## THE CITY OF PITTSBURGH AND ITS INDUSTRIES.

The smoky city of Pittsburgh, Pa,, has peculiar interest for all men engaged in the industrialarts, on account of hermany and various manufactures and the enterprise of her leading men, which hold out the promise of a great future for this renowned city. Iron and coal are of course her leading staples, and where there is iron there is naturally a large production of machinery, engineering appliances, and hardware; and cheap coal is immediately attended by glass making and many kindred trades. Of the extent of these manufactures we recently had occasion to publish a statement, which showed that over $10,000,000 value of iron, $4,000,000 of steel, and $3,000,000 of glass wares were produced by forty-one of the leading firms in Pittsburgh, in these three trades only.

Pittsburgh as a manufacturing center comprises two cities and eleven boroughs, covering a total area of about 25 square miles, populated by over 263,000 persons. The Monongahela and the Allegheny rivers meet here, and give the city access to over 12,000 miles of navigablest reams, affording carrying facilities of immense value, especially in a country where coal is so cheap. The two principal rivers are crossed by nine bridges, and the river shipping is stated by a competent authority to exceed in tunnage even that of New York city.

While the manufactures of Pittsburgh are found in every city on this continent, her supplies are drawn from all parts of the world. The copper of the Lake Superior region is brought here to be worked up, and the chemicals for her glass houses are produced in all parts of Europe and America. The mechanics who form the larger part of her people, renowned everywhere for their ingenuity and skill, are chiefly Americans, but number among them natives of nearly every country which has achieved fame in the industrial arts. The Welsh and Cornish miners, the steel melter of Sheffield and the glass mixer of Birmingham, and the gunsmith and fine metal worker of Liège are here to be found, uniting with the Americans in striving to maintain and extend the renown of the chief manufacturing city of our Great Republic.

We publish on the two previous pages a series of views of this most interesting city, and of some of her manufacturing processes. These engravings explain themselves, and will be examined with interest by our readers, for they represent scenes which all Americans view with pride in the present and hope in the future.

## NEW RAILWAY TUNNEL UNDER THE HUDSON RIVER, BETWEEN NEW YORK AND JERSEY CITY.

For many years the project of building a railway tunnel under the bed of the Hudson river, between New York and Jersey City, has been discussed, its importance and feasibility agreed upon, and its successful completion, upon paper, established. Only two things have been lacking for the actual realization of the work, namely, the money to build with, and the company of individuals enterprising and bold enough to assume the risks incident to such a task.

The bed of the Hudson, at New York, is a treacherous substratum, so far as tunneling is concerned, being porous, leaky, and lacking in firmness. All engineering experience in the construction of works in such soils has shown that their prosecution is attended with unusual risk and cost. But now comes along a new and enterprising engineer from California, Mr. D. C. Haskin, inventor of a new Improvement in the Art of Tunneling, expressly designed to make difficult works of this kind easy, patented February 3d, 1874. Mr. Haskin has organized a strong and wealthy company for the trial of his improvements, and the first essay is to be made upon the Hudson river tunnel, work upon which has recently been commenced. The vertical shaft has already reached a considerable depth. It is located near the river shore at the foot of 15th street, Jersey City, and from thence the tunnel will extend across under the Hudson river to or near the foot of Canal street in New York, thence up Canal street to a connection with the Broadway Underground Railway.

The greatest depth of water on the Hudson river over the tunnel will be about 100 feet; the total width of the river, 4,000 feet. The actual length of the horizontal tunnel, however, will hardly be less than 6,000 feet. The New York *Sun* states that Colonel Haskins "is confident of success, that there is no stock for sale, and that the members of the company have plenty of money to complete the work, and are willing to pay all costs and expenses."

It is rumored that the Delaware, Lackawanna & Western Railway Company claim that the Tunnel Company do or will infringe on their landed rights, and that they will obtain injunctions from the Court to stop the operations. We trust that this powerful corporation will do nothing of the sort. Instead of preventing, it should be the aim of the railway company to promote the work. In common with all our citizens, we heartily wish the Tunnel Company success.

We believe the public will resent any attempt, made by railway monopolists or others, to interfere with the work. The citizens of New York want the tunnel built, and will cordially extend the hand of encouragement to the builders.

