A MYSTERIOUS EXPLOSION AND ITS CAUSES.

BY JOSHUA ROSE, M.E.

A singular explosion recently occurred at John Ellet's kindling-wood manufactory, at 529 West 55th street, in this city. The bare facts are as follows: The boiler was licensed to carry 100 lb. of steam, but was usually worked at from 35 to 50; at the time of the explosion there was a pressure of 50 lb. A circular-saw bench stands about 16 feet from the boiler; the saw overhung the bench at one end of the spindle, while a fly wheel overhung it at the other end—the plane of rotation of this wheel being about in a line with the center of the vertical boiler. There was a pile of wood inside the saw bench, which was about 18 feet distant from the boiler, and the operator was standing at this pile of wood and between the saw and the fly wheel, facing the boiler, when a sudden explosion occurred, and a heavy volume of steam shot in a straight line upon the operator, very severely scalding him. He fell behind the pile of wood, whose partial protection probably saved his life, though at the time of this writing he lies in a very precarious condition. The boiler belched forth its steam in a solid column until emptied, and it was then found that the circular saw, with its spindle and the fly wheel, had disappeared, while there was a hole in the boiler measuring about 3 inches by 6 or 7. A short piece of the saw spindle was found, and on it the part of the saw shown in our engravings at Fig. 2. Other pieces were found embedded in the timbers of the building, where a piece still lies entirely out of sight. A piece of the rim of the fly wheel was found beside the hole in the boiler, which is shown in Fig. 1. Another piece was found about 500 feet distant, in Tenth avenue. But not more than one quarter of the wheel has been found at all, the remainder having totally disappeared. One piece in its flight tore a groove about 2½ inches wide in a beam and passed through the roof. Of the circular saw about three quarters have been found, the remainder being missing. The spindle tore itself out of the bearing caps and was found in the yard minus all the fly wheel except the hub, and minus the circular saw and the overhanging piece of shaft.

The spindle was 2¼ inches diameter, of wrought iron, and about 4 feet long. The saw was about 26 inches in diameter, and, contrary to the usual practice, was slightly thicker (say, one thirty-second of an inch) at the eye than at the rim. The fly wheel was about 30 inches in diameter, being a plate wheel with a web three-eighths inch thick.

A great many mechanics, as well as some of the authorities, have been investigating the matter to discover the cause of the explosion, and some of the latter are still investigating it for their private information. The general opinion prevails that all the materials were of good quality and sound, and that the saw flew first, and the spindle and fly wheel simultaneously, though at first it was supposed that the boiler was the first thing to give way. But there is an atmosphere of mystery surrounding the affair, and nobody seems to have any distinct theory of the order in which the casualties occurred, and no theory whatever as to the causes leading to them. Pieces of the fragments have been preserved as curiosities, and this possibly accounts for some of the missing parts.

The man in charge afforded me every facility to investigate in my own way, stating that the proprietor, Mr. Ellet, was one who spared no expense to have his machinery kept in the best order; that the establishment was nearly a new one, having run about three months, and that he, as much as anybody, was anxious for a solution of the mystery. The saw itself had been running about two months, but the spindle and fly wheel, or, more correctly, balance wheel, was old, having been running nobody knew how long in a circular saw mill in another establishment.

