CAUSE OF BOILER EXPLOSIONS.

THEIR PREVENTION—IMPORTANT INFORMATION.

In the month of October last a steam boiler exploded in Liberty-street, Pittsburgh, Pa., and the coroner's jury in the case rendered the following verdict:—"That the explosion of said boiler was caused by a defect in the angle iron of the head, which blew out, and by a scarcity of water in the boiler, thereby creating a pressure within it beyond its strength to resist." Benjamin Crawford, Esq., Supervising Inspector of Steamboats for that district, having been solicited to give his opinion on the explosion, has done so in a communication to M. De Lange, Esq., which has been sent to us, and in which we find some new and very useful information for engineers, owners of steam boilers and the public at large. He states that, in his opinion, the verdict of the jury was a correct one, and says:—

That there was a defect in the head that blew out, and that there was a scarcity of water in the boiler at the time of the explosion, was made clear by the testimony taken in the case. But how much of the disaster is due to each of these causes is more difficult to determine, or whether either was sufficient to produce it without the aid of the other.

The boiler was 40 inches in diameter by 22 feet long, made in the cylindrical form, without flues or tubes. The body of the boiler was said to be of the first quality of iron, one-fourth of an inch in thickness, and the heads were made of "angle" or "gunnell iron," which was half an inch in thickness. Stay rods, seven-eighths of an inch in thickness, were attached to the center of the heads, and extended back some four or five feet, and were secured to the side of the boiler. The head that blew out had one of these rods. If the angle iron in these heads had been sound, it ought to have withstood a pressure within the boiler of 300 lbs. to the square inch without rupture. The testimony before the coroner's jury in regard to the defect was somewhat conflicting, from the circumstance that oxydation had taken place on the ruptured parts before the examination was made, which made it difficult to distinguish between the fresh break and the previous defects. But to allow a diminution of one-third of the strength for the defects (which I think is as much as the testimony would justify), and there was still strength sufficient to bear a pressure of 200 lbs. to the square inch, which would be more than 200 per cent greater than the working pressure used on the boiler. The danger from low water arises from the sides of the boiler, below the fire lines of the furnace, becoming exposed and overheated when unprotected by the water.

In order to comprehend fully the state of a boiler in this condition, we must take into consideration all the circumstances connected with it, which are—

1st. The water in the boiler, when the steam is not passing off to the engine or otherwise, is in a quiescent state—almost as much so as if there was no fire under the boiler at all. But the moment vent is given to the steam, by starting the engine or raising the safety valve, ebullition takes place, and the water becomes more or less agitated, and often violently so, when, as a natural consequence, it would come in contact with the sides of the boiler far above where it was at when in a state of rest.

2d. When the water falls below the fire lines of the furnace, the sides of the boiler are liable to become highly heated, sometimes so much so that the iron loses its tenacity to such a degree (when red hot) that the pressure of the steam will force its way through it, as in the case of the steamer *Hartford*, a few years ago, where no damage was done except to destroy one sheet of the boiler. But a high black heat of the iron is more dangerous, should the water, by its agitation, come in contact with it, as it makes steam when it is in that condition more rapidly than if it were red hot.

3d. The amount of steam that is produced from a given quantity of water—which is, under the pressure of the atmosphere (fifteen pounds to the square inch), 1,700 times it volume; that is, one gallon of water will make 1,700 gallons of steam, at a density of fifteen pounds to the square inch. Of course, the higher the pressure the steam, the less will be the volume; as, for example, when the pressure is at sixty pounds the volume will be 470, and when at two hundred pounds the volume will be 158, and so on.

4th. The quantity of water the sides of the boiler, when overheated, will make into steam. This is a matter, notwithstanding its importance, that seems not to have been investigated to any great extent, as I have been unable to find in any works at my command treating on steam, anything in relation to it. I have, however, lately made some experiments with a view of an approximation to the quantity of water a square foot of boiler iron, one-fourth of an inch in thickness, when brought to a high black heat, will make into steam, and I found it to be about fifty-four cubic inches. I tried it both by measurement and by weight, and the result was about the same. The time occupied was a little over one minute, but a very large amount of it was made into steam in a very few moments.