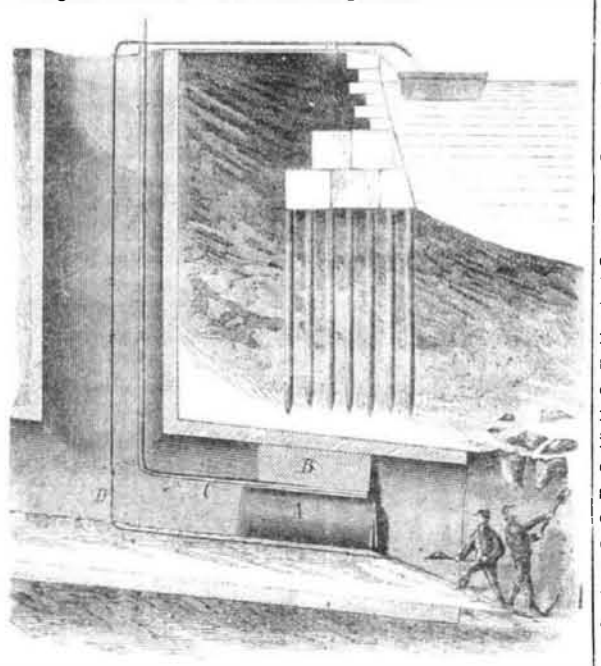
We will now describe this New Art of Tunneling, premising, however, that the failure of the plan, which we consider inevitable, will not, necessarily, stop the construction of the tunnel, as the air-compressing apparatus, which is the principal item of expense, will be useful in whatever method may be hereafter adopted. In our description, we will, for the most part, follow the language of the patentee, who, in his patent, says:

"Be it known, that I, DeWitt Clinton Haskin, of Valejo, Solano County, California, have invented a new and useful Improvement in the Art of Tunneling.

"My invention relates more especially to the construction of tunnels through sands, wet earths under water courses, and under such like conditions where the caving-in of the walls of the excavation or the infiltration or irruption of water is to be apprehended. Its object is to effectually prevent such incidents in a cheap and simple way, to which end my improvement consists in filling the excavation with compressed air of a density sufficient to resist the inward pressure during the construction of the shell or wall of the tunnel.

"The distinguishing feature of my system, however, is that instead of using temporary facings of timber or other rigid material, I rely upon the air pressure to resist the caving-in of the wall or the infiltration of water until the masonry wall is completed. This pressure is, of course, to be regulated by the exigencies of the occasion, and may be varied from anything above that of the atmosphere to 50 lbs. to the square inch, which is about as much as the human system will bear with safety. The effect of such pressure has been found to be to drive water in from the surface of the excavation, so that the sand becomes dry."

We give a sketch, taken from the patent.



HASKIN'S NEW ART OF TUNNELING.

Within the tunnel, a short distance back of the heading where the laborers are at work, is an air lock, A, composed of an iron cylinder, having entrance valves at each end, so arranged that when one is opened the other closes, thus permitting egress or ingress to the front. Above the lock is an airtight packing, B, while below the cylinder is a packing or filling of earth. When the air lock is duly set and sealed within the tunnel, compressed air is driven to the heading in front of the air lock, through air pipe, C. The excavated earth will be discharged from the heading, by the air pressure, through the pipe, D, and delivered into boats or other suitable receptacles at the ground or river surface, in the manner commonly practised in sinking caissons.

In carrying on the work, the laborers will excavate a chamber in the earth in advance of the finished masonry, which will then be carried forward, while the men dig out a new space in advance, and so on until the tunnel is completed. Any loose boulders, stones, earth, quicksands, or water, encountered in the roof or walls of the heading, are to be held up and prevented from caving-in upon the workmen by the air, like flies upon the ceiling. The clumsy, costly caissons, shields, and other appliances, heretofore deemed necessary by cautious engineers, are discarded in this New Art. It is, indeed, a new wrinkle in the science of engineering.

But we think the statement of the patent, that only 50 lbs. air pressure will be required, must be a mistake. Several cyphers have evidently been omitted from the figures, perhaps by a blunder at the Patent Office. A cubic foot of air weighs only 0·075 of a pound, while a cubic foot of stone weighs 165 lbs. To buoy up such a stone in air, requires a corresponding density of the air: which involves the compression of 2,200 cubic feet of air into every cubic foot of air contents within the heading, or a pressure of 33,000 lbs. to the square inch.

Our author makes another rather incongruous statement in his patent. He says: "In case a jet seam or small stream of water is encountered, I supply a temporary shield of canvas, leather, or other light flexible integument to the wall, against which the pressure instantly forces it and seals the leak."

Water weighs only 62½ lbs. per cubic foot, or less than half the weight of granite. If the direct air pressure, against the loose earth, sand, and stones, is sufficient to prevent their downfall in the excavation, surely no streams of water can come in, and the leather will be unnecessary.

"These three features," says the patentee, "constitute the leading characteristics of my invention, namely: First, the use of compressed air acting directly upon the excavation walls to prevent leakage or caving; second, the use of temporary flexible integuments to stop leaks; third, the partial refilling with earth of the completed tunnel, to diminish the area of the surface exposed to the action of the compressed air.

"I claim as my invention:

"1. The improvement in the art of tunneling herein set forth the same consisting in excavating in a working chamber, of which the tunnel head forms a portion, under an air pressure acting directly upon the surface being excavated, and sufficient to prevent the caving or leakage of said surface during the construction of the masonry walls.

"2. The method herein set forth of preventing leakage in the excavation surface of the working chamber, by the application thereto of a flexible integument held in position by atmospheric pressure.