The fragments of the saw were first examined. The metal appeared close grained and tough, with no signs of any thing but new clean fractures. Various pieces were tested by being bent back and forth with a hammer. It appeared sound and tough; indeed, of excellent quality, each piece tested having a clear ring. A file test showed it of even temper, and if anything, rather soft than otherwise, which added to its strength. Those who examined it state that it was quite cool when picked up after the accident, and that there were no signs of heating either in it or the spindle. The fractured piece of boiler had been preserved as a curiosity by one of the workmen, but it was submitted for inspection, and is shown in Fig. 1. It was five-sixteenths of an inch thick, of good sound fibrous iron, very free from scale, even the line made by the calking tool being clean and clear. The rivet holes were clear and as round as could be expected. It had clearly been fairly burst open by a flying fragment, there being on opposite sides of the rent two bright places as clearly cut as though cut by a milling tool: it was bulged out, or rather inward, an inch or two from the force of the blow. Failing to find any cause for the accident in either the boiler or the saw, the saw spindle was next examined at the blacksmith and machine shop of Messrs. Potter & Macdougall, who were making a new spindle of steel. The piece that flew off with the saw showed a clean, short fracture, with a fine dark line running across it, ending in a small flaw. The shortness of the fracture and absence of any signs of fiber in the iron led to a suspicion that the iron was crystallized, an opinion with which Mr. Potter concurred; but the other side of the fracture (on the main body of the spindle) showed the fine dark line a part of the way only, and no signs of any flaw, while the circumferential surfaces of both pieces appeared quite sound. With a view to test the soundness of the spindle, I had the spindle made red hot and cold water poured upon its end, and as a result there appeared a crack whose outlines became apparent in a black line, caused by the rapid cooling of the crack edges on one side; this darkness developed a complete cavity about half an inch deep, this cavity corresponding in location to the flaw at the end of the black line in the other half of the fracture shown in Fig. 3. To test if this crack ran along the shaft, and to see the difference in the grain of the iron, a piece was broken off the spindle end, the fracture being shown in Fig. 4, the crack having disappeared. The remaining end of the shaft was then annealed to see how far such annealing would remove the granulation and restore the fibrous structure of the iron, and the fracture of a piece broken off after the annealing is shown in Fig. 5. The remaining end of the shaft was then forged down square, the fracture being shown in Fig. 6. Here the grain shows a close, clean, dull-gray fiber, and an entire absence of the granular crystals. It will be noted that the original fracture is the shortest and the most granular, and that the iron became more fibrous after the annealing and after the forging, the latter having totally altered the structure. Referring to the piece broken off before the annealing, its fracture shows a far superior one to that occurring with the explosion, but more granulation than the annealed piece, and in this connection it may be stated that Mr. Potter, of the firm named, informed me that to remove the crystallization Messrs. Caird & Co., the eminent engineers of Greenock, Scotland, made it an annual practice to take down, during the Christmas holidays, the chains from all their heavy lifting cranes for the purpose of annealing them—a practice, indeed, that is followed in many of the large engineering establishments in England.

The method of effecting the fractures was as follows: Each piece was nicked around with a cold chisel; the piece was then put under the same steam hammer, the weight of the hammer holding the piece, and the side face of the hammer being even with the nick, the protruding end being broken off by sledge hammer blows. The chisel nicks are of equal depths, measuring 1⅝ inch at the bottom of the nick for the two pieces, Figs. 4 and 5. But it was found that the annealed piece took more blows and more forcible ones to break it, as is shown by the hammer marks in Figs. 7 and 8. The flattened places are those made by the sledge hammer to produce the fractures, those in Fig. 7 evidencing how much stronger the annealed was than the unannealed piece.

The heights of the various fractures are shown as evidencing that in proportion as the location of the fracture was receded from, and as the metal was worked (either by annealing or forging), the metal improved. It is probable that the crystallization of the metal proceeded more rapidly at the line of original fracture because of the presence of the flaws, which would induce increased vibration at that cross section when in rapid motion.

