Steam-Boiler Explosion at Messrs. Cornelius & Baker's Manufactory, Philadelphia—Verdict of the Coroner's Jury.

In accordance with your (Coroner Taylor's) instructions, we, your jurymen, have examined carefully the premises of Messrs. Cornelius & Baker, on Cherry Street, the scene of the late disastrous explosion; have heard the testimony of the witnesses brought before us, and, having exercised our best judgment in the consideration of the case, are now prepared to render our verdict, prefacing it by a statement of the facts as presented to us, and detailing our deductions from all the evidence variously accumulated.

The boilers which exploded were designed* and built by Messrs. Morgan & Orr, of Philadelphia, and had been in use about two and a half years. There were two of these boilers set side by side, but working independently of each other; of these, the one towards the south was built and put in operation a few weeks before the other, which we may call the north boiler. Each of these boilers consisted of three parts, or three cylindrical boilers, placed horizontally one above the other, and called, in the order of their superposition, the mud-drum at the bottom, then the tube-drum, and on top the steam-drum. The mud-drum was back of the grate bars, and was 24 inches in diameter and 6½ feet long. The tube-drum extended over the fire, and was 41 inches in diameter and 10 feet long. The steam-drum was 36 inches in diameter and 14½ feet long. The water line was at the middle of the steam-drum, which part was therefore half full of water: the tube-drum and mud-drum below this were of course, intended to contain water only.

The mud-drum was connected with the tube-drum by one neck 12 inches in diameter and 12 inches long, while the tube-drum was con-

* By this word, the Jury did not mean to say that the boiler was originally designed or devised by Messrs. Morgan & Orr, (for it was in testimony before them that the original design or arrangement was by Mr. Gavitt,) but that it was selected or designated for Messrs. Cornelius & Baker by Messrs. Morgan & Orr. Ed.

nected with the steam-drum by four necks each 12 inches in diameter and 8 inches long.

The tube-drum contained 58 tubes of wrought iron each 3 inches internal diameter, running from end to end; through these the fire passed, the water surrounding them. There was thus left water spaces between the tubes themselves, and between the outer row of tubes and the shell of the boiler of only 1 inch in each case.

The fire from the furnace was made to pass under the tube-drum and over the mud-drum to the back end of the former, then returned through the tubes of the tube-drum to the front of the boiler, and then passed over the upper half of the tube drum and under the steam-drum to the chimney.

Water was supplied to the boilers by a No. 5 Giffard injector, through pipes passing from the front of the boiler to the back of the mud-drums, which they entered at the lowest part. Water was supplied to each boiler separately, and cocks were arranged to control the filling of each boiler independently. There was no water connexion from boiler to boiler other than these feed-pipes, which in practice were not used to connect the boilers, but each one was fed separately.

The steam was taken from the front ends of the steam-drums by cast iron pipes. To each boiler over the pipe was attached a safety-valve, and the steam passed to the engine through a single pipe, but could be controlled by both cocks, so as to enable each boiler to be used independently of the other. To determine the water level, each boiler was supplied with three try-cocks: one at the working water-level—*i.e.* at the centre of the steam-drum—one four inches above and another four inches below this point. There were no other means of observing the water level beside these cocks: and the lowest of them stood nine feet from the floor, and could only be reached by means of a rod or by climbing up to it.

The firm seemed to have placed great reliance upon steam-pressure-gauges, one of which was situated in their office in a conspicuous place, while the other was near the engine: but so far removed from the boilers that it could not be seen by the engine tender when he was at the boilers, the engine and boilers being at least fifty feet apart. Thus the engine tender had no means of judging as to his steam-pressure when working at or near his boilers.

From the evidence presented to us we learn that some three months previous to the explosion, the mud-drum under the south boiler was found to leak in one of its cast iron heads and was consequently removed and sent to Messrs. Morgan & Orr for repairs. But upon examination, they (finding the iron very thin from corrosion) notified Cornelius & Baker of the fact, and the firm ordered a new mud-drum to be put up in place of the old one.

The mud-drums of both boilers were said to have been made from pieces of boilers which had been previously in use for two years, but which were considered to be in good condition, and, in the opinion of the builders, better than new iron. We are surprised that, at the time of the substitution of the new drum, there was no rigid examination into the

condition of the mud-drum under the north boiler, which was also made of old iron, and had been in use nearly as long as the one which had given out.

The mud-drum under the north boiler at the time of the explosion was therefore about the same age, or had been in use about as long as the old mud-drum under the south boiler, and after the explosion was found to be very badly corroded on the inside, the iron in some places being less than one-sixteenth of an inch in thickness; this in places where there seemed to have been no outside rusting of the drum. The outside was also found to be much corroded in parts which had been in contact with the walls.

The engine-tender has been examined, and seems to understand his business, and no testimony has been submitted to us that would in the least degree tend to show any habitual neglect of his duties, but, on the contrary, his character for sobriety and close application to his work seems fully substantiated.

From his testimony, corroborated by that of other witnesses, we learn that on the morning of the explosion he was behindhand with his steam which was not up to its working pressure when the engine was started.

He was not putting any water into the boiler at the time of the explosion, nor for some time before. The only testimony we have of the height of the water at this time is from the engine-tender himself. He states that he had a full supply of water, and that he tried the cocks just before leaving the boiler-room. Other witnesses were in the boiler-room a few minutes previous to the explosion, and had there been any water indicator which could have given a visible indication of the water level, their testimony would have been of the greatest value.

