

### EXPLOSION OF A PLAIN CYLINDER BOILER IN PHILADELPHIA.

BY S. N. HARTWELL.

The front page cuts illustrate the explosion of boiler No. 3 in the dye works of Gafney & Co., in Kensington, Philadelphia, which occurred during the noon hour, on the 1st day of June, 1881, killing three persons and injuring a number of others. The coroner's sensible and pertinent inquiries into the cause of death brought out the usual variety of opinions of the cause of the primary rupture from which the explosion arose.

#### THE CONSTRUCTION OF THE BOILER

was not new or uncommon, nor was the material or work unusually bad. The shell plates, which did not break, were marked at a fair tensile strength, and the head that did break was of a fair quality of cast iron where the rupture began. The type and principal dimensions are as follows: A plain cylinder, 30 feet long by 36 inches diameter, composed of No. 3 iron plates in nine courses, single riveted; the least observed thickness at the edge of plate was 0.255". The end plates or heads were flat cast iron disks having suitable flanges turned inward, with cored radial holes for the rivets that secured them to the shell plates. Thickness of disks, 1 7/8 inches; flanges, 1 3/8 inches. The pitch or spacing of the rivets was according to accepted American practice. A man-hole was cut in the center of the front head, 12 3/4 by 15 1/2 inches, the form of which appeared to be not an ellipse, but of somewhat larger area. The gasket seat had been planed, but the corresponding seat on the man-hole plate was not planed, though it appeared quite as true as such castings usually are.

The arrangement of the boilers is shown in the engravings, by which it will be seen that two, namely, Nos. 1 and 2, were set over the same furnace, and No. 3 by itself over an adjoining one. The former, called the old boilers, had been in use two years, and the latter, the new boiler, had been working but two months prior to the explosion. Two pair of safety valves, one pair to each system, were fitted as shown, their connecting pipes coming through the wall of the steam dry house under which the boilers were set. The pair of boilers had a pair of 2 1/2 inch, and the single boiler, No. 3, had a pair of similar 2 inch safety valves. The main steam stop valves, by which communication between the boilers and with the heating and drying systems of pipes was regulated, were also in front of the wall, as shown. The steam and water pipes were so arranged that the single boiler could be used alone.

These boilers were insured by the Hartford Steam Boiler Inspection and Insurance Company, and allowed to carry 70 pounds of steam. The usual working pressure appears to have been from 60 to 65 pounds by the gauge, the pressure increasing when the demand for steam was less than the supply, indicating that the safety valves did not fully relieve the boiler. The increase of pressure that might have occurred with all the distributing valves closed is therefore unknown.

The new boiler was inspected on or about the 7th of March, and no doubt the hydrostatic test (about 100 pounds) was applied according to law. The builder swears before the coroner that he applied a cold water test of 115 pounds, and found it all tight, etc.

This boiler, No. 3, was fitted with the usual gauges and other attachments, and fed by an injector, either separately or in common with the other two boilers. The steam was used for boiling dye-stuff and for drying.

The observed phenomena indicate unmistakably that

#### THE EXPLOSION

was due to a pressure a little in excess of the strength of the weakest point of the boiler. The course of the initial ruptures is clearly indicated in the engravings, radiating from the man-hole. The cast-iron head was not compensated for the loss of continuity. There was simply a slight chipping spot just raised above the general inner surface, for convenience in finishing a gasket seat upon the planing machine. The removal of the firm and tenacious skin of the iron by the planer reduced its strength. The slight sustaining power of the pinch on the gasket is an indefinite and variable factor, and a great strain falls upon the margin of the man-hole.

So far as the writer knows, there is no well defined and simple rules for determining the strength of flat disks with man-holes in them. To make this front head equal in strength to the rear one, omitting now all comparison with the strength of the cylindrical portion of the boiler, it seems evident that a rib is necessary around the man-hole of sufficient depth to fully compensate for the removal of so important a part of the disk.

But without a full line of ultimate experiments on the strength of these forms it would be difficult to specify the depth of the rib.

It may be said, and is strongly maintained by some engineers, that the concave form, shown in figure 6, is stronger than the flat; but how these two forms compare in strength when they have equal inward projections, experiment only can determine.

No respectable guess, therefore, can be made at how much internal pressure was required to break this boiler. Either of its heads had less resisting power than the cylindrical portion, on which form plenty of experiments have been made.