The boiler that exploded on Liberty-street was of a capacity of about 192 cubic feet, and according to the statement of some of the witnesses who examined the boiler, and who were engineers of large experience, there could not have been more than about 20 cubic feet of water in the boiler at the time of the explosion. To fill the remaining space with steam at 60 lbs. to the square inch—which was about what was in the boiler at the time of the explosion—would require two and seven-tenths gallons of water converted into steam. There was exposed to the heat of the furnace, above the water, about 18 inches of the sides of the boiler, which would make 66 square feet of surface. This, if heated to a high black heat (and there was evidence of some portions of it having been red hot), was capable of converting fifteen and one-third gallons of water into steam; about one-third of this quantity, or five and three-tenths gallons would produce a pressure of 200 lbs. to the square inch. This shows what the heated iron in that boiler was capable of doing, providing the water came in contact with it, which it would do the moment vent was given to the steam by the raising of the safety valve, or in any other way. As the safety valve was loaded to about 60 lbs. to the square inch, and as there was about that amount of steam in the boiler immediately before the explosion took place, I have no doubt but the safety valve did commence blowing off steam, which caused the water to foam over the heated sides of the boiler, and which, in my opinion, produced the explosion.

In regard to the "requisites for the prevention of similar calamities," my opinion is that a well regulated system, enforced by law, similar to the steamboat law passed by Congress in 1852, is the best means to accomplish that object. Before the enactment of that steamboat law, disasters were constantly on the increase. Scarcely a week passed that the community were not shocked by the news of some terrible steamboat disaster on the western rivers or on the lakes. Indeed, I remember of three most direful explosions having occurred in the space of one week (the *Red Stone*, *Glencoe*, and *Saluda*), by which more than two hundred lives were lost. Since the law has been in force, few explosions, comparatively speaking, have occurred. This law requires all steamers carrying passengers to be inspected at least once a year, subjecting their boilers to a hydrostatic test. The pressure of steam is limited in accordance with the thickness of the iron, the diameter of the boiler, and the hydrostatic test applied; and other precautionary measures are required, calculated to guard against danger from explosion. All engineers are required to be examined, licensed and classified by the Inspectors, before they can serve in that capacity on any such steamer. Licenses are revoked for negligence, misconduct, or inattention to their duties. There are other regulations to guard against fire, collisions, and other dangers, and also requiring all pilots to be licensed, &c.

As an example of the working of this law, it may not be out of place for me to make a statement of the operations under it in this supervising district (which embraces Pittsburgh, Wheeling and Cincinnati), for the year ending on the 30th o. September. There were 205 steamboats inspected; 1,024 licenses granted to engineers and pilots; 30 revocations and refusals of licenses (the greater part on account of intemperate habits); 12 cases of violation of the law reported to the United States District Attorney for prosecution (principally steamboats; one, however, was against a person for concealing gunpowder in a box and shipping it as hardware); 11 boilers were found defective upon inspection, some of which were repaired, and others condemned from further use. No explosion has occurred in this district, nor to any boat inspected in this district, nor has any accident of any kind happened to any inspected steamer in this district, by which life has been lost or personal injury sustained.

I have no doubt but a law can be framed, which, if properly enforced, will give almost perfect security against the explosion of stationary boilers, and at the same time will not in the least operate against the interests of proprietors.

ATMOSPHERIC CIRCULATION AND AERIAL NAVIGATION.

