bring it to a state of incandescence by driving air through it, then to shut off the air and force steam through the incandescent mass of coal. At this high temperature the incandescent carbon decomposes the steam, forming carbonic acid and hydrogen, and the carbonic acid, as it passes farther through the mass, is itself decomposed or robbed of one equivalent of oxygen by the carbon to form carbonic oxide. The commingled carbonic oxide and hydrogen then constitute the base of the water gas, and pass out of the generator, to be subsequently carbureted by passage through a hydrocarbon, and then fixed to form a stable gas by being heated in a separate set of retorts. The object of this invention is to provide means for enabling the operator to detect at any time the passage of undecomposed steam along with the carbonic oxide and hydrogen.

A device for operating elevators, so constructed as to raise the cages of the elevators by the movement of a train of cars, and which is especially designed for operating passenger elevators at stations upon elevated and underground railways, has been patented by Mr. Nicholas Nolan, of New York City.

A simple and efficient apparatus for cooling liquids and freezing ice cream by means of chemicals, has been patented by Mr. William F. Clapp, of Alleman, N. C. The invention consists of an oscillating or rotary vessel provided with compartments for the cooling mixture and the liquids to be cooled, and a central chamber for the reception of the ice or other refrigerant and the vessel containing the cream.

Mr. John De Frain, of Philadelphia, Pa., has patented an improved vegetable cutter, which is so constructed that it may be adjusted to cut the vegetables into slices or strips of any desired thickness.

An improved sash supporter, which is simple in construction and operation, and which holds the sash in any desired position, has been patented by Mr. William W. Sweetland, of Edwardsburg, Mich. The invention consists of an articulated spring latch, through which a rod fastened to the upper part of the window frame passes, and against which the latch is pressed to hold the sash in position. The latch is operated by means of a lever worked by a cord.

The First Rolling Mill in America.

To the Editor of the *Scientific American*:

I wish to correct a statement in your issue (No. 7) regarding the first rolling mill in America.

Your correspondent is mistaken in stating that his father built the first rolling mill in this country. My great-grandfather, Isaac Pennock, established one in 1798. I have the ledger bearing that date now in my possession.

The mill was called the "Federal Slitting Mill," and was located in East Fallowfield Township, Chester county, on the Buck run. It was used for rolling sheet iron and strips, principally the latter, which were slit up into rods for nails, etc. All nails then were forged out of rods by hand on the anvil. There were no boiler plates made or needed in those days.

My grandfather, Dr. Charles Lukens, was the first maker of boiler plates in Pennsylvania, and it is to be presumed in America. He was for a time at the Federal Slitting Mill, but in 1816 moved to Coatesville, and operated another mill called "Brandywine Iron Works." There boiler iron was first rolled.

At the death of Dr. Lukens, in 1825, the business was carried on by his wife, Rebecca W. Lukens, who greatly increased it and conducted it successfully for a number of years. As a tribute to her memory the name of the works was, after her death, changed to "Lukens Rolling Mill."

This was the first of the several mills now in this town, and has been operated continuously in the family from 1816 to the present day. It is now used merely as a feeder to a large steam mill erected alongside.

There were no railroads in this country then, and all iron and fuel had to be teamed, most of it to and from Wilmington and Philadelphia, the former 26, the latter 39 miles distant; some, however, was teamed to Pittsburg (315 miles) and beyond.

The old Federal Slitting Mill has long since been abandoned for manufacturing iron. A paper mill is now erected on its site.

A. F. HUSTON.

Lukens Rolling Mill, 2d mo. 14th, 1880.

Wild Dogs in the West.

For several years a pack of wild dogs have been known in the Yellowstone Valley. They are described as resembling a cross between a wolf and a spaniel. A more savage pack of wolf dogs are now reported in the wilds of Northwestern Nebraska. It is said that about two years ago two bull-dogs joined a band of wolves near the head of the Birdwood, and have remained with them ever since. Within the past year a species of dog-wolf, supposed to be the offspring of the escaped bull-dogs, have been committing depredations in that section. They are said to possess the cunning of the wolf combined with the ferociousness and pluck of the bull-dog, and are consequently much more to be dreaded than the common prairie wolf, and are far more bold and savage. The *Deadwood Times* says that they are becoming numerous and quite troublesome.