The arguments used against the hydrostatic pressure as a test of the strength of unequally heated and complicated boilers, do not so well apply to this case, for this head was in a fairly uniform condition of temperature throughout, so

that unequal tension, except such as might arise from a badly fitted man-hole plate, is hardly admissible. Its strength, if uniformly heated to 350° or 400° Fah., would not differ greatly from its strength when the cold test of 115 pounds was applied. And here are its neighbors, cast from the same pattern apparently, that have held out for two years, while no doubt many of the hundreds of cast iron boiler heads now in use in Philadelphia and elsewhere in America, are no better and have stood longer and heavier strains than those now under consideration.

A defect is noticeable in the circular fracture, as much as 3 or 4 inches long by width of 0 to 1/2 inch, in the middle of the plate and near the lower part, consisting of confluent blow holes; but it is difficult to conceive how the rupture could start at any point in the circle from which lines of fracture should converge toward the manhole so as to break the head as shown. The rupture, no doubt, began almost simultaneously at the inner end of the four radial lines, in which case a defect in the circular line would not affect the weakest point at the margin of the hole.

It is not pleasant to think that a boiler which ought to be able to stand five times the working load would be so capricious as to blow up upon slight provocation. Scully, the fireman, stoutly and persistently denies having wet this head with his hose, although it was sought to be proved that he did so, and it was assigned as a sufficient cause of the breaking of the head.

Many of the steam valves were found to be closed when dug out of the debris; in fact the writer has not seen one that was open when found, but has seen four that were closed, and under such conditions that no amount of swearing by interested witnesses to the contrary would stand as truth.

The diagram, Fig. 5, is a plan of the neighborhood of the explosion. The buildings occupied by Gafney & Co. are (were) located between Martha and Collins sts., the boilers in the lower story of the three story brick building, A, adjoining the one story dye house, E. To the left is the shed building, M, on the roof of which the dyed material was sundried in fine weather. The dye tubs, F, were square wooden vats, heated by direct steam, admitted by branch steam pipes, in each of which was a steam stop valve, controlled by each dyer, according to his requirements. G is the small detached office building of the proprietors. H is the location of the two story dwellings, one of which was badly smashed and took fire, but it was soon extinguished. Beds, cooking stoves, and household utensils in the ruins, were painfully suggestive of the horrors that attend a first-class boiler explosion. The stable, L, was also destroyed by the falling of adjacent walls. The boiler gave out by the bursting of the front cast-iron head, which broke into four quarters, the fracture running from the man-hole radially, as shown in drawing; thence the break continued along the circular base of each quarter of the head, leaving the entire rim or flange outside of its junction with the disk attached to the shell plates. This rim was smashed, as shown in the cuts (Fig. 3), by the fall upon the ground at D, or possibly by contact with some solid object in its flight. On leaving its bed the main portion of the boiler took a direct, nearly horizontal, course in the line of its projected axis, and striking the terrace at the corner of the graperly in front of the dwelling, B, it rose and turned to the left, some 15° or 20°, passing over or in front of a passenger street car, at N, which was about to enter the station house of the Second and Third street horse railroad, shown at C, whence the cars depart at the opposite end on Frankford road. In striking the terrace, the rear head, which was foremost in the flight, was demolished, and the adjoining shell sheet torn and turned inward, as seen at Fig. 3.

The four quarters of the front boiler head were found scattered at various points in the foreground, the lower piece, in which was the feed water opening, was found on removal of a large mass of debris, about twenty-five feet from, and directly in front of its former site. Here also were found a 2 1/2 inch steam pipe (easily distinguishable from the feed water pipe of same size), in which was a stop valve closed; to this pipe was connected several 2 inch branches, and valves, also closed when examined by the writer, before they were touched by any person, after the explosion. Mr. Farran, of the Hartford Steam Boiler Inspection and Insurance Company, observed the same thing, and the attention of bystanders was called to this important fact. Mr. Williams, a member of the coroner's jury, was informed, and the valves shown to him before their removal. That gentleman remarked that other steam valves were also closed when found, notably the one in the pipe connecting this boiler with the others. In fact all steam valves were found closed when taken from the ruins so far as known.