MESSRS. EDITORS:—That we have "trade winds" blowing from the northeast in the northern equinoctial belt, and from the southeast in the southern equinoctial belt, is a fact long known to mariners, and equally well known to all students of Nature. That these currents are piled up, rarified and made to rush toward the west by the compound force of the two streams and the calorifying power of the torrid zone, is all rational enough in itself; that is to say, the uprising and westward moving of the atmosphere of this equinoctial belt is a necessary consequence to the inflowing condition of the trade winds. Now, where does this wind, *i. e.* atmosphere, come from? and whither does it go? It has an inlet here, and it must have an outlet here, also. Maury says it goes to the poles in the southwest "passage winds" in the northern hemisphere, and the northwest passage winds in the southern hemisphere. These are facts also known to mariners. But how do they make their circuits back? Mariners cannot tell. They only feel their courses on the surface of the sea. Maury deduces theoretically that they return by upper currents from the northwest in the northern hemisphere, and from the southeast in the southern half of the globe. I shall not, in this brief statement, follow Maury's theory for their return, profound though it may be, because the facts as elicited respecting the upper currents of the atmosphere show the return current in our latitude to come from the northwest. In my twenty-five years' balloon sailing, I have always found two currents of air. One from the southwest; another higher up, from the northwest. Between these two currents, an eddy current is found moving toward the east. This northwest current is drawn into the equatorial vortex, where it becomes the northeast trade wind known to mariners. The reverse is the use in the southern hemisphere.

Having thus far traced the actual courses of the wind, let us examine the cause. Assuming that the equatorial heat and the polar cold are the causes of the currents going to and fro by incessant heating and cooling processes, operating upon the mobile atmosphere, shall we not find in the same cause, though in a modified form, the constant tendency of the atmosphere in one zone moving from east to west; that is to say, will not the warming process of the coming morning sun, rising constantly in the east, have a tendency to draw the atmosphere in that direction, bringing it from the cooling shades of night, also constantly acting upon it on the western side of the daylight? That is the best theory that I can hang upon the fact. I do not pretend to say that it is the true theory, but the facts of the wind's courses are nevertheless established; on the surface of the earth by mariners, and in the upper currents by twenty-five years' sailing among them.

Upon this great circulatory system of the vast atmosphere I base the ultimate success of aerial navigation. By studying the currents and deflections in detail, we will be enabled to move among them to any part of the globe we wish to reach. Maury leaves nothing to be deduced in his outlines of the currents of air on the surface of the globe; they are all elaborated and systemized facts; and these currents on the surface partake of various directions corresponding to the points of the compass. It is therefore a rational deduction that they must have their corresponding counter currents above, though my experience only positively reveals the two spoken of above; one from the southwest, the other overlapping it and coming from the northwest.

There is yet a new world of wonder and happiness in the vast and unexplored region of the atmosphere. Ought this grand subject not be brought under the scrutiny and general investigation of artistic and scientific men by a preliminary experiment of sailing round the globe with a balloon? It can be done at a cost of not over $10,000.

JOHN WISE.

Lancaster, Pa., Dec. 4, 1860.

SULPHUR WATER.

MESSRS. EDITORS:—In perusing your valuable journal, I find on page 178, Vol. III., that a correspondent at Sparta, Ga., asks the question whether sulphur water could have been the cause of his flue boiler exploding.

Sulphur water, as it is commonly called, we are very familiar with; and its effects are very destructive in anthracite coal regions—or, at least, in this and our adjoining counties. The water running out of old mines may be as clear as crystal, and yet, by evaporating it in boilers, it will turn red and rusty in a short time. It is only used when no other can be obtained; for it is so destructive as to render boilers useless in a short time. Our boilers are generally constructed in a cylindrical form, about 31 inches in diameter, of one-fourth inch iron for colleries, and in many instances, where the water is used direct from the mines, they are repaired about every month; and frequently in ten or twelve months rendered entirely useless. Could some of your intelligent writers give us a remedy for this great evil?

D. ZUERN.

Shamokin, Pa., Dec. 5, 1860.

THE world receives now, in a single year, nearly one-tenth as much gold as was obtained in the whole period from the discovery of America down to the year 1848.