The engine-tender was away from his post at the time of the explosion, and no competent man had been left in his place. The only instructions were to a workman in the stamping-room near-by to watch the steam-gauge, which was in the engine room out of sight of the boilers, as before mentioned, and your jury do not think that the man to whom the direction was given was a competent person to take charge of the boilers.

In the absence of any evidence of gross neglect on the part of the engine tender, and assuming that the water was at its proper height a few minutes before the explosion, and that the steam-pressure was moderate, as was proved by many witnesses, we must direct our attention to the probably weak parts of the boiler, in looking for the cause of its disastrous explosion.

The mud-drum under the north boiler has shown itself to be less than 1-16th of an inch in parts which did not break, and was presumably weaker in parts destroyed by the rupture. No one can maintain for an instant that it was in a fit condition to bear the ordinary working pressure.

We believe that this was the first part to give out, but as the bursting of a mud-drum does not always cause an explosion of the boiler, and as the violent explosion in this case seems to have occurred in the

tube-drum of this north boiler, which was literally torn to pieces, we must infer that, as the water fell, by reason of this primary rupture in the mud-drum, to a dangerous level, the water was driven away from the tubes by excessive ebullition; that thus some of the tubes being bare and unduly heated, the water temporarily driven away returned, and coming upon the heated tubes, caused the explosion.

We believe the explosion of the south boiler to have been the result of injuries inflicted by the bursting of the north boiler.

With regard to the form of the boiler and its liability to explosion, your jury believe, from the weight of the expert evidence brought before them, that this form of boiler is not safe, and that, by excessive firing and even moderately low water, (we mean before the water has fallen so as to uncover any of the tubes,) the water can be driven away from parts of the tubes, laying them bare for a time: and that, upon any slacking of the fire and the return of the water upon the tubes, an undue strain will be brought to bear on the boiler.

We think that the boiler is constructed on erroneous principles, for the following reasons: Granting that the cylindrical form of each part gives strength, the cylinders are materially weakened by the holes made for the connecting necks.

We hold, too, that the mode of applying the heat is entirely wrong. The greatest heat of the fire comes in contact with the under side of the tube-drum at its front end; it then, at a gradually decreasing temperature, passes upward in the system through the tubes, and thus through the very water put in motion by the intense heat at the lower part of the tube-drum, and finally passes away in contact with the steam-drum above. The capacity of water to take up heat from the products of combustion is, as we know, proportional to the difference of temperature in favor of the latter. In other words, water at 80° can take up more heat from products of combustion at 300° , than water at 300° can.

To use the heat, therefore, to the best advantage, the products of combustion should be made so to pass through the boiler system as to bring the gradually cooling gases in contact successively with cooler portions of the water. We express this opinion only to show that we do not think this boiler has any claim for economy to compensate for its complicated form, and we judge that a single cylinder boiler partly filled with tubes, with the water-line in the same cylinder, would be at once safer and more economical than this form of boiler. We are aware that many of these boilers are in use, and we would urge the greatest caution in their management. They may be moderately safe when the boiler capacity is large as compared with the work to be done, but are not safe where the consumption of steam requires heavy firing to keep up the pressure. Living as we do among steam boilers, knowing that in our most crowded thoroughfares they are under the very pavements, it is due to the safety of the community that strict municipal surveillance should be kept over the condition and the structure of the boilers used. We would, therefore, in the strongest terms urge the action of the authorities in reference to the use of steam.

There seems now to be no system of inspection in existence. Any form and any condition of boiler may be put in use, and when an explosion occurs, the fact that so many similar boilers have not exploded shields from blame those who would justly be held accountable for the destruction caused.

Messrs. Cornelius & Baker, are like thousands of others using steam power, not professional engineers; they therefore depend upon the advice of others in regard to all matters connected with their steam generating apparatus. Their responsibility would seem to rest with the choice of advisers and with their close supervision of those under them in responsible positions. We believe that they have in the latter case been careful in selecting an engine tender, and watchful over his actions; we can find no testimony to impeach the sobriety or competency of this engine tender; but we believe he has not made as careful and as frequent examination of the internal condition of the mud-drum as he should have done; but in this he is not singular; we have heard, and are hearing daily since the explosion, of mud-drums giving out in various parts of the city, and the warning has led to an examination of others which, although they have not exploded, are too thin to be safe.

All this points to the necessity of some reform in the laws regulating the use of steam; competent inspectors, free from all political influence, should be in charge of the matter, with power to call on the best engineering talent of the country for advice: and laws should be passed regulating the number and character of danger indicators which should be attached to each boiler as is customary in France and other countries.

For the safety of our citizens it has been found necessary to provide building inspectors, and to pass laws governing the thickness of walls and the arrangement of buildings, but no law is brought to bear upon the regulation of steam power.

The sooner this is done the better for the community at large.

We therefore render the following verdict. That on the 25th of April, 1864, William Bartholomew, Alfred Schaffer, Samuel Davis, Thomas H. Albertson, George Hess, J. L. Snyder, John Porter, and Anthony S. Fry, came to their death by reason of injuries inflicted by the explosion of a steam-boiler in the establishment of Messrs. Cornelius & Baker, Cherry Street, below Ninth, Philadelphia, the primary cause of said explosion being the weakness of a part of the boiler known as the mud-drum.

COLEMAN SELLERS,
R. E. ROGERS,
JOHN W. NYSTROM,

JOHN F. FRAZER,
HENRY MORTON,
SAMUEL J. CRESSWELL.

Why Bees Work in the Dark.

From the London Chemical News, No. 230.

A lifetime might be spent in investigating the mysteries hidden in a bee-hive, and still half of the secrets would be undiscovered. The