The man-hole crossbar, a pretty heavy one, with its bolt, which engaged with the plate by means of a pocket in the plate, into which the head of the bolt fitted loosely, was detached when the boiler head was broken and its tension relaxed, and it flew to the front, crossing Martha street, to the second door on the cross street, where it struck the brick door jamb. A man was found dead or fatally injured at this point, marked J on the diagram, having been hit by this piece before it struck the brickwork. It made an indentation of a depth indicating that its force was far from being spent upon the body of the man. The man-hole plate itself flew a greater distance in the same direction, said to have been more than two squares, where it lodged on top of a building. This is the longest distance traversed by any

of the pieces. A piece of the rear head bounded from D into Frankford road and landed in front of a boarding saloon where a number of people were taking dinner. This was warm, said to be hot, as well as the main piece of the boiler, which caused steam to arise from the damp manure heap on which it landed. A rumor gained circulation that the boiler flew through the air like a glowing meteor, red hot, but no evidence of an extraordinary temperature was found on any part of the fragments.

Some search was made for the steam gauge that was said to have been attached to this boiler, but its condition could have given no clew to the pressure at the time of the explosion, and it could not have contradicted other phenomena.

The fact that the plate and crossbar of the man-hole of the broken head were shot with violence as from a gun, indicates that the head, weak though it is acknowledged to be, resisted considerable pressure, and at last gave way with a snap. This wreck has been studied from a disinterested standpoint, and the

#### CONCLUSION IS

that the flow of steam from this boiler was stopped or obstructed by the defective condition of the safety valves, the distributing valves having been incidentally closed at the noon hour, by the several workmen who were in the habit of handling them according to their several demands for steam, and that the pressure gradually increased, the fire being active, till the boiler gave way at its weakest point, which was manifestly the front head.

#### RECENT DECISIONS RELATING TO PATENTS.

##### United States Circuit Court.—Eastern District of Wisconsin.

ROWELL *et al.* vs. LINDSAY *et al.*—PATENT CULTIVATOR.

Dyer, J.:

1. A patent for a combination of known parts is not infringed by the use of any number of the parts less than the whole.

2. Where some of the parts of a combination are new and others old, and where the new parts are distinctly claimed as inventions, the appropriation of a part which is new is an infringement.

3. Where a patentee claims as his invention only the combination which he describes, the separate constituent parts of such combination are to be regarded as old or common and public.

4. A combination must be maintained as an entirety. If one of the elements is given up the thing claimed disappears. The different parts may perform more or less important functions, but each and all are essential to make the thing which the patentee has claimed as his invention.

5. A combination is not infringed by the substitution of a new element or of one that performs a substantially different function, or by the substitution of an old element not known at the date of a patent as a proper substitute for the omitted ingredient, or by a new combination of the existing elements of the patented combination.

6. A patent for an improvement in cultivators claimed the combination of a slotted beam, shank, brace-bar, and bolt, when the parts were constructed and arranged to operate as and for the purposes specified: *Held*, that such patent was not infringed by a machine which contained such slotted beam, shank, and bolt, but did not include the brace-bar or any mechanical equivalent for the same.

##### United States Circuit Court.—District of Massachusetts.

PENNINGTON *et al.* vs. KING.—PATENT SPRINKLER.

Lowell, J.:

1. Letters patent No. 203,069, granted to Pennington and Beggs, April 30, 1878, for an improvement in lawn sprinklers, which describes, *inter alia*, "the rose C, provided with a number of discharge holes, *d*, at the outer circumference, which holes are placed in a plane passing preferably through the hole, B, but bored at a certain angle of inclination through the rose, so as to produce the revolving motion of the same by the forcible discharge of the water through the holes," is not anticipated by sprinklers having radial arms which are caused to revolve by the force of the water passing out through one and the same side of each arm, nor by sprinklers wherein the chamber or rose is caused to revolve by forcing the water through perforations in the same side of ridges formed on its convex surface.

2. In the absence of other evidence, a patented invention will be held to date from the time of filing the application, and not from the time of the grant.

#### Polar Observation.

It will be remembered that the ill-fated *Guivre* left at Lady Franklin Bay a number of men to form a permanent colony for arctic exploration and meteorological and magnetic observation.

The Government has just chartered the Newfoundland sealing steamer *Proteus* to convey thither the relieving party under Lieutenant Greeley. The *Proteus* is described as nearly new, stoutly built for encounters with ice, of about 800 tons capacity, and with engines of 300 effective horse power.

#### Proposed Statue to Robert Fulton.

A monument to Robert Fulton is talked off, to stand on a prominence on Polipe's Island, situated in the Hudson River at the southern end of Newburg Bay. A heroic figure of Fulton will surmount the monument.