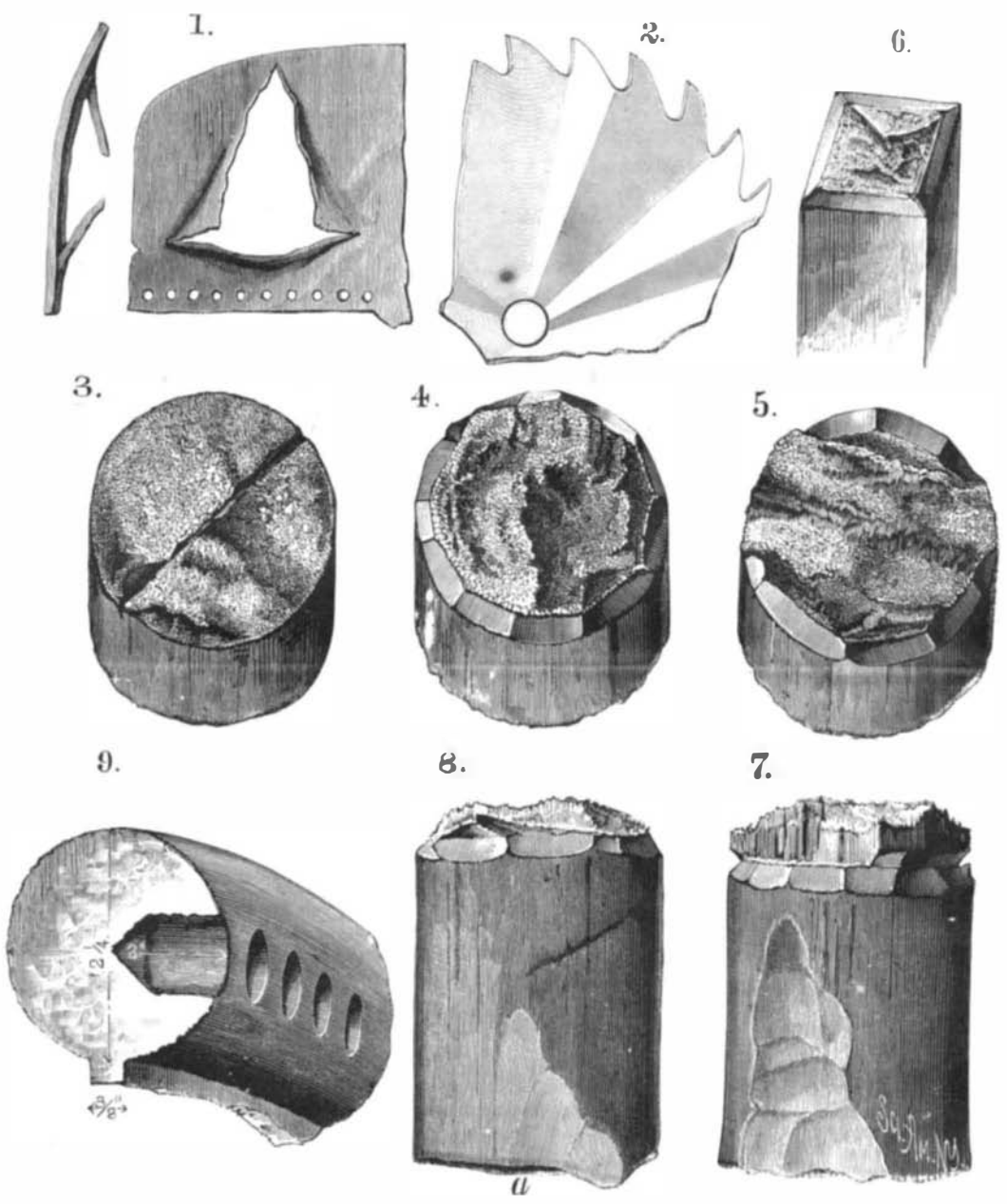
a, in Fig. 8, is a side view of the original fracture to show its shortness.

It is suggested that some of our technical mechanical schools test these pieces of spindle for torsional strength, to see if the order of strength agrees with the apparent order of crystallization and the effect of the reforging. The conclusion appears unquestionable that the shaft broke first, for the following reasons: Had the saw broke it would have simply left the spindle in its bearings with the fly wheel in place. If the fly wheel broke first, it should have left the spindle all right running in its bearings. But as soon as the spindle broke the saw would revolve eccentrically, generating a force sufficient (at the great speed) to cause the breaking of both the fly wheel and the saw, and account for the spindle tearing from the bearings.

The bursting of the fly wheel is plainly due to the holes drilled in it, and it is unaccountable how any mechanic could commit such a blunder as to drill such holes in such a location; their number, and size (as shown in Fig. 10), preclude the idea that they could have been made to balance the wheel, especially as it appears a well-shaped casting, and was a web or plate wheel. In the only other piece of the wheel rim found there are none of these holes, and the fracture occurs in the center of a hole, all pointing to the same conclusion, namely, an unbalanced wheel whose explosion caused all the damage.

It is only proper here to express thanks to Messrs. Potter & Macdougall for their kindness in placing a blacksmith at my disposal, laying other work aside to test the pieces as described in the interest of science, and refusing compensation for the same.

The diameter of the fly wheel being thirty inches, and its revolutions being 2,000 per minute, its velocity was over 500 miles an hour; but in this connection it may be stated that the diameter was estimated by the attendants, who did not know as to its correctness, there being not enough of the wheel left to ascertain its exact diameter, the piece shown in Fig. 10 being the largest remaining. The iron of the wheel looks close-grained and of good texture, the break being around the web close to the rim and across the rim. That at the center of one of these holes is undoubtedly the original fracture, the other fractures occurring subsequently.



FRACTURES CAUSED BY A MYSTERIOUS EXPLOSION.

OWING to the severe competition of Swiss and German factories the manufacturers of St. Etienne, France, are arranging to substitute gas for coal as a source of power for looms and the like. As there are coal mines in the neighborhood of St. Etienne, it is expected that the gas will be cheap, and that by its use the productive power of the machinery will be increased at least fifty per cent.