"3. The method herein set forth of partially refilling the completed tunnel in advance of the air lock, to diminish the air surface thereof.

"In testimony whereof I have subscribed my name."

## The Economy of Powdered Fuel.

With a quick draft and a thick fire, as in locomotives, 18 lbs. of air suffice to burn 1 lb. of coal; but in ordinary furnaces the quantity required is 24 lbs. or even more. We have seen that the temperature, when 1 lb. of coal is burned with 12 lbs. of air, only amounts to 4,580° Fah. If we increase the admission of air to 18 lbs., the resulting temperature falls to 3,200° Fah. while if we double the quantity of air it falls to 2,440° Fah. Oxygen of dilution is only required because the carbon cannot, unless oxygen is present in the furnace in excess, obtain what it wants; and this is due to the fact that the coal in combustion does not expose sufficient surface to the air passing over it. If we can increase the surface of carbon exposed, prevent the carbon from being surrounded by an atmosphere of carbonic acid, and get rid of ash, then no excess of oxygen will be required.

Now this is just what Mr. Crampton does. Taking small coal, he grinds it between a pair of ordinary millstones, and bolts it in a coarse bolting machine. He thus procures coal flour. This coal is fed by a most ingenious machine into a nozzle or tweer through which air is forced from a fan. The coal flour is thus blown in a cloud into the furnace or combustion chamber; and there igniting, it is converted into a body of flame. The grinding of the coal really is nothing more or less than an expedient for increasing the oxidizable surface exposed to the air; for let us suppose that one pound of coal in a block has a surface of, say, one fourth of a square foot, it is obvious that by grinding this pound of coal to flour its surface will be augmented, possibly a thousandfold, and each little molecule will expose to the oxygen an enormous surface as compared with its cubic capacity—indeed, a surface out of all proportion greater than that supplied by a pound of coal in mass as compared with *its* cubic capacity. The direct result is just that which might be anticipated. Mr. Crampton burns powdered coal with as little as 13 lbs. or 14 lbs. of air per pound of fuel, and has, we believe, obtained satisfactory results when but 12 lbs. of air were admitted.

The direct effect of the admission of a minimum quantity of ar to a furnace is a direct and enormous saving in fuel. Let ius take, for example, the operation of puddling. In the ordinary puddling furnace, at least 20 lbs. of air are burned per pound of coal. Now, to puddle a tun of iron with a tun of coal is an exceedingly good result. Let us say that in ordinary fair work 2,500 lbs. of coal are required. By an actual experiment, if such it may be called, which we saw carried out at Woolwich with the Crampton furnace—10 cwt. of old shells were charged into this furnace, and at the end of about one hour and forty minutes, 11 cwt. 2 qrs. of excellent iron was taken out of it. During the puddling of the charge in question, 4·5 cwt. of damp coal was blown into the furnace per hour. Thus 11·5 cwt. of wrought iron were made, while about 7·5 cwt. of coal was consumed.—*The Engineer*.

## New Teleg aph Relay.

A new form of relay, the invention of Mr. E. P. Warner, of the Western Electric Manufacturing Company, Chicago, has lately been introduced. The objects sought to be gained in this relay are the reduction of the coercitive force of the iron cores to a minimum, the exemption from the retractible force of springs acting in opposition to the force of the magnets, the abolition of an unpolarized armature, and the utilization of the attractive and repulsive force of a permanent magnet upon the tongue operating the local circuit.

It is well known that soft iron armatures retain the polarity impressed upon them by the electromagnets for a short time after the current ceases, also that the longer the electromagnet the greater its retaining power and consequent sluggishness. In the Warner relay, these disadvantages are overcome by having magnets one half the length of the shortest used in the best style of horseshoe relays. This insures the quick discharge of each core, and reduces its retaining power to the lowest point, especially as the purest iron is used.

No armature has to be magnetized by induction from the poles of an electromagnet. The cores are simultaneously magnetized by the same current, and their extensions have sufficient metal section to reduce their magnetic resistance to a very low point, and, at the same time, the weight of the movable core, its extension and tongue, does not exceed, to any great extent, the weight of an ordinary armature tongue and axis.

The relay has been severely tested in circuits of all conditions, and performed admirably. Unlike many other relays, the permanent magnet stands separate and apart from convolutions and reversing coils of every kind, and will not undergo that deterioration which is experienced in other combinations. One of the Warner relays, 150 ohms, was worked on a straight wire, between Chicago and New York, with no intermediate battery, and recorded fairly the signals, which were very light and unsteady on a 600 ohm testing relay of usual make. The *Journal of the Telegraph* says that the result of a comparative test, however, made at the Western Union Telegraph Office in this city, does not indicate any superiority over the regular form of relay now in use.

THE Academy of Sciences of Berlin has offered a prize of of $200, payable July, 1876, for the best essay recording experiments as to whether changes in the hardness and friability of steel are due to chemical or physical causes, or both. Papers, in German, Latin, English, or French, are to be sent in before March, 1876.